Vol. 9, No. 3 March 1999

GSA TODAY

A Publication of the Geological Society of America

INSIDE

A New Magnetic View of Alaska

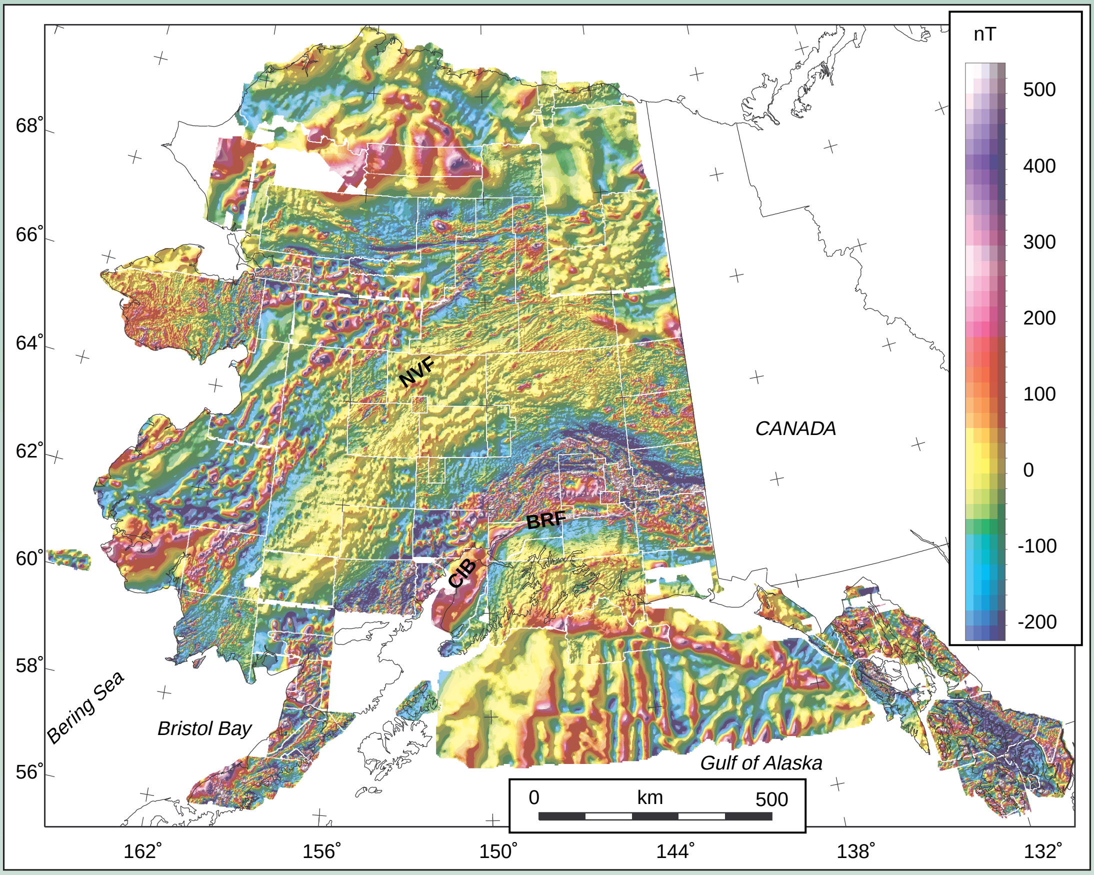


Figure 1. Composite aeromagnetic map of Alaska that depicts total field magnetic data values (International Geomagnetic Reference Field has been removed) from a compilation of 85 separate surveys and two grids. Thin data gaps mark the boundaries between data sets. CIB—Cook Inlet Basin, NVF—Nowitna volcanic field, BRF—Border Ranges fault. Data set can be downloaded from the Web at: ftp://greenwood.cr.usgs.gov/ pubs/open-file-reports/ofr-97-0520/data. A 1:2,500,000 plot file of this data set is available at: ftp://greenwood.cr.usgs.gov/pubs/open-file-reports/ofr-97-0520/plots.

Richard W. Saltus, U.S. Geological Survey, Mail Stop 964, Denver, CO 80225-0046
Travis L. Hudson, Applied Geology, P.O. Box 1428, Sequim, WA 98382-1428
Gerald G. Connard, Northwest Geophysical Associates, P.O. Box 1063, Corvallis, OR 97339-1063

ABSTRACT

A new, publicly available aeromagnetic data compilation spanning Alaska enables analysis of the regional crustal character of this tectonically diverse and poorly understood part of the North American Cordillera. The merged data were upward-continued by 10 km (mathematically smoothed without assumptions about sources) to enhance crustal-scale magnetic features and facilitate tectonic analysis. This analysis reveals a basic threefold magnetic character: (1) a southern region with arcuate magnetic domains closely tied to tectonostratigraphic elements, (2) a magnetically neutral interior region punctuated locally by intermediate and deep magnetic highs representing a complex history, and (3) a magnetically subdued northern region that includes a large deep magnetic high. Our tectonic view of the data supports interpretations that Paleozoic extension and continental rift basins played a significant role in the tectonic development of northern and interior Alaska. Accretion of oceanic and continental margin terranes could be restricted to the southern region. The new magnetic view of Alaska can be compared and contrasted with other Pacific margin regions where convergent margin and accretionary tectonic processes are important.

INTRODUCTION

Alaska, an important part of the North American Cordillera, is a type example for the nature and significance of accretionary tectonics along a convergent continental margin (e.g., Coney and Jones, 1985; Plafker and Berg, 1994). The prevailing tectonic interpretation is that this vast part of North America has had a long history of accretion of diverse tectonostratigraphic terranes. These terranes are thought to represent a wide variety of oceanic, arc, and continental margin assemblages. They form an amalgamated, commonly 30-km-thick crust throughout

Magnetic View *continued on p. 2*

GSA TODAY March
Vol. 9, No. 3 1999

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

SUBSCRIPTIONS for 1999 calendar year: Society Members: *GSA Today* is provided as part of membership dues. Contact Membership Services at (800) 472-1988, (303) 447-2020 or member@geosociety.org for membership information. Nonmembers & Institutions: Free with paid subscription to both *GSA Bulletin* and *Geology,* otherwise $50 for U.S., Canada, and Mexico; $60 elsewhere. Contact Subscription Services. Single copies may be requested from Publication Sales. Also available on an annual CD-ROM, (together with *GSA Bulletin, Geology,* GSA Data Repository, and an Electronic Retrospective Index to journal articles from 1972); $89 to GSA Members, others call GSA Subscription Services for prices and details. Claims: For nonreceipt or for damaged copies, members contact Membership Services; all others contact Subscription Services. Claims are honored for one year; please allow sufficient delivery time for overseas copies, up to six months.

STAFF: Prepared from contributions from the GSA staff and membership.
Executive Director: *Donald M. Davidson, Jr.*
Science Editors: *Suzanne M. Kay, Department of Geological Sciences, Cornell University, Ithaca, NY 14853; Molly F. Miller, Department of Geology, Box 117-B, Vanderbilt University, Nashville, TN 37235*
Forum Editor: *Bruce F. Molnia, U.S. Geological Survey, MS 917, National Center, Reston, VA 22092*
Director of Publications: *Peggy S. Lehr*
Managing Editor: *Faith Rogers*
Assistant Editor: *Vanessa Carney*
Production Manager: *Jon Olsen*
Production Editor and Coordinator: *Joan E. Manly*
Graphics Production: *Joan E. Manly, Leatha L. Flowers*

Issues of this publication are available as electronic Acrobat files for free download from GSA's Web Site, http://www.geosociety.org. They can be viewed and printed on various personal computer operating systems: MSDOS, MSWindows, Macintosh, and Unix, using the appropriate Acrobat reader. Readers are available, free, from Adobe Corporation: http://www.adobe.com/acrobat/readstep.html.

This publication is included on GSA's annual CD-ROM, *GSA Journals on Compact Disc.* Call GSA Publication Sales for details.

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

50% Total Recoverd Fiber
10% Postconsumer

IN THIS ISSUE

Memorial Preprints

The following memorial preprints are now available, free of charge, by writing to GSA, P.O. Box 9140, Boulder, CO 80301-9140.

Louis DeGoes
Albert L. Washburn, Jerry Brown, George A. Kiersch, James T. Neal, Troy L. Péwé

Peter Dehlinger
Vernon F. Cormier

Gilbert Howry Espenshade
Douglas W. Rankin and Avery Ala Drake, Jr.

Jacob E. "Jack" Gair
John F. Slack and William F. Cannon

Herbert E. Hawkes, Jr.
Arthur W. Rose

Samuel J. Kozak
Frederick L. Schwab

Henno Martin
Klaus Weber

Preston McGrain
Garland R. Dever, Jr.

Benjamin M. Page
Darrel S. Cowan

Kenneth A. Sargent
Paul L. Williams

Caswell Silver
Nolan Ashburn

Magnetic View *continued from p. 1*

interior and southern Alaska. The diversity of tectonostratigraphic elements suggests a complicated crustal basement that is covered by Mesozoic and Cenozoic sedimentary basins over much of Alaska. A new regional magnetic compilation (Fig. 1) provides an independent means for examining the character of this crust, even where younger sedimentary cover is extensive (Fig. 2). This paper presents this new magnetic compilation, explains how these data were compiled and processed to emphasize crustal-scale magnetic character, and illustrates how these data can be used to constrain regional geologic and tectonic interpretations.

Previous workers have examined regional aeromagnetic data based on older analog and digital compilations for parts of Alaska. The focus of these studies has been primarily on interpretation of shallow crustal features. For example, Griscom and Case (1983) discussed magnetic anomalies south of the Denali fault system; Cady (1989, 1991) and Saltus et al. (1997) interpreted magnetic and gravity data in northern and central Alaska. In contrast to these studies, we take a more regional and deeper view of the magnetic data.

Aeromagnetic surveys are generally flown over small regions and must be stitched together to create data sets large enough for deep characterization of the crust. In this study, a robust digital filtering scheme was applied to merged aeromagnetic data to separate the magnetic features caused by shallow (thin) crustal sources from those caused by deep (thick) sources. The term "deep" does not require that tops of these sources be deeply buried, but rather that the overall depth extent (thickness) of the sources is significant on a crustal scale.

MAKING A MAGNETIC QUILT

The merging of the aeromagnetic data sets was the first step. The new magnetic compilation (Saltus and Simmons, 1997) combines 85 aeromagnetic surveys and two previously compiled grids. The surveys were flown between 1945 and 1990 and vary in flight-line spacing and elevation. Data collected before about 1972 were digitized from maps or flight-line plots; newer data were mostly processed from digital flight-line information. The data total to about 1 million-line-km

In Memoriam

Lawrence W. Chasteen
La Canada, California
October 10, 1998

Reuben C. Newcomb
Molalla, Oregon
May 31, 1998

Desmond A. Pretorius
Pinegowrie, South Africa
September 23, 1998

Gilbert O. Raasch
Champaign, Illinois
January 20, 1998

Daniel A. Sundeen
Hattiesburg, Mississippi
January 1999

GSA ON THE WEB

Visit the GSA Web Site at http://www.geosociety.org.
From our home page you can link to many information resources.

New Web Page Offers Variety in Programs, Policy

Looking for the latest on sustainable energy development? How about climate change, ecosystem management, or Congressional views on science and technology policy? Care to be a mentor or get involved with GSA Connect? The Institute for Environmental Education is pleased to announce the unveiling of our new Science and Society Web page, located within the GSA Web site. Science and Society will bring you program information, jobs and opportunities, meetings, and events, government and policy reviews, hot topics in integrated science and the environment, and much, much more. We encourage you to browse, surf, and send us your comments. It is important to us that you like what you see—so please don't be shy! The Science and Society Web page is an ongoing evolutionary process, so be sure to check back on a continuing basis.

and would cost at least $6 million to reacquire.

Two digital data grids were produced with a 1-km grid spacing: A composite grid (Fig. 1) with all surveys at their original resolution and a merged grid with all surveys mathematically continued to a common flight height of 300 m above ground. Data processing was performed by Northwest Geophysical Associates, Inc. and incorporates a previous compilation for interior Alaska (Meyer and Saltus, 1995) processed by Paterson, Grant, and Watson, Ltd.

The data values are total field amplitude (in nanoteslas, nT) of Earth's magnetic field, with the long-wavelength core field (the International Geomagnetic Reference Field) removed. The variation in values reflects variations in the amount and type of magnetic minerals—chiefly magnetite (Fe_3O_4) and its solid solutions with ulvospinel (Fe_2TiO_4)—in the crust (Blakely and Connard, 1989; Reynolds et al., 1990; Blakely, 1995). To eliminate long-wavelength errors resulting from the data merging process, we replaced the longest wavelengths (>600 km) with comparable wavelengths of a satellite-derived Earth's magnetic field model to spherical harmonic order 65 (Arkani-Hamed and Dyment, 1996).

The aeromagnetic data grids as well as plot files and other information about the compilations are available via the World Wide Web (http://greenwood.cr.usgs.gov/pub/open-file-reports/ofr-97-0520/alaskamag.html).

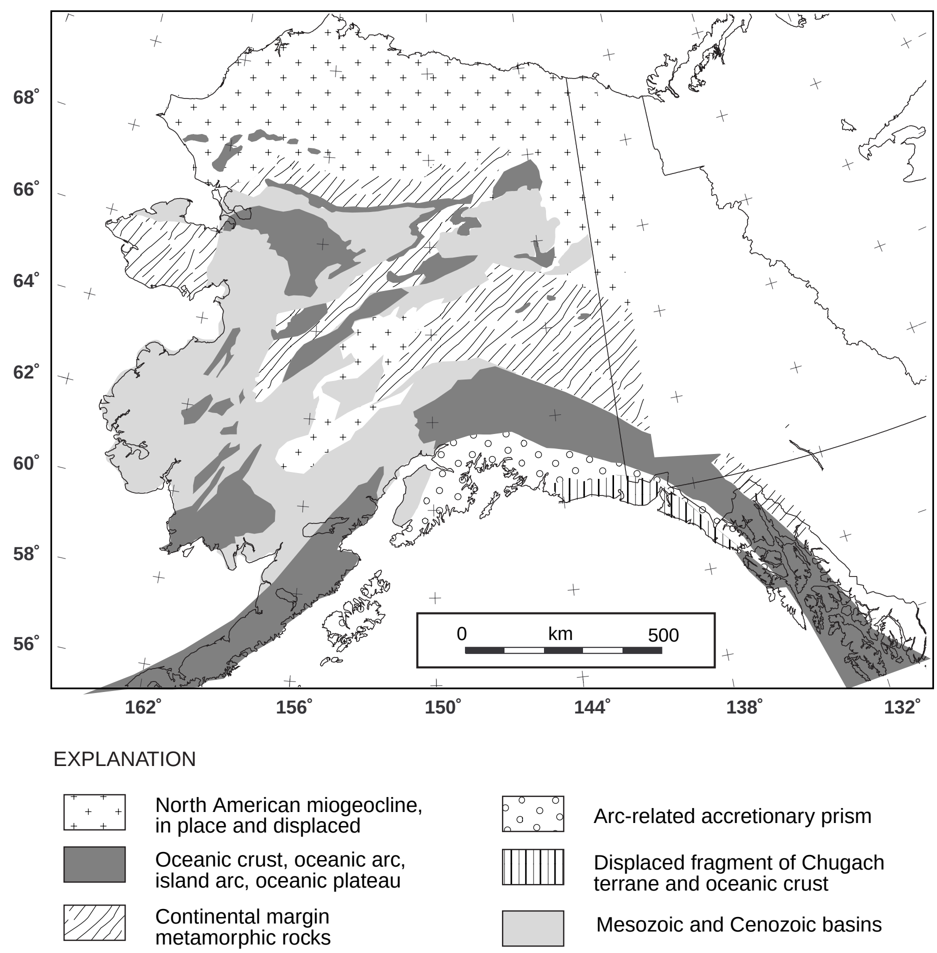


Figure 2. Tectonic affinity of selected terranes in Alaska (generalized from Plafker and Berg, 1994, Fig. 1). The diversity and mixing of genetic origins implies crustal heterogeneity, particularly in interior Alaska. Much of interior and southwestern Alaska is covered by Mesozoic and Cenozoic basins.

WORKING WITH REGIONAL MAGNETIC DATA

The short-wavelength features that are visible in Figure 1, but not in Figure 3, are the part of the magnetic field most commonly used in local-scale geologic analysis. For example, contrasts in the short-wavelength data help define depth of sedimentary basins, distribution of certain igneous rocks, and locations of faults or other geologic boundaries. Examples at the scale of Figure 1 include the Cook Inlet basin, the Nowitna volcanic field, and the Border Ranges fault. Many of these magnetic features, which can be very important for understanding surface and near-surface geologic relationships,

Magnetic View *continued on p. 4*

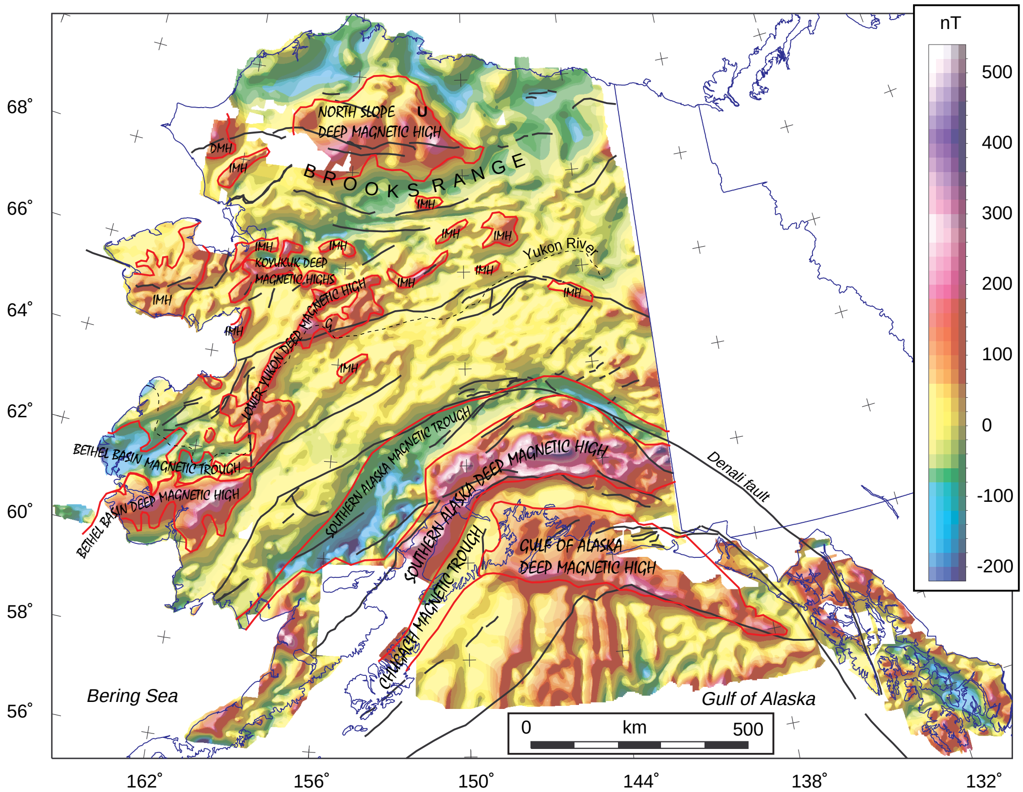


Figure 3. Deep magnetic feature map that depicts a 10 km upward continuation of merged aeromagnetic data. Upward continuation is a mathematically stable way to smooth the data set without making assumptions about magnetic sources (Blakely, 1995). Black lines mark major faults of Alaska. Red lines show boundaries between the magnetic domains discussed in the text (Table 1). U—Umiat.

Magnetic View *continued from p. 3*

are not crustal-scale components of the region (e.g., Cretaceous and Tertiary plutons).

Although the mathematics of upward continuation has long been known, we feel it is underutilized in regional magnetic interpretation. We use this simple and robust filter (e.g., Blakely, 1995) to separate the magnetic expression of shallow and deep crustal magnetic features. Generally, a magnetic feature caused by a deep (thick) distribution of magnetic minerals will have a broader (longer wavelength) shape than those caused by a shallow (thin) distribution. We found that upward continuation to 10 km (Fig. 3) and 40 km proved most useful for delineation of domains in Alaska, but results may vary by tectonic setting and overall crustal thickness. A 10 km upward continuation severely damps wavelengths smaller than 25 km. A shallow magnetic domain map, particularly useful for detailed geologic and geophysical analysis, can be produced by subtracting the upward continued data grid from the merged aeromagnetic data grid.

Just as every magnet has a positive and negative pole, all magnetic source bodies are dipolar; they cause magnetic features that consist of both positive and negative parts. For most regional-scale magnetic sources, the shallower positive pole causes a focused high, whereas the deeper negative pole causes an associated broad low. We have mostly delineated the positive parts of features; exceptions include the very large magnetic troughs in southern Alaska.

Crustal-scale features in aeromagnetic data compilations may contain significant errors as a result of data adjustments made during the merging process. We address this problem by adjusting the longest wavelengths in our compilations to agree with a satellite magnetic model of Earth's field (Arkani-Hamed and Dyment, 1996). However, as there is a gap in resolution between the size of the typical aeromagnetic survey and the satellite models, it is important to check regional magnetic features for correlation with survey boundaries.

To interpret crustal affinity from large-scale magnetic features, we assume that bulk crustal-scale magnetization is primarily dependent on the total content of iron in the crust. Thus, we expect a typical bulk increase in magnetization from sialic to mafic crust. This is a first-order simplification of the complex field of rock magnetism (for more detail see Reynolds et al., 1990). Of concern is the possibility that patterns of magnetization, particularly in interior Alaska, are related to metamorphic alteration of the composite terranes. Metamorphism can either produce or destroy magnetic minerals, but usually diminishes magnetization of igneous rocks (Reynolds et al., 1990). The presence of crustal-scale magnetic highs in interior Alaska shows that wholesale destruction of magnetization has not occurred there, but metamorphism may still have had an important effect.

CRUSTAL-SCALE MAGNETIC DOMAINS OF ALASKA

There are many crustal-scale magnetic domains in Alaska (Fig. 3, Table 1). Some have magnetic highs that do not persist to depth if the data are upward continued to 40 km (intermediate highs in Table 1, labeled IMH in Figure 3). Some have strong spatial correlation with tectonostratigraphic terranes; others don't (Table 1).

At the broadest scale, Alaska may be subdivided into three magnetic regions: (1) a southern region that spans much of the area south of the Denali fault system and is composed of a series of arcuate magnetic domains (both highs and lows) with strong tectonostratigraphic ties (Table 1) that parallel the continental margin; (2) an interior region extending from Canada west to the Bering Sea, that contains a few local magnetic highs with mixed tectonostratigraphic ties interspersed in a broad expanse of neutral magnetic character; and (3) a northern region that includes the Brooks Range and North Slope and is dominated by a subdued magnetic character but is also host to a large magnetic high. Within these broad divisions, both long- and short-wavelength magnetic domains reflect features of tectonic and geologic significance. In a general way, the southern region mainly reflects continental margin and oceanic

TABLE 1. CHARACTERISTICS OF SELECTED ALASKA MAGNETIC DOMAINS

Name	Size (km)	Description	Tectonostratigraphic Setting
Magnetic Domains With Strong Tectonostratigraphic Ties			
Pacific Ocean domain	>900 × >300	Distinctive north-south high and low stripes	Oceanic crust of Pacific Ocean basin
Gulf of Alaska high	700 × 200	Broad 100 nT magnetic high	Accreted oceanic crust and continental margin sediments of Prince William and Yakutat terranes
Chugach trough	>1000 × 100	Arcuate magnetic low	Accreted Upper Cretaceous flysch of Chugach Terrane
S. Alaska high	>1400 × 200	Arcuate zone of large-amplitude magnetic highs	Jurassic arc-related rocks and their basement, Wrangellia composite terrane
S. Alaska trough	>1200 × 100	Arcuate magnetic low	Collapsed Mesozoic flysch basin of Hagemeister subterrane (Decker et al., 1994), Kahiltna terrane (Nokleberg et al., 1994), and Gravina-Nutzotin belt (Berg et al., 1972)
Intermediate highs	<100 × <50	Isolated highs that do not persist when data are upward continued to 40 km	Mainly allochthonous mafic rocks of the Oceanic composite terrane
North Slope high	400 × 200	Broad magnetic high with superimposed north-south high bands; magnetic data gap prevents evaluation of the western continuity of this domain	Coincides with thick parts of the Ellesmerian section in the Umiat basin; Paleozoic continental rift?
Magnetic Domains Without Strong Tectonostratigraphic Ties			
Bethel Basin high	300 × 150	Broad 200 nT magnetic high	Area of extensive Quaternary cover rocks; oceanic or continental rift?
Bethel Basin trough	300 × 100	Broad >100 nT magnetic low	Area of extensive Quaternary cover rocks; sialic continental crust?
Lower Yukon high	500 × <100	Northeast- trending group of narrow magnetic highs	Most closely coincides with Cretaceous and Tertiary igneous rocks
Koyukuk highs	250 × 50	Irregularly circular group of magnetic highs	Does not closely coincide with surface geology; oceanic arc or continental rift?

Note: Terrane nomenclature follows Plafker and Berg (1994) unless otherwise indicated.

rocks, the interior region reflects crystalline sialic rocks, and the northern region reflects thick sedimentary rock sequences. The crustal-scale magnetic domains of these three large regions, and the relations of magnetic domains to defined tectonostratigraphic terranes within them, have implications for understanding convergent continental processes and the tectonic evolution of Alaska.

Southern Region

The southern region is magnetically distinct from other parts of Alaska. There, strong magnetic highs and lows are continuous high-amplitude features that extend for over 1000 km along strike and have strong tectonostratigraphic ties (Table 1). Examination of offshore magnetic data (Godson, 1994) indicates that the southern Alaska deep magnetic high and flanking troughs continue westward to the Bering Sea shelf edge (also see Worrall, 1991, Fig. 15C). Combining these extensions with the southeasterly extension seen in Figure 3 doubles the length of these features. The coupled character of the very long and arcuate southern Alaska deep magnetic high (arc-related) and the adjoining magnetic trough (deformed flysch belt) to the north suggests tectonic links between them.

The southern region magnetic domains are strongly tied to convergent margin tectonostratigraphic terranes that include arc systems, deformed flysch belts, and accreted oceanic rocks (Fig. 2, Table 1). The characteristic magnetic features are large, elongate, vertically and horizontally continuous, fault-bounded highs flanked by similarly extensive lows. As this region is a type example of convergent margin processes, this crustal magnetic character could be expected along similar margins elsewhere.

Northern Region

The overall magnetic character of the northern region reflects the thick, weakly magnetic sedimentary rocks of this important petroleum province. Also present is the North Slope deep magnetic high, the largest individual onshore domain of intense magnetic highs outside of the southern Alaska region.

The sources for the North Slope deep magnetic high are buried by at least 10 km of sediments. This cover includes an Ellesmerian (Mississippian to Early Cretaceous) section that is over 4 km thick in the Umiat basin. The early Ellesmerian (Upper Devonian? and Mississippian) sediments include a nonmarine coal-bearing section up to 3 km thick (Eo-Ellismerian section of Grantz and May, 1988; Grantz et al., 1994) that was deposited in sags and half grabens (Kirschner and Rycerski, 1988). A similar early Ellesmerian section could be present in the Hanna trough, 150 km west of the North Slope in the Chukchi Sea (Grantz and May, 1988) where an analogous magnetic high occurs (Godson, 1994). Kelly and Brosge (1995) argued that Late Devonian depocenters, produced by wrench faulting or rifting are also important elements of the Brooks Range. As such, a Late Devonian to Early Mississippian extensional tectonic setting seems well established.

The deep magnetic sources in the Umiat basin area are likely to be basalt and related mafic intrusives. These mafic rocks could be either pre–Late Devonian in age or associated with the Late Devonian extension responsible for the development of the Umiat basin. If these persistent magnetic highs are related to the Umiat basin, extension could have significantly thinned the pre-Devonian crust or replaced it with mafic (oceanic) crust. The Umiat basin could be a largely undeformed example of a continental rift basin with extensive basaltic magmatism that formed in the Devonian and continued as a significant regional depocenter into the Jurassic.

Interior Region

The interior region is a broad expanse of neutral magnetic character containing local and irregular intermediate-depth and deep magnetic highs with generally poor tectonostratigraphic ties. A key to tectonic interpretation of these highs is whether the region has a broadly oceanic (like the southern region) or continental (like the

Magnetic View *continued on p. 6*

Magnetic View *continued from p. 5*

northern region) crustal character. An oceanic crustal character is consistent with the view of Plafker and Berg (1994; Fig. 1) that this part of Alaska is composed of accreted assemblages from the ancestral Kobuk Sea (Plafker, 1990) or Angayucham Ocean (Moore et al., 1994). A continental character is consistent with a collapsed continental-rift interpretation (Gemuts et al., 1983; Dover, 1994).

The mostly neutral magnetic character of the interior region compares with the subdued magnetic background of the northern region, as would be expected for a sialic crust. Such a signature is consistent with the widespread occurrence of crystalline and supracrustal rocks in interior Alaska (e.g., the Central composite terrane, Ruby terrane, Kilbuck terrane, Idono Complex, and Yukon composite terrane; Plafker and Berg, 1994).

In a continental framework, the various magnetic highs of the interior region could reflect collapsed fragments of an ancient rift basin analogous to the Umiat basin on the North Slope. Such fragments would be long-standing crustal elements that provided loci for later episodes of extension (Miller and Hudson, 1991), or Cretaceous and Tertiary magmatism. In these cases, the magnetic sources in these domains would be composite features with long and complicated Phanerozoic histories complicating their present-day magnetic character. This interpretation is consistent with the view (Dover, 1994) that many of the Devonian to Jurassic mafic igneous rocks and related basinal sediments of interior Alaska are best interpreted as rift-related sequences with ties to substrate and peripheral geologic elements; perhaps they do not represent highly allochthonous, far-traveled oceanic elements.

CONCLUSIONS

Regional aeromagnetic compilations provide independent three-dimensional synthesis of regional crustal character and recently developed regional satellite magnetic models for the Earth can help to validate the longest wavelengths in these compilations. Modern digital compilations offer the opportunity to apply filters, such as upward continuation, for selective enhancement of features related to various depths and scales of geological investigation.

The new compilation of aeromagnetic data for Alaska presented here provides a view of the major crustal character across this large and complex part of the North American Cordillera. The focus of this paper has been on the long-wavelength data because of their important implications for interpreting the tectonic evolution of Alaska. The long-wavelength data have directed us toward the view that much of Alaska is underlain by sialic crust and that Paleozoic extension has played a significant role in the development of continental rift basins in Alaska. The best examples of convergent margin and ancestral Pacific Ocean rocks seem to be restricted to southern Alaska.

The value of these magnetic data and this compilation will be realized when many workers critically evaluate the data and incorporate them into their syntheses and interpretations. We invite everyone to take advantage of the data for their studies—we are confident that there is much to learn from them.

ACKNOWLEDGMENTS

Esther Castellanos (Digimap), Pat Hill (USGS), and Stewart Racey (National Geophysical Data Center, NOAA) supplied important technical assistance for merging the aeromagnetic data. John Meyer, Jr. (State of Alaska, Division of Oil and Gas) provided support for the interior Alaska magnetic compilation. This work benefited from detailed comments and reviews by Dave Campbell, John Cady, Andrew Griscom, Tom Moore, Jack Reed, Gary Winkler, Rich Reynolds, Wes Wallace, and Terry Pavlis.

REFERENCES CITED

Arkani-Hamed, J., and Dyment, J., 1996, Magnetic potential and magnetization contrasts of Earth's lithosphere: Journal of Geophysical Research, v. 101, p. 11,401–11,425.

Berg, H. C., Jones, D. L., and Richter, D. H., 1972, Gravina-Nutzotin belt—Tectonic significance of an upper Mesozoic sedimentary and volcanic sequence in southern and southeastern Alaska, *in* Geological Survey research 1972: U.S. Geological Survey Professional Paper 800-D, p. D1–D24.

Blakely, R. J., 1995, Potential theory in gravity and magnetic applications: New York, Cambridge University Press, 441 p.

Blakely, R. J., and Connard, G. G., 1989, Crustal studies using magnetic data, *in* Pakiser, L. C., and Mooney, W. D., eds., Geophysical framework of the continental United States: Geological Society of America Memoir 172, p. 45–60.

Cady, J. W., 1989, Geologic implications of topographic, gravity, and aeromagnetic data in the northern Yukon-Koyukuk province and its borderlands, Alaska: Journal of Geophysical Research, v. 94, p. 15,821–15,841.

Cady, J. W., 1991, Angayucham and Tozitna geophysical domains—Geophysical and geochemical ties between parts of the Angayucham and Tozitna terranes, northern Alaska [abs.]: Eos (Transactions, American Geophysical Union), v. 72, p. 296.

Coney, P. J., and Jones, D. L., 1985, Accretion tectonics and crustal structure in Alaska: Tectonophysics, v. 119, p. 265–283.

Decker, John, Bergman, S. C., Blodgett, R. B., Box, S. E., Bundzten, T. K., Clough, J. G., Coonrad, W. L., Gilbert, W. G., Miller, M. L., Murphy, J. M., Robinson, M. S., and Wallace, W. K., 1994, Geology of southwestern Alaska, *in* Plafker, G., and Berg, H. C. eds., The geology of Alaska: Boulder, Colorado, Geological Society of America, Geology of North America, v. G-1, p. 285–310.

Dover, J. H., 1994, Geology of part of east-central Alaska, *in* Plafker, G., and Berg, H. C., eds., The geology of Alaska: Boulder, Colorado, Geological Society of America, Geology of North America, v. G-1, p. 153–204.

Gemuts, I., Puchner, C. C., and Steffel, C. I., 1983, Regional geology and tectonic history of western Alaska, *in* Proceedings of the 1982 Symposium on Western Alaska Geology and Resource Potential: Alaska Geological Society, v. 3, p. 67–85.

Godson, R. H., 1994, Composite magnetic anomaly map of Alaska and adjacent offshore areas, *in* Plafker, G., and Berg, H. C., eds., The geology of Alaska: Boulder, Colorado, Geological Society of America, Geology of North America, v. G-1, pl. 10, scale 1:2,500,000.

Grantz, A., and May, S. D., 1988, Regional geology and petroleum potential of the United States Chukchi shelf north of Point Hope, *in* Gryc, G., ed., Geology and exploration of the National Petroleum Reserve in Alaska, 1974 to 1982: U.S. Geological Survey Professional Paper 1399, p. 209–229.

Grantz, A., May, S. D., and Hart, P. E., 1994, Geology of the Arctic continental margin of Alaska, *in* Plafker, G., and Berg, H. C., eds., The geology of Alaska: Boulder, Colorado, Geological Society of America, Geology of North America, v. G-1, p. 17–48.

Griscom, Andrew, and Case, J. E., 1983, Magnetic expression of geologic terranes in southern Alaska: Geophysics, v. 48, p. 444–445.

Kelley, J. S., and Brosge, W. P., 1995, Geologic framework of a transect of the central Brooks Range; regional relations and an alternative to the Endicott Mountains allochthon: American Association of Petroleum Geologists Bulletin, v. 79, p. 1087–1116.

Kirschner, C. E., and Rycerski, B. A., 1988, Petroleum potential of representative stratigraphic and structural elements in the National Petroleum Reserve in Alaska, *in* Gryc, G., ed., Geology and exploration of the National Petroleum Reserve in Alaska, 1974 to 1982: U.S. Geological Survey Professional Paper 1399, p. 191–208.

Meyer, J. F., Jr., and Saltus, R. W., 1995, Merged aeromagnetic map of interior Alaska: U.S. Geological Survey Map GP-1014, scale 1:500,000, 2 sheets.

Miller, E. L., and Hudson, T. L., 1991, Mid-Cretaceous extensional fragmentation of a Jurassic–Early Cretaceous compressional orogen, Alaska: Tectonics, v. 10, p. 781–796.

Moore, T. E., Wallace, W. K., Bird, K. J. H., Karl, S. M., Mull, C. G., and Dillon, J. T., 1994, Geology of northern Alaska, *in* Plafker, G., and Berg, H. C., eds., The geology of Alaska: Boulder, Colorado, Geological Society of America, Geology of North America, v. G-1, p. 49–140.

Nokleberg, W. J., Plafker, George, and Wilson, F. H., 1994, Geology of south-central Alaska, *in* Plafker, G., and Berg, H. C., eds., The geology of Alaska: Boulder, Colorado, Geological Society of America, Geology of North America, v. G-1, p. 311–366.

Plafker, George, 1990, Regional geology and tectonic evolution of Alaska and adjacent parts of the northeast Pacific Ocean margin, *in* Proceedings of the Pacific Rim Congress 90: Queensland, Australia, Australasian Institute of Mining and Metallurgy, p. 841–853.

Plafker, George, and Berg, H. C., 1994, Overview of the geology and tectonic evolution of Alaska, *in* Plafker, G., and Berg, H. C., eds., The geology of Alaska: Boulder, Colorado, Geological Society of America, Geology of North America, v. G-1, p. 989–1021.

Reynolds, R. L., Rosenbaum, J. G., Hudson, M. R., and Fishman, N. S., 1990, Rock magnetism, the distribution of magnetic minerals in the Earth's crust, and aeromagnetic anomalies, *in* Hanna, W. F., ed., Geologic applications of modern aeromagnetic surveys: U.S. Geological Survey Bulletin 1924, p. 24–45.

Saltus, R. W., and Simmons, G. C., 1997, Composite and merged aeromagnetic data for Alaska: A Web site for distribution of gridded data and plot files: U.S. Geological Survey Open-File Report 97-520, 15 p.

Saltus, R. W., Meyer, J. F., Jr., Barnes, D. F., and Morin, R. L., 1997, Tectono-geophysical domains of interior Alaska as interpreted from new gravity and aeromagnetic data compilations, *in* Dumoulin, J. A., and Gray, J. E., eds., Geologic studies in Alaska by the U.S. Geological Survey, 1995: U.S. Geological Survey Professional Paper 1574, p. 157–171.

Worrall, D. M., 1991, Tectonic history of the Bering Sea and the evolution of Tertiary strike-slip basins and the Bering Shelf: Geological Society of America Special Paper 257, 120 p., 4 pl.

Manuscript received August 10, 1998; accepted January 6, 1999 ■

Institute for Environmental Education

The Value of Mentors

Cathleen May, Director, Institute for Environmental Education
Stacey Ginsburg, Project Coordinator, Institute for Environmental Education

To help, or to receive additional information about mentor programs at GSA, please contact Cathleen May at (303) 447-2020, ext. 195, or Stacey Ginsburg at (303) 447-2020, ext. 194.

Think back. Whether you are a graduate student, an early or mid-career professional, or a senior earth scientist, chances are you can think of at least one person who made a tangible, positive difference in your professional life. I'm not talking about those people who were obligated to help you along your way: (your major professor, members of your thesis committee, supervisor, department chair or dean, though many people in those positions do act as mentors). I'm talking about that person who went out of their way, who took the personal time to guide you a step or two down the road you chose to travel, or who helped you make that choice by offering a vision of what might lie ahead. Maybe she coached you through your tenure-track; maybe he encouraged you to reach higher and apply for that job you didn't think you'd get. A mentor opens a door or a window, providing a boost when you need it, or a glimpse of your unrecognized potential, or an option you never considered. A mentor expands your world by sharing experiences.

I could parenthetically litter the examples above with the names of at least a dozen people whose mentorship made differences, great and small, in my professional life. I am sorely tempted to do so, because each deserves recognition and thanks, but the list is too long. I have been so fortunate. And I know that the best form of thanks is to follow their example, to be a mentor myself. Aren't we all similarly obligated?

I think we are. I think that mentorship is an identifying attribute of the true professional. I believe that mentorship should be a hallmark of an effective professional society. Obviously, many individual members of our Geological Society of America have shared these values through the history of our Society. Thankfully, many of our members act as, or actively support, mentors. Currently, two programs of the Institute for Environmental Education are devoted to ideals of mentorship: the John F. Mann Mentor Program in Applied Hydrogeology, and the Roy J. Shlemon Mentor Program in Applied Geology. Though these programs are implemented in different ways, and vary subtly in their objectives, both the Shlemon and Mann programs are designed to extend the mentoring reach of individual professionals. Both programs seek to provide that "glimpse through the window" on potential careers in applied geology that students may not be exposed to in the academic environment. Roy J. Shlemon and the John F. Mann, Jr. Institute for Applied Geosciences, respectively, fund these mentor programs through endowments. When Roy Shlemon and the late John Mann founded and endowed their mentor programs through IEE at GSA, they set an example for all of us. Roy Shlemon ensured that annually, each GSA Section could afford to bring someone in to talk to their student membership about the opportunities and realities of employment outside academia or government. John Mann ensured that a team of mentors could afford to take a program on careers in applied hydrogeology to at least one university campus annually. Roy Shlemon and John Mann each provided a vision, a challenge, an example, and the means to accomplish what we should. Along with Stacey Ginsburg, I am proud to be responsible for GSA's efforts to make the most of these opportunities. If you too take pride in your society's commitment to mentorship, please consider volunteering, nominating, commenting, or suggesting new ways in which we can fulfill this honorable obligation.

—Cathleen L. May

~

The Roy J. Shlemon Mentor Program in Applied Geology was established to: expose geology students to the scientific challenges presented by the applied fields, to present students with information on professional opportunities in applied geology, and to give students an opportunity to interact with practicing applied geologists. Shlemon Mentors present workshops to registered participants at Section Meetings. In 1999, three sections will host Shlemon Mentors (see p. 43). We thank the 1999 mentors in advance, and thank the Shlemon Mentors of 1996–1998: James E. Slosson, William R. Cotton, Michael Hart, Dean Lewis, Ryan D. Turner, Russ Slayback, G. "Skip" Warfield Hobbs, Stephen Testa, and Todd Keay.

The Mann Mentorship Program in Applied Hydrogeology provides opportunities for geoscientists to share their professional and personal experiences in applied hydrogeology with undergraduate and graduate students and faculty. Students gain insight into preparation for entry-level positions, and foresight into requirements for advancing in technical and administrative positions. The Mann Mentors are a team of applied geohydrologists, one a senior-level professional and one representing early-career experience. Last spring, Robert Stollar and Brandon Eisen, both independent groundwater consultants, spoke of their professional experience to students at California State, Fullerton and California State, Los Angeles. The mentors also met individually with students to answer questions and offer career advice. Finally, a field trip (held in conjunction with the Groundwater Resources Association of California) allowed students to interact with professional geohydrologists. On February 17, 1999, for the last in a series of three university visits, Stollar and Eisen will speak at California State, Long Beach. Look for a summary on these meetings and an article written by Mann Mentor Robert Stollar, in coming issues.

We are currently planning a spring 1999 Mann Mentor Program to take place in upstate New York, though details are not yet available. It is not too early to nominate or volunteer as a Year 2K Shlemon Mentor, or a fall 1999 or Year 2K Mann Mentor. We are also actively seeking input on how to improve attendance and effectiveness of the Shlemon Mentor Programs. If you can help, please contact us soon.

Keep your eyes and ears open for future developments, including our Virtual Mentor Program. We hope to extend GSA's mentoring reach beyond physical limitations. Wouldn't it be great if students living in Australia or Siberia could interact with a mentor from any one of the disciplines and professional sectors represented by our Society's membership? GSA's new Web site can turn this possibility into a "virtual reality." If you have ideas that will help us develop the Virtual Mentor Program, or wish to volunteer as an on-line mentor or virtual facilitator for late 1999 implementation, please contact us this spring.

—Stacey Ginsburg

SAGE REMARKS

Thomas Muryl Boyd, Colorado School of Mines

Introduction to Exploration Geophysics: A Web-Based Learning Environment

Teaching to Non-Majors

Imagine you are approached by a housing developer who needs to know the extent of a subsurface hazard. She explains that, at the turn-of-the-century, extensive coal mining was conducted in an area that is now undergoing a housing boom. Some mines ventured close to the surface, and in 1896, a mine flooded and collapsed, killing a dozen miners.

She asks for advice concerning the use of geophysical methods to detect underground tunnels and voids beneath the proposed development site. After asking questions regarding the specifics of the area and the developer's needs and expectations, you suggest that a gravity survey might be the most cost-effective technique for providing the needed information. She invites you to submit a formal bid.

Now imagine that you are trying to complete your undergraduate degree in a field other than geophysics, and you are working through scenarios such as this to complete the only geophysics course required in your curriculum. This is the case at the Colorado School of Mines (CSM), where we have built a cross-disciplinary course around hypothetical scenarios like that described above to teach the fundamentals of geophysical exploration.

Through the support of the Society of Exploration Geophysicists, we have designed and implemented a Web-based learning environment for teaching introductory geophysics to non-geophysicists. Unlike many other Web-based courses, ours entails much more than simply providing traditional course materials (e.g., syllabus, lecture notes, references, quizzes, etc.) in an electronic form. Rather, the relevant material is conveyed through the use of a generalization of the case-study approach we refer to as an interactive case study. Unlike a traditional case study, through the use of computer simulations students become engaged in an interactive case study by making all of the relevant decisions (i.e., survey design and cost decisions, data and interpretation decisions, etc.) regarding the case. In completing an interactive case study, students not only develop an intuitive understanding of the nature of geophysical exploration, but also develop an appreciation for how geophysicists think and how to communicate with them, and a sense for what subsurface properties can and cannot be constrained by geophysical investigations.

As described below, the case studies used in this course are couched in terms of a request for bid (RFB) that requires students to use a specific geophysical technique to address a geologic or engineering problem. In responding to this RFB, students write proposals, design geophysical surveys, collect data using these designs, interpret the resulting data, and report on their results. All of these activities are supported through interactive, Web-based tools distributed as part of the learning environment. Everything described below is freely available at http://www.mines.edu/fs_home/tboyd/GP311.

The Course

The introductory course is divided into four modules, one each on the use of gravitational, magnetic, DC resistivity, and refraction seismic observations. Each module has two main subsections—lecture notes and the interactive case study.

The lecture notes are presented in a hypertext manner as a series of short World Wide Web pages complete with graphics and links to outside resources (see Fig. 1). Our implementation allows students to access the material in three ways. The first method incorporates the use of hyperlinks to the appropriate lecture material directly from the case study. Thus, students can start with the problem and refer to the notes as information is needed to complete the case study. Additionally, the lecture notes are indexed on an outline Web page. Using this page, students can browse those notes containing material in which they are interested, or in which they feel deficient. Finally, students can move through the notes sequentially before addressing the interactive case study.

As mentioned above, each interactive case study is framed around a specific RFB. The RFB presents a problem to be addressed by a specific geophysical method. Students respond to the RFB by submitting a proposal that includes a geophysical survey design, a discussion of geophysical noise relevant to the particular survey, estimates of the geological sources of signal that would and would not be detected by the survey, and estimates of the cost of completing the field acquisition and data interpretation. Examples of student proposals are available on the Web site.

To help complete the survey design, students are provided with Java-based programs that allow them to model the geophysical response over geologic structures relevant to the particular RFB. The modeling programs generate synthetic observations over simple geological models. Using these forward modeling programs and cost estimates, students determine optimal survey parameters for the particular problem. Because the optimal survey is defined in terms of a cost benefit tradeoff, different participants rarely base surveys on the same set of parameters. We encourage students to try surveys with different designs.

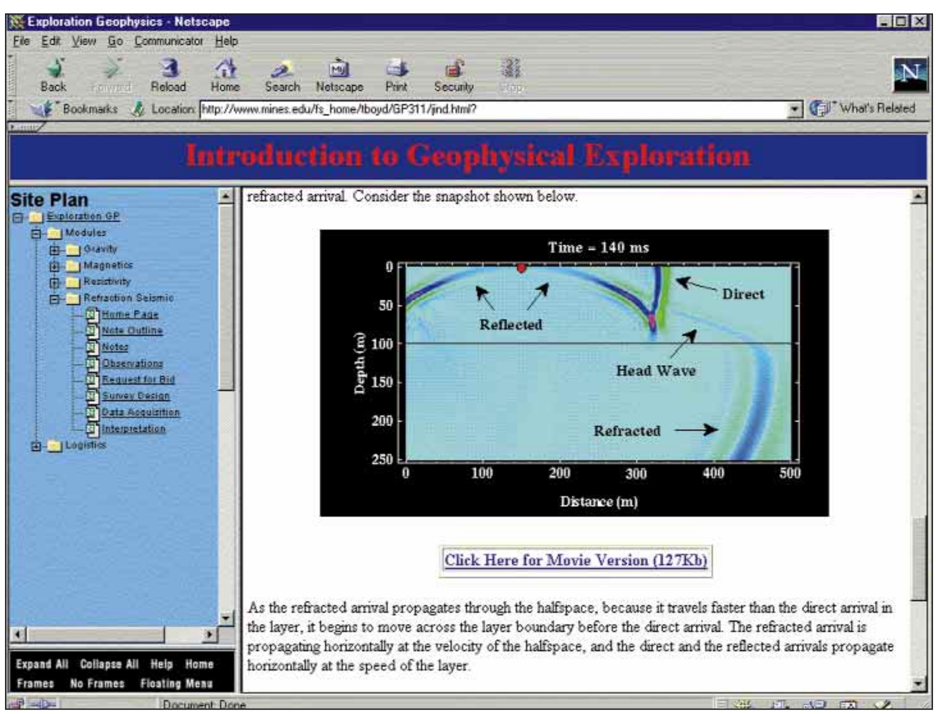


Figure 1. Example of screen.

After designing the survey, students can enter their survey design parameters into a WWW page and immediately receive a data set that includes random and systematic noises unique to their survey design. Students are then guided through a data-reduction procedure using simple spreadsheet manipulations. Upon completing the data reduction, students can upload their reduced data into Java-based modeling programs that allow them to interpret their observations.

Although generated from 3-D geologic models, the data sets collected by students can be remarkably diverse (Fig. 2). In the Figure 2 example, the relevant survey design parameters include station spacing (?x) and base station repeat time (?t). Example A shows a survey that minimized cost by using a relatively large station spacing (10 m). As a result, the geophysical anomaly is poorly defined. Example B shows a survey that minimized cost by using a relatively large base station repeat time. The resulting data set is contaminated with earth tides, causing the geophysical anomaly to appear asymmetric, even though the geologic model used to generate the data set (a simple 2-D tunnel) produces a symmetric anomaly. Data set C represents what the students in class, after examining data derived from a number of survey designs, thought to be optimal.

Client-Side Requirements

In developing these materials, I have attempted to keep the client-side hardware and software demands to a minimum. Client machines should have Internet connections of no less than 28.8 Kbytes. As is always the case, however, faster is better. To access the site and all of its features, the client needs a Java and Javascript-aware browser. Netscape 3.0+ was used as the development environment. In addition, the site has been tested using Microsoft Internet Explorer 3.0+. The client-side operating platform under which I developed the site is Windows 95/NT. I have, however, tested most features using a Macintosh client also. There are known problems when using the site with a Unix-based client. These have to do mostly with the Javascripts used in the seismic refraction module. Finally, in addition to an appropriate browser, students also need access to spreadsheet and word processing software for data reduction and report preparation.

How the Site Is Used at CSM

At CSM, students use this site as their sole resource in completing the introductory geophysics course. These materials are not supplementary to other things done anywhere in the course; they are the course. Each of the four modules requires approximately three to four weeks to complete. As students progress through each module, they submit weekly written reports. Typically, three to four are required, one each on observational limitations and errors, project bid, interim project report, and a final project report. Final grades are based on these written reports, weekly quizzes, and a final project that involves critiquing several published geophysical case studies.

While I do hold regular, six hours per week classroom meetings, lectures are not presented during this time. Rather, students are given individualized guidance and instruction as they progress through the interactive case studies. As you might expect, these in-class meetings are held in a computer laboratory. In this learning environment, the role of the instructor changes from one of being a content provider to one of being a coach and a mentor. The instructor provides content, clarification, and motivation, as requested by individual students—when they need it. The instructor also provides classroom structure by establishing expectations, guidelines, and a timetable for when work needs to be completed. Thus, although the instructor in this environment does not lecture, his or her classroom role is not diminished. ■

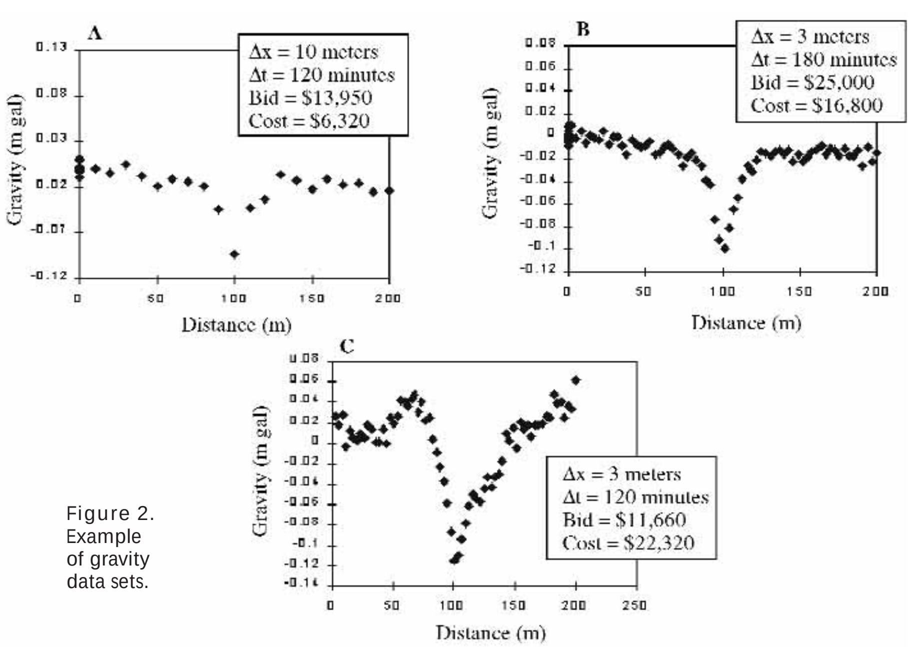


Figure 2. Example of gravity data sets.

WASHINGTON REPORT

Bruce F. Molnia, bmolnia@erols.com, bmolnia@usgs.gov

Acronym Immersion 101: Again

> *Acronym—A word (as radar or snafu) formed from the initial letter or letters of each of the successive parts or major parts of a compound term*
>
> —Webster's Ninth New Collegiate Dictionary

In 1992, Washington Report printed a list of acronyms that would allow readers to navigate their way through the alphabet soup of the earth sciences community and through publications originating from many diverse sources in Washington, D.C. This Washington Report presents more than 1,000 acronyms, abbreviations, and initialisms (more than twice the size of the 1992 listing) pertaining to U.S. and international federal agencies, international and domestic earth science organizations and societies, organizations of the National Academy of Sciences and its international counterparts, selected Earth Observing System (EOS) instruments, and a smattering of other sources. Generally, acronyms for geographic locations and for corporate and university entities are not included. The list is on the GSA Web site at http://geosociety.org/pubs/gsatoday/9902anym.htm, and is far from inclusive. Clearly visible is my bias as a Quaternary and high-latitude investigator. International entries focus on International Council of Scientific Unions member councils and affiliates, the International Union of Geological Sciences, the International Union of Geodesy and Geophysics societies, and the International Arctic Science Committee.

Congressional Climate Change on Global Warming?

Kai Anderson, GSA Congressional Science Fellow

In this initial report, I will briefly describe my motivation to work on science-policy issues and my early experiences in Washington, D.C. as the 1998–1999 GSA/USGS Congressional Science Fellow. I came to Washington as a geoscientist dedicated to exploring the nexus between science and public policy because I was, and am, profoundly interested in the relationship between people and Earth. This relationship is sometimes wrongly portrayed as a strict trade-off between the economy and the environment. At the end of a four-week orientation and interview process, I chose to work for Senator Joseph I. Lieberman (D—Conn.), in part because he articulates the point that economic vitality and environmental achievements are critically interdependent, not mutually exclusive. He refers to the misconception described above as a "false choice" between economic vitality and environmental stewardship. This false choice has great potential consequences for the complex and contentious domestic and international debates regarding global climate change. In addition, because climate change poses a myriad of global scientific and socioeconomic challenges, the international and domestic debates on the issue provide fascinating windows into the relationship between science and policy.

The complexity of the climate change debate reflects three vexing problems. First, from a scientific perspective, Earth's climate is dynamic, complex, and difficult to model with great temporal or spatial accuracy. Second, in a geopolitical context it is commonly assumed that attempts to mitigate climatic forcing will require significant reductions of greenhouse gas emissions, including carbon dioxide. Emission of greenhouse gases result, in turn, largely from fossil fuel burning, which drives the global economy. Finally, although climate change may seem rapid when viewed from the frame of reference provided by geologic time, to date it has not alarmed a sufficient number of people to galvanize multinational commitments to greenhouse gas emissions reduction. This does not mean that people are not concerned with the issue; rather it simply underscores the fact that the lack of a catastrophe directly attributable to anthropogenic global warming diminishes the sense of urgency that the issue might otherwise inspire.

My on-the-job education regarding geopolitics and science of climate change began in earnest at the Fourth Conference of the Parties (COP-4) to the United Nations Convention on Climate Change held in Buenos Aires, Argentina, November 1998. The week I spent staffing Senator Lieberman as a member of the Congressional oversight delegation to the COP-4 provided a challenging and inspiring start to my year on Capitol Hill.

I arrived at the COP-4 with Sally Kane, an economist detailed to Senator Lieberman's office from the National Oceanic and Atmospheric Administration (NOAA), five days before Senator Lieberman began his two-day stint in Buenos Aires. We spent several days attending State Department briefings of the congressional, industry, and environmental nonprofit delegations and visiting with members of these constituencies as well as White House representatives. As a veteran observer of the COP-3 negotiations held in Japan, which resulted in the drafting of the Kyoto Protocol, Sally helped orient me to the proceedings that appeared, at first, to be equal parts chaos and cosmopolitan cocktail party. Formal negotiating sessions and informal discussions largely focused on the economic, political, and environmental implications of reducing greenhouse gas emissions, using the flexible mechanisms provided for by the Kyoto Protocol such as greenhouse gas emissions trading. Technical discussions examined issues such as carbon sequestration by agriculture and forestry management.

The atmosphere of the conference itself heated significantly when a rumor began circulating that the Clinton Administration would sign the Kyoto Protocol during COP-4. Shortly thereafter, in response to the rumor, Republican representatives held an anti-Protocol press conference. The event was highlighted by a question posed by a well-known climate change skeptic who was not, coincidentally, a member of the press corps. The question turned out to be a statement expressing the skeptic's conviction that climate change science is highly uncertain and anthropogenic activities are not causing global warming. The question, in turn, prompted Representative James Sensenbrenner (R-WI) to conclude the press conference by reiterating his opinion that signing the Kyoto Protocol was a very bad idea, but that if it were signed, it should be immediately submitted to the Senate for ratification (a veritable death sentence given the current political climate). In all, the press conference was a sobering introduction to the political use of scientific uncertainty.

During the anti-Protocol press conference, I helped to coordinate and distribute a press release by Senator Lieberman that explained the rationale for, and encouraged the Clinton Administration to sign, the Kyoto Protocol. One timely argument in support of signing the protocol during the COP-4 was that the act would increase the American negotiators credibility at the bargaining table. Senator Lieberman's statement was outlined and reviewed in D.C. by his environmental legislative assistant, rewritten and finalized in Brazil by the senator, and copied and distributed to members of the media in Buenos Aires by Sally and me at the conclusion of the Republicans' press conference. The battle for media coverage provided my first taste of the partisan side of Capitol Hill.

During a briefing for Senator Lieberman, Sally and I highlighted three aspects of the COP-4 that we felt particularly noteworthy: (1) fragmentation of the developing-country negotiating bloc (G77); (2) constructive participation by industry representatives; and (3) widespread interest in Senator Lieberman's Credit for Voluntary Early Action bill.

We viewed the developments as positive signs for the negotiating process generally, but particularly interesting insofar as they could help to advance the climate change debate in the U.S. Senate. In the first case, developing countries, including Argentina and Kazakstan, announced their intentions to limit increases in the growth of their greenhouse gas emissions. Carlos Menem, the President of Argentina, stressed the importance of a healthy environment for robust and sustainable economic growth during his plenary address. The presence of industry representatives lent balance and legitimacy to the proceedings and helped delineate the issues critical to cost-effective implementation of the Kyoto Protocol. Finally, interest in the Credit for Voluntary Early Action bill had sparked many informal discussions.

Later during COP-4, Senator Lieberman and representatives of industry and the environmental community led a seminar that attracted more than 225 participants to a 100-person office. The intense interest in the bill reflected curiosity regarding the bill itself and a widespread international desire that the U.S. lead on the issue of climate change.

The Credit for Voluntary Early Action bill, which was introduced at the end of the 105th Congress by Senators John

Climate Change *continued on p. 11*

GSA Employment Matching Service

LOOKING FOR A NEW JOB?

Are you looking for a position in the geosciences? Let the GSA Employment Matching Service provide economical, effective assistance. Potential employers use the service throughout the year to find the qualified individuals they need. Your name and résumé will be provided to all participating employers who seek individuals with your qualifications.

You may register for the Employment Matching Service at any time during the year. To register, obtain an application form from GSA headquarters or at www.geosociety.org; return the completed form, a one- to two-page résumé, and your payment to GSA headquarters. A one-year listing for GSA Members and Associates in good standing is $35; for nonmembers it is $65.

If possible, take advantage of GSA's Employment Interview Service, which is conducted each fall in conjunction with the Society's Annual Meeting. The service brings potential employers and employees together for face-to-face interviews. Mark October 24–27 on your calendar for the 1999 GSA Annual Meeting in Denver, Colorado.

NOTE TO APPLICANTS: If you plan to interview at the GSA Annual Meeting, and want your record included in the information employers receive prior to the meeting, GSA should receive your material no later than September 15, 1999. Submit your forms early to receive maximum exposure! Don't forget to indicate on your application form whether you would like to interview in October. For additional information or to obtain an application form, contact Nancy S. Williams, Professional Development Department, Geological Society of America, P.O. Box 9140, Boulder, CO 80301, (303) 447-2020, or e-mail: profdev@geosociety.org.

LOOKING FOR A NEW EMPLOYEE?

When was the last time you hired a new employee? Did you squander time and effort in your search for a qualified geoscientist? Let the GSA computerized search make your job easier.

Simply fill out a one-page order form available from GSA headquarters or at www.geosociety.org—and the GSA computer will take it from there.

You will receive a printout that includes applicants' names, addresses, phone numbers, areas of specialty, type of employment desired, degrees held, years of professional experience, and current employment status.

Résumés for individual applicants are also sent with each printout at no additional charge. For 1999, the cost of a printout of one or two specialty codes is $175. (For example, in a search for an analyst of inorganic matter, the employer requested the specialty codes of geochemistry and petrology.) Each additional specialty is $50. A printout of the applicant listing in all specialties is available for $350.

If you have any questions about your personalized computer search, GSA Career Services will assist you. Also, employers are invited to post the position announcement on the GSA Web site for three months at no cost.

The GSA Employment Matching Service is available year round; however, GSA also conducts the Employment Interview Service each fall in conjunction with the Society's Annual Meeting (this year in Denver, Colorado, October 24–27). You may rent interview space in half-day increments, and GSA staff will schedule all interviews with applicants for you. In addition, GSA offers a message service, complete listing of applicants, copies of résumés, a posting of all job openings, and a one-month ad in *GSA Today,* all at no additional charge.

For more information or to obtain an order form to purchase a printout, contact T. Michael Moreland, Director, Professional Development, Geological Society of America, P.O. Box 9140, Boulder, CO 80301, (303) 447-2020, or e-mail: profdev@geosociety.org.

More GSA Representatives Needed

In the mid-1980s, GSA launched a new representative program targeting companies, agencies, and consultants throughout the country. The purpose was to broaden GSA's representation to include all employment sectors. The program was modeled on the successful campus representative program that began in 1979 and now includes 550 representatives at colleges and universities throughout North America.

We now have 82 company, 64 agency, and 33 consultant GSA representatives. However, we need more volunteers. Our goal is to designate a representative at all major company offices and governmental agencies throughout the country. We want to develop a similar liaison with GSA members who are self-employed and serve as consultants. They would also represent major cities and geographic regions.

Representatives serve as liaisons between GSA headquarters and their constituency in a particular city or region. They provide information on the programs and benefits of the Society to other members in the region and explain to prospective members the advantages of joining GSA. Each representative receives a notebook containing complete information on all GSA programs, activities, publications, meetings, and other benefits that the Society provides its membership.

We need your help to continue this communication link between GSA headquarters and the membership of the Society. If you are a Member, Student Member, or Fellow (not Student Associate) and are interested in serving GSA as a representative for your company, agency, or group of the employment sector, please contact T. Michael Moreland, Manager, Membership Services, Geological Society of America, P.O. Box 9140, Boulder, CO 80301, (303) 447-2020 or e-mail: tmoreland@geosociety.org.

Climate Change *continued from p. 10*

Chafee (R-RI), Lieberman, and Connie Mack (R-FL) is slated by its co-sponsors as a legislative priority for the 106th Congress, which began in January. The bill represents a bipartisan effort to eliminate barriers and disincentives to reducing carbon dioxide emissions and/or improving energy efficiency by crediting those who voluntarily undertake emissions reductions in advance of future regulation. The bill promises to defy the cliché that "no good deed goes unpunished." Most importantly, it represents an opportunity to break Congressional ice on this polarized issue.

As a result of my experience in Buenos Aires and the importance of the Credit for Voluntary Early Action bill, I am excited and ready for the legislative battles and lessons that lie ahead in the the 106th Congress. ■

GSAF UPDATE

Robert L. Fuchs, Vice-President, GSA Foundation

Did You Know That …

Americans are charitable people. Individually, 70 percent of us give to charitable organizations each year, accounting for 85%–90% of all charitable giving. The total is a big number, $122 billion, in the most recent year for which figures are available.

The other side of the coin is surprising. When it comes to bequests, only three percent of us remember favorite charities in our wills. Within the next two decades, more than $10 trillion will be transferred from the oldest generation to younger generations. Only a small percentage of that enormous sum will go to charitable organizations to enable them to carry on their work.

Charity certainly does begin at home, and it is of prime importance that we support our children, grandchildren, and needy relatives. However, it makes good social and community sense that we allocate some portion of our estates to the world we live in, for that will also improve the lives of our children, grandchildren, relatives, plus many others. What would the world be like without arts, religion, health care, education, and scientific research?

Therefore, 1999 is a good time to review the plans for your estate to see if organizations such as the GSA Foundation have been included. Bequests from members beginning with the R. A. F. Penrose gift in 1931 compose the financial base for the Society's programs in support of geology. In recent years, the 1994 Joseph T. Pardee bequest was a major milestone. This past year was no exception. In December, the Foundation was the recipient of a bequest from Charles T. Hardy in the amount of several hundred thousand dollars. This is the best possible kind of news for GSA. The gift is unrestricted, which means that GSA can apply the bequest to the activities where it is most needed. Further, legacies of this sort provide assurance that GSA's solid financial base will remain healthy.

Please join the many other members who have or will leave a legacy to the Foundation. If you would like some additional information, or a discussion with someone about bequests, feel free to call the Foundation office in confidence at (303) 447-2020, ext. 101. ■

Donors to the Foundation, December 1998

Claude C. Albritton Memorial
John P. Albanese
Jane Christman Albritton◆
Lisa E. Wells

Antoinette Lierman Medlin Scholarship Award
C. S. Venable Barclay
Lawrence L. Brady
Katherine J. Howard
Frank E. Kottlowski
in honor of co-workers: Gretchen K. Hoffman, Charles L. Pillmore, & David W. Love
Edwin R. Landis

Birdsall Award
Alfred Clebsch
George H. Davis◆
David A. Stephenson

Gretchen Louise Blechschmidt Fund
John S. Lowther
Donald W. Tubbs

G. H. Cady Memorial Award
Edward C. Dapples*
Frank E. Kottlowski
in honor of co-workers: Gretchen K. Hoffman, Charles L. Pillmore, & David W. Love

Cordilleran Section Endowment
Monica E. Gowan◆
Thomas D. Hamilton◆
Keith A. Kvenvolden◆
Robert A. Larson

Allan V. Cox Student Scholarship Award
Harold E. Malde*
Jacek K. Sulanowski

Biggs Excellence in Earth Science Education
Mohamed A. Gheith

Doris M. Curtis Memorial
M. Charles Gilbert
Susan M. Landon
Alvin R. Leonard
Grover E. Murray*
in memory of Saul Aronow, Bruce B. Hanshaw, & Leonard R. Wilson

Charles Lum Drake International Award
Stephen Self

Shirley Dreiss Memorial
Barbara A. Bekins◆
Robert H. Fakundiny◆
Virgil A. Frizzell, Jr.◆
James B. Stevens
L. Jan Turk*
Peter J. Vrolijk

Dwornik Planetary Geoscience Award
Stephen J. Martel
Ted A. Maxwell
Ellen R. Stofan
Carolyn H. van der Bogert

Don J. Easterbrook Fund
Donald J. Easterbrook*◆

Engineering Geology Award
Scott F. Burns◆
Robert A. Larson

Building Expansion
Gordon P. Eaton*◆

GEOSTAR
Donald W. Boyd*
Garcia H. Carlos
Norbert E. Cygan
James B. Thompson, Jr.◆
Richard A. Zimmermann

History of Geology Award
Robert H. Dott, Jr.◆
John W. Hess, Jr.
Darryll T. Pederson
Erik W. Smith

Institute for Environmental Education
Joanne Bourgeois
William H. DiGuiseppi
Seung B. Hong
Newmont Gold Company*◆
Peter Robinson
Donna & James Russell◆
Daniel Sarewitz
David A. Stephenson
William E. Wertz
Richard A. Zimmermann

John C. Frye Environmental Award
Frank E. Kottlowski
in honor of co-workers: Gretchen K. Hoffman, Charles L. Pillmore, & David W. Love
Alvin R. Leonard
Shinjiro Mizutani

John F. Mann Institute for Applied Geosciences
Richard Lung

John T. Dillon Alaska Scholarship Award
Joseph L. Corones
Shirley A. Liss
Andrew J. Meigs
Thomas E. Moore*
Charles G. Mull
William W. Patton, Jr.
Frederic H. Wilson

Lipman Research Fund
Howard & Jean Lipman Foundation*◆

J. Hoover Mackin Award
H. Richard Blank, Jr.
Danny K. Hagans
Charles G. Mull
Donal R. Mullineaux
Stephen Self
Martin L. Stout Estate
John D. Vitek

Carol G. & John T. McGill Fund
Richard Lung

Memorial Fund
Frederick & Barabara J. Pearson, Jr.*◆
in memory of Bruce B. Hanshaw

Minority Fund
Joanne Bourgeois
Harold E. Malde*
Brian G. McAdoo
William D. Rose, Jr.
Steven Slaff
Frederic H. Wilson*

Northeastern Section Endowment
Farouk El-Baz◆
Robert H. Fakundiny◆
Richard E. Gray◆
Susan D. Halsey*◆
Stephen J. Urbanik◆
Kenneth N. Weaver*◆

Operating Fund
Robert L. Fuchs◆

Publications
Anonymous*
Andy Baker
William B. Dade
Thomas N. Irvine*
Gerard Pielin
in appreciation of Ann Crawford
Gregory J. Retallack
Faith E. Rogers◆
Robin A. Strachan
Yoseph Yechieli

Rip Rapp Archaeological Geology Award
Charles S. Bartlett, Jr.◆

Bruce L. "Biff" Reed Scholarship
Charles G. Mull
Allan F. Schneider◆

Research Grants
Rodey Batiza
Howell Bosbyshell
John R. Bowman
Kenneth G. Brill, Jr.
Karen Chin
Drew M. Clemens
J. Calvin Cooper
Campbell Craddock*◆
Michael Levi Cummings
Donald W. Curran
H. Allen Curran◆
Zoltan De Cserna
Paul K. Doss
Donald M. Ericson
Roland A. Gangloff
Cynthia A. Gardner
Charles R. Givens
Billy P. Glass
Robert D. Hatcher, Jr.*◆
Donald E. Hattin
James W. Hawkins, Jr.*
Stephen D. Hurst
Roscoe G. Jackson II*
Peter M. Jacobs
Claudia C. Johnson
Erle G. Kauffman
Suzanne Mahlburg Kay
Yousif K. Kharaka
J. Richard Kyle
Ed Landing
Helen M. Lang◆
Maureen P. Leshendok
J. G. Liou
Alvis L. Lisenbee◆
John W. M'Gonigle
Carol Mankiewicz
Randall A. Marrett
Jeffrey A. May
David L. Meyer
Calvin F. Miller
H. Richard Naslund
J. Michael O'Neill
John D. Obradovich
Ian J. Richards
Peter Robinson
Michel P. Semet
James R. Shannon
David B. Slemmons◆
Leeann Srogi
David M. Tuck
L. Jan Turk*
Ben A. van der Pluijm◆
Robert J. Weimer
Jay Zimmerman
Richard A. Zimmermann

Rocky Mountain Section Endowment
Bruce H. Bryant*◆
Rhea L. Graham◆
Brainerd Mears, Jr.◆

Keith Runcorn Fund
Charles G. Mull

SAGE
Christopher A. Anderson
Joanne Bourgeois
Michael Levi Cummings
EXXON Corporation*◆
Jonathan H. Goodwin
Philip L. Gyger
Pamela Hallock-Muller
Susan D. Hovorka
J. Richard Kyle
Timothy M. Lutz
Steven E. Mains
Andrew J. Meigs
Calvin F. Miller
Christopher J. Murray◆
Rodney D. Norby
J. Michael O'Neill
Daniel Sarewitz
Leeann Srogi
David A. Stephenson
Berry Sutherland
Jack W. Travis
Anne M. Trehu
Charles Marsh Woodruff, Jr.
Robyn Wright Dunbar
Richard A. Zimmermann

South-Central Section Endowment
M. Charles Gilbert◆
William W. Craig◆
Richard J. Diecchio◆
James A. Drahovzal◆
Frank R. Ettensohn◆
Alan E. Fryar◆
Robert D. Hatcher, Jr.◆
William A. Thomas◆

Roy J. Shlemon Applied Geology Fund
Robert J. Lynn

Shlemon Engineering Geology Award
Roy J. Shlemon*◆

Shoemaker Memorial Fund for Crater Studies
F. Eyolf Bronner
Frank & Virginia Byers*
Wilfred J. Carr◆
Marianne S. DuBois
B. Carter Hearn, Jr.
F. N. Houser
Scott S. Hughes
Richard W. Ojakangas
Susan E. H. Sakimoto
Priscilla L. Strain

Alexander Sisson Fund
Virginia B. Sisson*◆

Unrestricted
Michele L. Aldrich*◆
Clarence R. Allen*◆
Thomas F. Anderson
Ryo Anma
Anonymous*
George S. Austin
Arten J. Avakian◆
Paul A. Bailly*◆
Gordon C. Baird
David B. Bannan
Walther M. Barnard◆
Donald F. Beck
Somdev Bhattacharji
Sofia M. Bobiak
Joanne Bourgeois
Willi K. Braun
William J. Brennan
James C. Brice
Robert D. Brown, Jr.
Severn P. Brown
Robert A. Brozdowski
Charlotte A. Brunner
Bruce H. Bryant*◆
Donald M. Burt◆
Alfred L. Bush
James Bush
Steven C. Cande
Susan M. Cashman
Robert M. Chapman
Henry A. K. Charlesworth
Clement G. Chase
Earl A. Christiansen
Alfred Clebsch
G. Arthur Cooper*◆
Margaret Cooper
Edward J. Cording
Dexter H. Craig
William W. Craig*◆
John C. Crowell*
Edward S. Custer, Jr.
Ralph K. Davis
Virginia De Lima*◆
Richard J. Diecchio◆
Holly A. Dockery
Lisa A. Doner
Robert H. Dott, Jr.◆
James A. Drahovzal◆
Andres Duarte-Vivas

Digging Up the Past

Most memorable early geologic experience:

"Meeting an angry cougar while geologic mapping in western Utah. He wasn't interested in the geologic sample I offered him. He got insulted and left."

—Sheldon K. Grant

David E. Dunn*◆
Jerry P. Eaton
Farouk El-Baz◆
Frank R. Ettensohn◆
Cynthia A. Evans
Yehuda Eyal
Cyrus W. Field
Helen L. Foster◆
Robert E. Fox◆
Alan E. Fryar◆
Stan J. Galicki
Phillip Lee Garbutt
Geological Survey of Canada
William H. Gillespie◆
David P. Gold
Alan M. Goodwin
Monica E. Gowan◆
Rhea L. Graham◆
John R. Griffin◆
I. G. Grossman◆
Barbara J. Grubb
James N. Gundersen*
William C. Gussow*◆
Gerald H. Haddock*◆
Clyde T. Hardy Estate*
Joseph H. Hartshorn*
Robert D. Hatcher, Jr.*◆
Richard C. Hepworth
Louis S. Hochman
Thomas L. Holzer◆
Clifford A. Hopson
G. Randy Keller
Robert Kerrich
Charles S. King*
Stephen A. Kirsch
Charles E. Kirschner
James E. Kline
Stephen C. Kuehn
John T. Kuo◆
Willard C. Lacy
Robert A. Larson◆
William N. Laval*
Stephen C. Lee
Arthur L. Lerner-Lam*◆
Charles R. Lewis
Henry M. Lieberman
Robert G. Lindblom
William W. Locke
John S. Lowther
Steven E. Mains
Charles J. Mankin*◆
John W. Mason◆
John C. Maxwell◆
Marlene L. McCauley
Cole R. McClure, Jr.
Michael O. McCurry

Donors
continued on p. 14

Field Forums To Offer New Opportunity for Research Scientists

Sharon Mosher, Annual Program Committee Chair

GSA announces a new program of *Field Forums* to provide the opportunity for exchange of current knowledge and exciting ideas well expressed by the geology of a specific area. Field Forums are designed after Penrose Conferences, with a combination of invited and interested attendees, but completely in a field setting. The format is similar to GSA Annual Meeting field trips, but run independently from that or any other meeting. The intent is to stimulate and enhance individual and collaborative research, and to accelerate the advance of the science by interactions in the field. Field Forums are designed to encourage open and frank discussion of ideas in an informal field atmosphere.

- In this new Field Forum program, geologists can lead organized field trips to any area, unrestricted by the time or location of the GSA Annual Meeting or Section meetings. We anticipate a greater diversity of both field trips and attendees.
- Field Forums will have a specific thematic focus, similar to Penrose Conferences, but may be more geographically oriented. Content will be guided by a small group of leaders with logistical responsibility.
- Organizers will invite a few key participants, such as other people who have worked in the area or on similar problems, to ensure the success of the Field Forum. The rest of the participants will be selected by the organizers from applications received in response to an announcement of the forum in *GSA Today* and other scientific publications. Student participation (20%) will be encouraged through discounted rates.
- Field Forums will be 5 or more days, and the size of the group between 20 and 40. The length and size are flexible, however, depending on the logistics. The only in-house conferencing will occur in the evening and will be a very minor component of the forum.
- Field Forums may be international in scope and are not restricted to a single location.

Have a great idea for a Field Forum? An idea for a Penrose Conference that would be much more effective in a field setting? A field trip that captures the essence of new, exciting discoveries or a controversial topic? Submit a proposal for a Field Forum!

Interested? Watch for the announcements of the first *Field Forums* in 2000!

Specific Requirements

Field Trip Leaders. Field trip leaders should have technical competence and be knowledgeable about current activities in the field area to be visited. Responsibility for organizing a Field Forum should be shared by at least two leaders, one of whom has actively worked in the area. At least one leader should be a member of GSA. In addition to scientific expertise, field trip leaders must have experience leading field trips in general, and with the logistics involved in leading a trip to this specific area. Both organizational and interpersonal skills are required to deal positively and effectively with potential logistical problems and the many personality types of the participants. Leaders need to be able to run a field trip where open discussion of different ideas and interpretations is fostered.

Guidebook. A guidebook will be written for each trip and is the sole responsibility of the leaders. No formal publication is expected, but the leaders may submit a proposal to include the guidebook in GSA's field guide series.

Costs. The field trip must be self-supporting. The field trip leaders have complete responsibility for the planning, logistics, and finances. GSA provides the following benefits: insurance, publicity, registration, accounting, and surveying of registrants. GSA will provide administrative support through the early stages of the procedures.

Location of Trips. No restrictions about holding forums anywhere in the world are made, although logistics, costs, and other problems dictate caution in organizing forums outside North America. Such forums may add an important dimension to the Field Forum program.

Participation. Participants have the ethical obligation of not using, in any way, any original information that may be revealed in discussion by other participants.

Review. Proposals for 2000 will be reviewed by the Annual Program Committee, which will provide quality control and guidance to prospective leaders.

Sponsors. The Geological Society of America is the principal sponsor of the Field Forums; however, other societies, organizations, and institutions are welcome as cosponsors and may share in the costs.

Professional Rates. Companies are encouraged to pay a special rate for participation of employees to help cover partial costs of student participation.

Donors. Foundations and private industry may be solicited for donations to partially cover field costs, particularly for expensive trips, with prior approval of the Executive Director of GSA.

To submit a proposal or for more information, contact Edna Collis, GSA Professional Development Department, ecollis@geosociety.org. To discuss potential Field Forums, contact Sharon Mosher, chair of the Annual Program Committee (mosher@mail.utexas.edu).

Field Forums are a new member service, capturing a unique niche in an area of significant interest to GSA's field-oriented members. It is an example of GSA's new Strategic Plan in action! ■

Donors

continued from p. 13

Robert C. McDowell
Don A. McKee
Judson Mead
Thomas J. Messenger◆
Frederick Wayne Meyer
Howard D. Mooers
Ogden W. Nine, Jr.
Bruce James O'Connor
James F. Olmsted*
Barbara M. Palen
Harry McDougal Parker◆
H. Kenneth Peterson
Bernard W. Pipkin◆
Melvin H. Podwysocki
Forrest G. Poole◆
Paul E. Potter
Richard C. Quittmeyer
Andrew G. Raby
Douglas W. Rankin◆
James C. Ratte
C. C. Reeves, Jr.
Salem J. Rice
Peter Robinson
Lizzette A. Rodriquez
Reuben J. Ross, Jr.
Peter D. Rowley
Edward Carl Roy, Jr.
Ernest E. Russell◆
Tsunemasa Saito
Craig M. Schiffries◆
Frank W. Schwartz
Gregory F. Scott
James R. Shannon
Leon T. Silver*◆
Paul K. Sims
Rasoul B. Sorkhabi
George C. Soronen
Dennis M. Sparks
Craig L. Sprinkle
Lloyd W. Staples
Charles E. Stearns*◆
James B. Stevens
Christopher Anne Suczek◆
John F. Sutter*◆
Alan L. Swenson
Akihiro Tazawa
William A. Thomas*◆
S. Francis Thoumsin, Jr.
Jane S. Tribble
Samuel J. Tuthill
University of Toronto*
Victor Vacquier
James W. Vernon
Robert E. Wallace*
E. Bruce Watson
Robert J. Weimer
Karen L. Wetmore
Julie A. Wetterholt◆
Donald E. White*
Karen R. Whiteley
John A. Willott
Joseph R. Wilson
Steffen Wolff*◆
Lynn A. Yehle
Leland W. Younker
Mostafa M. Zayed
Richard A. Zimmermann

Women in Science

Joanne Bourgeois
Robert H. Fakundiny◆
Cynthia L. Fong
Maria C. Moya
Marilyn E. Quas
Marith Cady Reheis◆

*Century Plus Roster (*gifts of $150 or more*)
◆Second Century Fund.

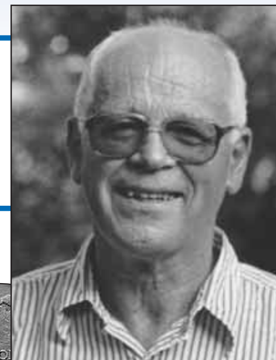
GEOLOGICAL SOCIETY OF AMERICA

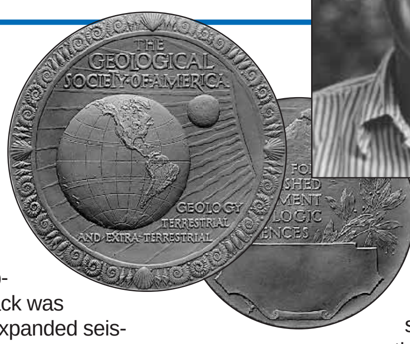
MEDALS AND AWARDS FOR 1998

PENROSE MEDAL

presented to

JACK OLIVER





Citation by BRYAN L. ISACKS

Jack Oliver has been a key player in at least four significant developments in geology during the past half century. The first two include his prolific work on surface waves and his roles in the development of seismograph networks. Jack was one of the Lamont pioneers who expanded seismology into the exploitation of long-period surface waves. He was perhaps the leading observationalist in the discovery of the menagerie of surface waves that travel across Earth's surface. The second development stemmed from his work on the Lamont IGY long-period network and the nuclear test ban negotiations. Jack played a key role in promoting the idea of a world-wide network of standardized seismographs (WWNSS). The resulting network had an enormous impact on seismology and supplied much of the critical seismological data for the plate tectonics revolution. Jack was also instrumental in the development of simple portable seismographs, exemplified by the widely used smoked paper MEQ system, which could be deployed in local networks in interesting and remote regions. Although mainly in the field of seismology, the agenda of all this research was mainly geological—determination of oceanic and continental crustal structures from surface wave dispersion, and study of seismo-tectonics imaged by global and local seismograph networks.

Jack played a central role in the plate tectonics revolution. It was during one of our many intense discussions about the meaning of the remarkable differences between the Tonga and Fiji recordings of deep earthquakes that we came upon the idea of connecting the anomalies associated with the dipping seismic zone with similar anomalies in seismic wave propagation through the suboceanic mantle. The result was the cross-sectional view of what later became known as the subduction of lithosphere. It was Jack's original suspicion that the Wadati-Benioff zones might mark a zone of unusual physical properties in the mantle that led to that "eureka" moment. Jack's role in the plate tectonics revolution is also exemplified by the enormous impact of the paper "Seismology and the New Global Tectonics." Although I am first author of that paper by the luck of a lottery unique in the history of science, I can say with some substantial authority that Jack was, in fact, the paper's guiding spirit.

The fourth development is a revolution still in progress, one that Jack largely set in motion through the Consortium for Continental Reflection Profiling (COCORP), an original project to explore the deep structure of continents by the method of seismic reflection profiling.

Jack Oliver has had two persistent scientific passions through his distinguished and remarkably prolific career. One is his practice of science, particularly the forging of new directions in research. The second is his interest in how discovery in science happens. This other passion is captured in the two books that he has published in the past several years. *The Incomplete Guide to the Art of Discovery* is a kind of manual of successful scientific strategy, while *Shocks and Rocks: Seismology in the Plate Tectonics Revolution* articulates Jack's provocative views of what he considers the three styles of science: serendipity (inductive), hypothesis testing (deductive), and synthesis. Jack advocates the inductive style and the primacy of observations in the evolution of science. In an address delivered at the 1998 fall AGU meeting Jack said, "Science in the deductive style tends to limit us to what we are capable of imagining. We need not be so constrained. Science in the inductive style improves our chances of learning things beyond our imagination."

Two aspects of Jack's work have especially impressed me. The first is the way in which the research has been done. Jack has generally worked in close and quite unselfish collaboration with others. In fact, these others have been most often students, and it is here that I can speak again with particular authority, since I was one of Jack's graduate students during the early 1960s. Jack's relationship to a student was never as a master to a disciple or an apprentice, but always as colleague to colleague, as one team member to another. This relationship is more than a personal one of friendship and respect, which is in itself remarkable; it is one that forces the student toward a great deal of freedom and independence to develop the unique motivation, talent, initiative, direction, and confidence that are so important for a career in science. He instilled in most of us a strong sense of the excitement of scientific exploration and discovery. The result is a large and impressive cast of former students, from both Columbia and Cornell, who give testimony to Jack's effectiveness as a scientific mentor.

The Penrose Medal is a quite special addition to the many that Jack has already garnered. It has the rather stern requirement, "in recognition of eminent research in pure geology"—the word "pure" seeming to imply, perhaps, that applied physicists and suchlike need not apply. Jack got his masters in physics at Columbia and then was lured into geophysics by Doc Ewing, another physicist turned geophysicist. Jack has always been a seismologist. However, Jack's priority has persistently been the understanding of our special planet, particularly our planet's crust and lithosphere, as a geologist, not as a physicist. To me, the beautifully simple idea for the COCORP project illustrates this best. Jack was struck by the disparity between, on the one hand, the incredibly complex and intricate structure of the upper crust revealed by the past several hundred years of field geology, and, on the other hand, by the extremely simple layered structure of the crust determined by seismologists, with their sharply defined mathematical discontinuities such as "Moho" or "Conrad." Certainly, Jack advocated, the crust and upper mantle must have complexity comparable to what we see on the surface. The idea was that the seismic reflection technique perfected by the oil industry had the resolution to resolve the true geological complexity of the deep continental crust and lithosphere and to relate it directly to surface structures. This idea worked. COCORP and the many successor projects that it has inspired have and are still revealing just how complex the deep crust and upper mantle really is. These projects have been particularly successful in showing how major structures observed near the surface can be extrapolated to depth. When all this finally comes together, we will have a revolution in our understanding of the continents that will probably be comparable to the plate tectonics revolution. As was Jack's prior work on plate tectonics and seismology, the COCORP project was the idea of a pure geologist who happened to find a particularly effective tool to do the job.

I am therefore very honored to present Jack Oliver to you, for the 72nd award of the R. A. F. Penrose, Jr., Medal.

Response by JACK E. OLIVER

SHAKESPEARE GOT IT WRONG!

Surely it goes without saying, although of course I'll say it, that I am both honored and delighted to receive the 1998 Penrose Medal of the Geological Society of America. After nearly 50 years in GSA, a number of them in the hierarchy, I am well aware of the prestige of this award, and I am in awe that my name has been added to the list of outstanding earth scientists who are previous winners. My sincere thanks go to the society for capping my career with this honor.

Following retirement to emeritus status a few years ago, I was asked by another scientific society to prepare some autobiographical material for archiving. That task, and aging as well, I suppose, has caused me to reflect on my life, and I would like to report here a few of the points that have arisen and that relate to success in science, and also to mention a few relevant examples from my career.

The first point is obvious. To do something useful in science, one must have a certain amount of good fortune. Being in the right place at the right time, often by chance, is a key to achievement. I grew up in a family without the means to send me to college, although my parents, particularly my mother, encouraged me to get somehow the kind of education that they never had. Fortunately, the local high school football team was coached by Paul Brown, a name recognized immediately by professional football fans. Brown's high school team was sensational and the mythical national champion. Although I was at best a mediocre player on that team, its fame brought me a scholarship, and hence an education in science, at a fine university, Columbia. Right place, right time!

While at Columbia as a physics student, fate intervened again as a football injury put me in touch with a fellow student, Dick Edwards, who would help me get a part-time job with a professor working in a department on another part of the campus and in a subject I knew little or nothing about. He was Maurice Ewing, a professor of geology and, incidentally, a former Penrose Medal winner. That was my entrance into earth science, and Ewing would be my guide and my indoctrinator, and would provide unbounded inspiration in that subject. He soon founded the Lamont-Doherty Geological Observatory where I spent the early part of my career including the time of the plate tectonics revolution. For me, it was right place, right time once again.

Through more good fortune, I have also benefited enormously from innumerable associations with fine colleagues, and with outstanding and stimulating students, far too many to mention individually here. At Columbia, the Lamont crowd shared an intense dedication to science that let no obstacle to research seem insurmountable.

At Cornell, where I spent the latter part of my career, good fortune followed me. I was hired to lead the rebuilding of the geology department, but, from the president, the dean, and others all down the line, there was so much enthusiastic support for that rebuilding that I often felt that I was merely riding a wave rather than leading something. And somehow those bright and eager students continued to appear at Cornell, as they had at Columbia. Right place, right time all over again.

Along this route blessed with good fortune, I did make a few decisions that I think were the correct ones, for me at least, and I would like to pass two of them along.

When I had to lead and build an organization, I never sought, or thought of, new employees as underlings who would merely do my bidding. Rather, I tried always to add people who would make the organization more vibrant and more capable of moving into new arenas. I tried consciously to hire those smarter and more talented than I was. Some would say that is the only activity of my career at which I was 100% successful!

Finally, for those young people who are just beginning careers and trying to set goals for themselves, I would like to relate the key decision that I made at that stage of my life and that, I think, affected my career profoundly. As a beginning student of science, my goals were conventional, i.e., a good job, a good salary, a nice family, a home with a two-car garage, etc. However, midway through my graduate student career, and inspired by Ewing about opportunity in science and the satisfaction of doing good science, I rethought those goals. I was footloose then with no wife or family to support, no need for more than minimal subsistence, and I didn't even know, or care, what tenure was. And I had become convinced that adding to human knowledge through science was a most worthy way to spend a lifetime. I therefore decided that from then on my life would be dedicated to achievement in science and that decisions about steps in my career would be made with that as the prime basis. I stuck with that policy throughout my career as those decisions arose.

Ironically, I sound hypocritical here because I ended up in a named chair at a major research university, with tenure of course, and with all the other things that were once my prime goals but that became merely pleasant trappings that came with the job as I emphasized production of good science to the limit of my capability.

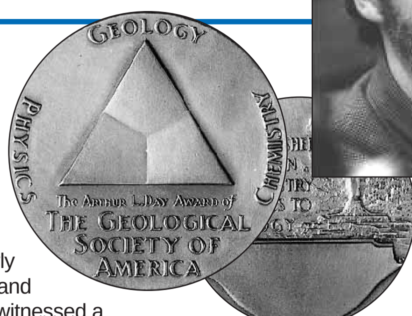
In short, my lesson here is that Shakespeare, in fact, got it wrong. The big question in a life of science is not "To be or not to be." It is instead, "To do or not to do"! Perhaps that sort of emphasis will work for some of you as you pursue your careers. I hope so.

Finally, I note that one of the most exciting parts of my career, a part that included some of my best science, took place during the mid-1960s as seismologists at Lamont were bringing earthquake seismology into what would become the plate tectonics revolution. During that same period, I met and married my wife and she produced, and cared for, and made a home for our two fine daughters, and me as well, just as that exciting work was going on. And she's been doing it ever since. She shares with me the honor of the Penrose Medal. Thank you again.

DAY MEDAL

presented to

EDWARD B. WATSON



Citation by T. MARK HARRISON and F. J. RYERSON

It is a great privilege and pleasure to give the citation for the 1998 Arthur L. Day Medalist, Edward Bruce Watson. In the nearly two decades that we have known and collaborated with Bruce, we have witnessed a remarkable career characterized by the development of experimental techniques that have profoundly influenced the field of experimental petrology. Twenty years ago, experimentalists had made great leaps in understanding the internal constitution of Earth and the Moon, but the view they provided was largely static. There were very few constraints on transport processes, diffusion rates, how fluids are distributed and move through rocks, or how minerals dissolve in melts and fluids. With his craftsman's touch and somewhat taciturn Yankee temperament, Bruce changed the way that experimental petrology is done—taking what were commonly viewed as limitations and turning them into assets. The elegance of these solutions is usually registered in responses from his colleagues to the effect, "Why didn't I think of that?"

Bruce's uncanny ability to identify the key parameter within a complex geological system and then reduce it to a problem that can be studied in the laboratory, almost always through an innovative experimental design, led him to his remarkable number of pioneering accomplishments. His first contributions were in the area of trace element partitioning. In the early 1970s there were some data on mineral-melt partitioning, and although the effect of temperature on partitioning was generally appreciated, the importance of rock-melt composition on these values was completely ignored. Realizing that partitioning of trace elements between immiscible basic and acidic silicate melts contained all the information required to assess this compositional effect, Bruce was able to take a petrological curiosity and use it to advantage by characterizing the partitioning of a spectrum of important trace elements and quantify the relative variations in activity coefficients as a function of melt composition. He then consolidated the implications of the two-liquid experiments by looking at compositional effects on the partitioning of calcium and manganese in olivine-bearing, haplobasaltic systems. Twenty years later these remain some of the most often cited contributions in this field.

In 1921, Bowen published a paper on "Diffusion in Silicate Melts." More than 50 years then elapsed in which little new information was gathered on the rates of diffusion in geologically important melts, and no data on the effects of geological variables such as pressure and volatile content. In a series of papers starting in 1979, Bruce single-handedly rectified this oversight. He made the first measurements of the effects of pressure and volatile content on diffusion in melts, overcoming the experimental difficulties associated with measuring transport in easily deformed materials at high pressures. Along with its obvious relevance to understanding geochemical transport in Earth's interior, the observation of the relationship between diffusion coefficient and volatile content later played an important role in the more general problem of water solubility and speciation in silicate melts.

Characteristically, Bruce viewed his arrival at Rensselaer Polytechnic without a cent of setup funds as an opportunity. He found an old platinum-wound 1-atmosphere furnace and asked himself what important questions might be resolved with this simple apparatus. The result was a breakthrough study of the contamination of basalt melts by continental lithologies that has been repeatedly emulated in the 15 years since publication.

On the basis of his earlier work on mineral-melt partitioning, Bruce realized that the activity coefficients of trace elements in melts can change markedly as a function of composition. If this was the case, then the solubility of accessory minerals, in which trace or minor elements are essential structural constituents, should also vary with melt composition. This realization led Bruce and his colleagues to pursue a series of investigations that fully characterized the behavior of accessory minerals in igneous rocks (and a few years later in metamorphic fluids). His work quantified accessory mineral solubility in *P-T-x* space, determined the rates of accessory mineral dissolution (which turned out to be controlled by diffusion in melts, strongly affected by volatile content), and the diffusion of trace elements (especially those relevant to geochronologic applications) in accessory minerals. The results have been applied to MORB and IAB petrogenesis along with broad applications to granitic rocks and geochronology. Similar to his contributions to diffusion in melts, his work characterized all of the important variables and processes, and established the framework by which we currently interpret the behavior of accessory minerals.

Bruce has a way of looking at what many of us would call experimental artifacts, and from them extracting important geologic information. For example, his solution for how to ensure apatite saturation of basalt at high temperature was characteristically simple and unconventional—he made the capsule out of apatite! Experimenting with polycrystalline zirconia as a potential capsule material, he noticed that a basaltic melt held in this material migrated along the grain boundaries. Realizing that he was seeing melt infiltration, he and his students turned their attention to understanding the factors that control fluid-mineral textural equilibria, a phenomena that has wider ranging implications for fluid transport in the earth. His investigations of the textural maturation of rock-melt systems and the effect of surface energy on the mobility of fluids in the crust and mantle has proven extraordinarily important and influenced our understanding of areas as diverse as the significance of fluid inclusions and the nature of metamorphism. He and his students developed a method for measuring diffusion enhancement due to an interconnected fluid phase, allowing them to determine at what melt fraction interconnectivity is lost. Again, the experiments conducted by Bruce and his colleagues established the framework for understanding these processes.

Along the way, Bruce has also profoundly influenced the style of research in his field through mentoring the many students and colleagues, including us, who have flocked to his lab in the generally incompletely realized hope of emulating the master. Bruce has been unfailingly generous with his time and is widely revered by his colleagues. For his inventive application of experimental petrology to understanding Earth, we recognize E. Bruce Watson with the 1998 Day Medal.

Response by EDWARD B. WATSON

Receiving the Day Medal has special significance to me for several reasons. I am, of course, deeply honored and pleased—as well as somewhat humbled—to join the company of previous medalists, whose collective contributions to geology are truly enormous. In addition, though, I am reminded that my membership in the GSA goes back more years than any of my other professional affiliations. I joined the Society 28 years ago, when I was an undergraduate at the University of New Hampshire. Believe it or not, I remember poring over each issue of the *Bulletin* in my dormitory room, even though I didn't understand all the articles and couldn't really appreciate the significance of many that I did understand. Having the volumes on my shelf gave me inspiration and goals during years that I now recognize as among the most formative of my professional life.

The Day Medal is particularly rewarding to me also because it recognizes and encourages "applications of physics and chemistry to the solution of geological problems." I think this is a fair representation of what I do (the chemistry part, at least), but I got to this point by a circuitous and somewhat rebellious route. Early in my education, I was a successful but unenthusiastic student of physics and chemistry. In retrospect, I think my lack of enthusiasm stemmed from the fact that these disciplines were taught, at least at the introductory level, as if there were nothing more to discover—as if our knowledge were complete. My first geology course came as a breath of fresh air, not least because I began to hear professors say "we don't know the answer" or "we don't understand this." This confession of ignorance in science struck me as an extraordinary thing, and I was encouraged by the thought that I could someday contribute something really new to science by studying geological things that weren't already known. It was later pointed out to me that I might have to learn a little more science and math to actually do this.

The Day Medal is special to me, finally, because of the specific intent of the award to "recognize outstanding achievement and inspire further effort." I don't know if the "inspire further effort part" is intended for the current medalist each year, but I like the interpretation that I, personally, am seen as potentially capable of making more contributions in the future. I certainly hope that is so.

I was introduced to geology at Williams College 30 years ago, but I really began my education under Wally Bothner and Henri Gaudette at the University of New Hampshire, where I transferred after my freshman year. With Wally's encouragement (translate as "unbelievably time-consuming lab exercises") I learned a great deal about rocks; this knowledge still guides me today. From Henri I learned that one could apply the principles of chemistry to the understanding of rocks and water, which got me into the frame of mind I would need to survive courses in thermodynamics at MIT. Together, Wally and Henri brought enough persuasive power to bear that I took not only more traditional math courses than my degree required, but also a new course called "digital computer systems." My friends (and my wife) know a conservative side of me that is skeptical of trendy developments that seem designed to undermine honest work and human talent (I did not, for example, start using e-mail until three years ago); at least after UNH I never had to be persuaded that computers are a good thing.

I went to MIT in the fall of 1972 with the idea of becoming a volcanologist, but I was quickly drawn to the energy of the geochemistry program, and to a fellow New Hampshire native—in the person of John Dickey—as my advisor. Eventually, John gave up trying to lure me to Mediterranean Spain for a field-based thesis, and—upon noting that my hands are possibly a stronger asset than my brain—he got me an entree to the Geophysical Lab for a predoctoral fellowship. I went to Washington, however, not with ideas of making new phase diagrams, but to sort out some of the mysteries of crystal/melt partition coefficients. At MIT, Fred Frey had taught me trace-element geochemistry, and he also helped me to see where strategic experiments might push the discipline ahead a little. And so—with Hat Yoder's forbearance and the blessing of my mentors at MIT—I became an "experimental geochemist."

Something unusual and very significant happened when I returned from the Geophysical Lab for a final year of thesis writing at MIT: Stan Hart joined the faculty as a senior professor. During his very first semester, Stan offered his course in geochemical kinetics, which I took for a grade—even though I was closing in on thesis completion. One needn't squint very hard at my list of publications to discern the impact that course had on me.

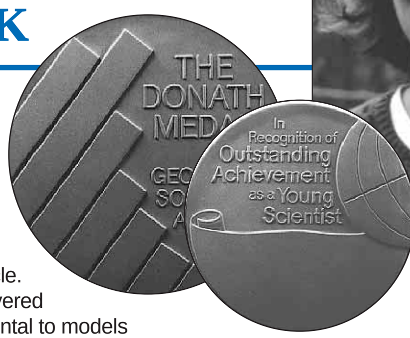
One more small incident has had a disproportionate influence on my scientific philosophy and approach. Not long after I arrived at Rensselaer in 1977, I was invited (as all new RPI professors are) to give a seminar at SUNY Albany. This was well before what are now known at Albany as "the Harrison years"—at the time, the department was a leading center of thought in plate tectonics. I was introduced to the individual Albany faculty before my talk, and I vividly remember shaking the hand of a very tall marine geologist by the name of Jeff Fox (now in Texas). I explained to Jeff that I had come from MIT via the Geophysical Lab, and that I did high *P-T* experiments. A knowing, not unfriendly look came over Jeff's face, and he said "Oh—you're one of those guys who's lost inside the basalt tetrahedron. Will we understand anything you're going to say?" My talk quickly ensued, so I had no opportunity to defend myself, but Jeff's words have stuck with me. Whether he meant to or not, he succeeded in communicating two bits of wisdom to a young scientist: (1) in doing research, keep the forest in view even when you must momentarily focus on the trees, and (2) strive to communicate the significance of what you do in the broadest possible way. I've tried to do those things ever since; maybe they even helped to get me here this evening.

I owe thanks to many people in addition to those I've already mentioned: My parents, of course, for letting me find my own way (and for a few other things); Don Miller, my long-time chairman at RPI, for not burdening young faculty too heavily with administrative chores; Mark Harrison, for sharing some of the difficult years as young scientists finding our wings; Rick Ryerson, for turning from a scientific competitor into a friend and amazingly versatile colleague; Frank Richter, for not belittling my forays into numerical modeling and for sharing his gifts with the geochemical community in general; Calvin Miller, for always reminding me that if you don't see it in the rocks it probably isn't there; my graduate students, for helping me to get the job done over the years; Daniele Cherniak and Dave Wark, for sharing so generously their talents in research; and all my geoscience colleagues at RPI, who, in our vigorous little department, inspire by example. Last and most of all, I thank my wife, Susan, and my son, Jonah, who cope remarkably well with my scientific preoccupations—I couldn't do my job without their encouragement and support.

YOUNG SCIENTIST AWARD (Donath Medal)

presented to

TERRY PLANK



Citation by CHARLES H. LANGMUIR

Terry Plank has made major advances to our understanding of the plate tectonic geochemical cycle. At convergent margins, she discovered new systematics that are fundamental to models of convergent margin processing: major element compositions of basalts correlate with crustal thickness, and sediment input correlates with arc output. By developing quantitative models to explain these facts, Terry's work has both defined new global systematics and presented working hypotheses to account for them. Terry also determined the global composition of subducting sediment, deduced new values for the chemical composition of the continental crust, and constrained whole-earth sediment recycling. At ocean ridges, Terry explained how variations in the melting regime affect basalt chemistry, and she resolved the dispute between geophysicists and geochemists over the mean extent of melting of the mantle. Terry is that rare individual who is able to make new discoveries by combining excellent analytical chemistry with modeling, sound reasoning, and a global vision. She has also emerged as a scientific leader at a young age, as witnessed by her distinguished record of service and selection as ODP co-chief scientist.

Her ability to identify crucial problems, amass encyclopedic knowledge, obtain crucial data, develop innovative models, write seminal papers, and lead the community identifies Terry Plank as a truly outstanding young scientist.

Response by TERRY PLANK

Thank you, Charlie, for your kind words, and thanks to the Geological Society of America for this great honor, the Donath Young Scientist Medal. It is an especially great honor, given the many people I admire among my contemporaries who are equally deserving of this award. Clearly, awards such as these represent work that is much greater than any individual's effort, and it is no exception in my case. I take this opportunity to thank the many people who have helped shaped my career as a geologist.

Unlike most of you, I'm sure, my life as a geologist began at birth. I was literally born in a rock quarry, the Wooddale quarry of Wilmington, Delaware, with 200 foot sheer cliffs of migmatized Wissahickon schist. My father was somehow drawn into building our house in this quarry, and it has metaphorically and physically centered my family. It is not just the best exposure in Delaware, but it was my first field area, and eventually became the topic of my mother's Master's thesis. I was an avid mineral collector, and was fortunate to have my mother and brother accompany me on field trips over ten years. I was also mentored early on by Peter Leavens at the University of Delaware and members of the Mineralogical Society of Delaware. I have come to realize there was something special about Wilmington. Largely because of the DuPont Company, Wilmington was full of chemists, and it turned out to be a particularly rich environment for spawning scientists. I keep finding talented, Delaware-raised geologists, like Marc Spiegelman, Peter Kelemen, Anne Trehu, Ken MacLeod, Lars Stixrude, and John Farrell.

My first research experience involved a small mapping project near our home, in a metagranodiorite unit. From this I had to prepare my first talk, as a junior in high school, for the National Youth Science Symposium. I remember sitting at the kitchen table with my mother and my sister, making beautiful overheads showing the plate tectonic cycle, and eventually how boulders in Delaware related to the closing of Iapetus and the Appalachian orogenies. In a 15-minute talk, I probably spent 14 minutes discussing the theory of plate tectonics. Needless to say, I didn't spend enough time demonstrating to the jury what my unique contribution had been, but looking back on it, I realize I have always been fascinated by the largest-scale processes that shape our planet.

I was fortunate to attend Dartmouth College, with its excellent geology program for undergraduates. John Lyons taught me more of the secrets of the Appalachians, and Dick Stoiber and the famous Dartmouth Stretch ignited my interest, like so many others, in volcanoes. A summer research experience with Jean-Guy Schilling and Haraldur Sigurdsson at the University of Rhode Island convinced me to enter a Ph.D. program.

Maybe it is clear at this point how a budding metamorphic petrologist ended up at Lamont, but it was a lucky move, and much of what I've accomplished was born from the petrology group at Lamont. I arrived when Charlie Langmuir, Dave Walker, and Alan Zindler were building that group, and it was such an exciting place to be. There was a large collection of very gifted fellow students, including Emily Klein, Carl Agee, Youxue Zhang, Dan Miller, Jennifer Reynolds, Cheryl Peach, Franco Marcantonio, Laurie Reisberg, Bernard Bourdon, and Jeff Ryan, and many postdocs, research scientists, and visiting dignitaries who were part of the geochemistry group at one time or another, including David Christie, Chip Lesher, Jim Rubenstone, Cindy Evans, John Longhi, John Ludden, Hubert Staudigel, Tim Elliott, Ken Farley, and Francis Albarede. I thank all of these people for helping me along various parts of the learning curve. Clearly, there is something special about the Lamont petrology group. Among my peers alone, it has produced recipients of six Young Scientist Medals from various societies.

Many exciting ideas came out of the Lamont group. In 1986, Emily Klein and Charlie Langmuir discovered global correlations between mid-ocean ridge depth and the Na content of MORBs. Not long after, we found similar relationships in arc basalts. Our decompression melting model has served as a good target for others to aim at, but questions as to the relative contribution between water-fluxed and decompression melting are still at the forefront today.

My interest in sediment subduction can actually be traced back to a lecture in the Costa Rican jungle during my junior year on the Dartmouth Stretch. Barbara Barreiro had recently joined the Dartmouth faculty from a postdoc at Carnegie, where Julie Morris, Fouad Tera, and Lou Brown had just shown that the cosmogenic isotope ^{10}Be recycles from subducted seafloor sediments to arc volcanoes. This was conveyed in an alfresco lecture by Barbara, as we were sitting on the flanks of Poas volcano, about 100 km over the subducting Cocos plate. The drama of the moment was not lost on me, and many years later Charlie and I found ourselves being able to use a variety of simple element tracers, such as Ba and Th, to trace sediments into the trench and back out volcanoes in Central America and elsewhere around the world. Today, I am collaborating with Julie Morris and Mike Carr—another Dartmouth product—and my student Vaughn Balzer to watch the effects of changes in the subducted stratigraphy on the Cocos plate to the evolving Nicaragua volcanic arcs.

I have been lucky to have continued such fruitful collaborations with many people. While I was a postdoc at Cornell, Bill White and Mike Cheatham taught me the art of ICP-MS analyses, and a casual offer to measure Nb and Ta in some of Tim Elliott's Marianas basalts led to finding some compelling relationships with U-series isotopes that Tim obtained while at Lamont, and trace element ratios that I obtained at Cornell. In this remarkable data set, we also discovered that Nb/Ta ratios do indeed vary, something that was discovered at the same time by groups at Mainz and the Australian National University.

While at Cornell, I also began a collaboration with Marie (Krikitt) Johnson. Inspired by recent work by Caltech and Japanese groups, we used diamonds in experimental charges as collection sites for melts and fluids. I still remember the day Krikitt mailed to me from Lamont her first diamond layer from a sediment subduction experiment. This was a subsolidus experiment, and a simple peak scan on the ICPMS showed huge enrichments in Pb and U and the alkalis. We are still mining the secrets of these experiments, but the combination of experimental petrology and ICPMS and laser microanalysis holds great promise for making progress on tracer partitioning.

Next year I look forward to drilling into the oldest seafloor in the oceans, before it subducts into the Marianas trench, a remarkable opportunity afforded by the Ocean Drilling Program.

I have so many people to thank. First, obviously, is Charlie Langmuir. He was and continues to be a remarkable person to work with. His sharp mind and accurate intuition have always helped keep me headed in the right direction. He is the most exciting person I know to think with, and our interactions have always been full of discovery. Emily Klein and Tim Elliott I thank for hours of phone conversation and megabytes of e-mail communications. Thanks to many others, who, whether they realize it or not, have shared valuable advice or insight: Jim Gill, Roger Larson, Ed Stolper, Chris Hawkesworth, John Ludden, and Eli Silver.

I also thank my colleagues at the University of Kansas, for supporting my work and along with NSF and the Keck Foundation, helping provide me with an excellent analytical lab. Larry McKenna, Gwen Macpherson, and Doug Walker, in particular, have been valued colleagues. Thanks to all the other creative people at Kansas who found jobs for me and my husband. At a time when many two-career couples are challenged by the job market, Geoff and I have been lucky to have found a home for both of us, in a rare situation where we are equally supported.

Finally, I thank my husband, Geoff Abers, who has always been loving and supportive. He is also a geophysicist, and thus comes in handy all the time. I benefit every day from his deep understanding of the physical processes that shape our Earth.

Thank you very much for this great honor.

DISTINGUISHED SERVICE AWARD

presented to

JUNE R. FORSTROM
GEORGE R. HALLBERG
CHARLES J. MANKIN

Mankin Forstrom Hallberg

JUNE FORSTROM

Citation by FAITH ROGERS

Picture, if you will, the perfect GSA staff member: knowledgeable, interested in the work at hand and in the future of GSA programs, thorough, pleasant, efficient. June Forstrom embodied those attributes and more during her 25 years of administrative work at GSA headquarters. As Research Grants Administrator, she kept accurate records of myriad complex grant proposals, efficiently prepared materials for the Research Grants Committee, worked with the GSA Foundation to coordinate funding sources—and maintained an even-handed professionalism all the while. She was a familiar presence at GSA Council meetings, where she both taped the proceedings and took notes. June also coordinated publication and mailing of GSA Section and Division newsletters, and she applied her organizational and scheduling skills to the Annual Meeting newsroom, where each day is an intense round of press releases and scientist interviews.

More than one Research Grants Committee chair has cited June's positive attitude and pleasant demeanor as prime factors in keeping the committee members enthusiastically involved in the grants process. She knew the program thoroughly, and she accomplished the work with a cool head and a warm heart. Her retirement from GSA in May of this year brought a chorus of regrets from the current Research Grants Committee and even previous chairs.

June's long hours of hard work, her courtesy, and her genuine care for the Research Grants program and all those volunteer committee members are more than ample reason to honor her with this Distinguished Service Award.

Response by JUNE R. FORSTROM

I want to say thank you to the many members of the society with whom I have had the privilege of working in the past 25 years. I especially enjoyed working with everyone connected with the Research Grants program.

I am really thrilled to receive this honor.

GEORGE R. HALLBERG

Citation by ROBERT F. DIFFENDAL, JR.

George Hallberg became a member of GSA in 1971 and was subsequently elected a Fellow of the Society in 1983. George was elected secretary of the North-Central Section in 1989, and he served in this role until October 1997. He also served on the GSA Geology and Public Policy Committee from 1994 to 1997.

George took over the job of section secretary at a time when section finances were in order, but limited. The section had assets of slightly over $11,000 at the end of 1988. Financial help to students in the section that year amounted to $1,400 for two research awards and four Best Student Paper Awards.

George had great success in building the assets of the section, developing planning for section meetings at least four years in advance, and greatly expanding the funds awarded to students. At the end of his service in 1997, the section had assets of more than $50,000, had planned meetings through 2001, was awarding about $12,000 in student travel, research, and best paper awards, and was contributing to the GSA Second Century Fund annually.

The members of the North-Central Section and GSA recognize George's great contributions to GSA and the section with the Distinguished Service Award.

Response by GEORGE R. HALLBERG

It has always been an honor to serve GSA. I have found it a way to say thank you, and to pay back some of the many benefits that the Society has given me and all of us in the profession. And once again I find myself simply being able to say thank you, GSA, not only for this acknowledgment but for the many valued services you provide to all of us.

CHARLES J. MANKIN

Citation by ROBERT L FUCHS

Charlie Mankin is a zealot in the cause of geology. His deep interest and involvement have ranged widely across the science—from field work to research to teaching to science administration to government service. It is in this last arena that Charlie has particularly excelled. He has been a persistent advocate for all of us at both the state and federal levels. In his role as director of the Oklahoma Geological Survey for more than 30 years, Charlie is an eloquent and forceful spokesman for earth science and natural resources. His familiarity with the inner workings and nuances of governments may be unequaled among GSA's members. Time and again he has demonstrated a superb political ability to get things done for geology, for geologists, and for the citizenry.

As government questions the value of earth science, industry restructures, and academia seeks new pathways and new students, Charlie Mankin's considerable talents have made him our invaluable spokesman. His ability to lead organizations of scientists through dangerous political terrain is well documented. Charlie has been equally adept at detecting (à la Sherlock Holmes) and heading off impending disasters.

Charlie Mankin's extensive career accomplishments in science, education, and political relations are paralleled by his 30 years of distinguished service to GSA. He has been a member of 16 committees, chairing about half of these. Two tours of duty merit special note—Councilor and member of GSA's Executive Committee in the mid-1980s and Trustee of the GSA Foundation for the past ten years.

In 1992 the GSA Foundation began a comprehensive capital campaign, the Second Century Fund for Earth • Education • Environment. This was uncharted financial territory for GSA, and actually for scientific societies as a whole. Charlie chaired the Foundation through most of this campaign. He was a diligent, major gift fund raiser. Success is near at hand; the Second Century Fund is projected to surpass its $10 million goal by the end of the campaign in October 1999. Charlie's leadership of the Foundation plus his ability to ask for and get money were major ingredients behind this good news.

It is a great privilege to present to Charlie Mankin the Distinguished Service Award.

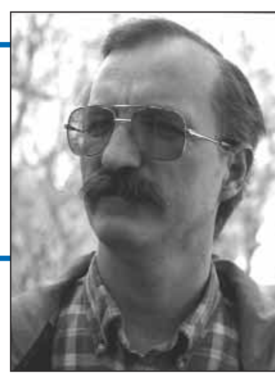
Response by CHARLES J. MANKIN

I sincerely appreciate receiving a Distinguished Service Award from the Geological Society of America. I accept this recognition on behalf of those who are primarily responsible, the members of the Board of Trustees and the staff of the GSA Foundation. I am proud to have had the opportunity to work with these dedicated people in service to the Society.

RIP RAPP ARCHAEOLOGICAL GEOLOGY AWARD

presented to

VANCE T. HOLLIDAY



Citation by EILEEN JOHNSON

"Wow, this place is flat! Keep driving, there's nothing out here." This statement no doubt has been uttered thousands of times by travelers passing through or around the Llano Estacado in wagons 100 years ago and those in cars and other vehicles today. The level horizon of the Southern High Plains gives way to an extensive grasslands dotted with thousands of playa lakes and a flatness relieved only by two major dune fields and precipitously by incised but now shallow draws (stream valleys) that meander across the region. Today, the region is stark, with little rain, the grasslands broken and playas drained for agricultural use, and the draws usually dry. Dust storms plague the region in springtime and the wind blows year-round, from gentle to tornadic. "Blue northers" come through in the winters followed by searing triple-digit heat in the summers. It takes a certain type or special person to live on the Southern High Plains, just as it takes a special type of scholar to unravel and reveal all its wonders.

Vance Holliday is one of those special scholars. Twenty-five years ago as a young undergraduate anthropology student at the University of Texas, he volunteered to be a member on the first field crew of what was then the Lubbock Lake Project. He found himself in the middle of the Llano Estacado, immersed in 12,000 years of stratigraphy and archaeology and many more thousands of years of geology within a setting of endless vistas and working within that interdisciplinary framework. Vance has been "hooked" ever since, hooked on the Southern High Plains and on geoarchaeology.

Vance has been following in the footsteps of a very select group of Quaternary scholars who ventured onto the Llano Estacado and remained to delve into its amazing deposits. Perhaps the most central figure within that small group is Glen L. Evans, Paleoindian specialist extraordinaire, who in the 1930s to 1950s as a geologist literally wrote the book, with Grayson E. Meade (a vertebrate paleontologist), on the Quaternary geology and Paleoindian archaeology of the Southern High Plains. While Glen wrote volume 1, Vance has been preparing and writing for volume 2.

The ancient waterways of the Llano Estacado have served as major highways across the region for thousands of years and as storehouses of information on the comings and goings over those thousands of years. Those comings and goings are not just of the various peoples who inhabited the region, but also of the natural history, climate and environments, hydrology, and sediments and soils, all within a stratigraphic framework. Understanding and detailing that framework has been a major focus of Vance's research over the past two decades. Using his extensive knowledge of the Lubbock Lake Landmark deposits, he conducted a systematic program of coring, sampling, describing, and dating the draw deposits throughout the region. A major research question was whether the Landmark's stratigraphic framework serves as a regional model or an exception. In the end, it is neither and both, and that question remains a topic of discussion between us. This systematic program is the first of its kind for the Southern High Plains, and while incorporating the work of previous scholars, it represents Vance's own unique perspective and determined efforts.

The impact of Vance's work has been felt across the Southern Plains from southeastern Colorado to lower Texas. Sought out by fellow scholars or contractors conducting cultural resource management projects, he is equally at ease with working out the terrace sequence of an old river system, Holocene dune events, or the microstratigraphy involved with a Paleoindian burial within lacustrine deposits. Wherever these pursuits have taken him, Vance comes back to the Llano Estacado as his research base. His interests have taken him throughout the Quaternary, from the transition from the Tertiary to soils developed only 100+ years ago. Vance's insights into the Blanco and Blackwater Draw formations, generally the bedrock for the archaeological record on the Llano Estacado, have provided a better understanding of their character, chronology, deposition, and topographic distribution. His work on Holocene buried soils in Yellowhouse Draw at the Landmark stands out as a major contribution towards understanding soil development and dynamics and the fast rate in which soils can develop and be buried in the late Quaternary. Vance's main focus, however, has been on the late Pleistocene and early Holocene and the Paleoindian period. His work has been instrumental in providing the geologic framework in which to decipher context and chronologic problems for Southern High Plains Paleoindian sites initially researched decades ago, as well as those being studied now and what may be found in the future. The Southern High Plains has not completely revealed its ancient history to Vance. Current work on playas and dunes is setting the interpretive framework for the archaeology within their sediments, a major segment of the archaeological record far too long ignored in the region.

Through his publications and teaching, Vance is influencing the next generation of researchers for whom geoarchaeological studies are the norm. Equally important, his work continues to impact the type and quality of archaeological field work being done by contemporaries through his constant demonstration of the usefulness and interpretive power of a geoarchaeological framework. For 25 years, Vance and I have been colleagues and research partners. Through long discussions, concurrence, divergent views, compromise, and occasional agreement to disagree, we have traveled a roadway that at times was straight and narrow and at other times branching, with many intersections. Learning together and from each other, we have had quite a ride across the Llano Estacado, where the flatness is only superficial and the monotonous landscape belies the past dynamics, changing topography, and vibrancy of the region.

Glen Evans, a consummate Quaternary scholar of his day, was conducting geoarchaeology long before the term was coined or the concept well integrated into field research. Vance began his studies just as the term was coming into existence and researchers were struggling to validate geoarchaeology as a discipline in its own right. He has been at the forefront of that struggle, and the body of his work and particularly the research on the draws of the Southern High Plains has influenced how geoarchaeology is viewed on those plains and throughout this country. Although too modest to admit it, Vance Holliday certainly is an accomplished Quaternary scholar of today.

Response by VANCE T. HOLLIDAY

Thank you, Eileen, for your kind words, and for much more, which I will return to later. I also thank Rolfe Mandel and the Archaeological Geology Division Awards Committee for your support and Rip Rapp for his many years of work to found and build this division and for endowing the award.

To have one's work ranked with the previous Archaeological Geology Division awardees is indeed an honor. That list includes many of my geoarchaeological heros, such as Glen Evans. I think of myself as just getting started in this game, but when most of us think about career awards, we usually think of grizzled old-timers. We can compromise and I'll just describe myself as a grizzled middle-aged guy!

I will begin at the beginning and thank my parents, Terrell and Adeline Holliday, who instilled in me an interest in the world and encouraged me to follow my own path. I was started on my geoarchaeological path when I was an undergraduate anthropology major at the University of Texas and worked for the late David Dibble at the Texas Archeological Survey. Dave, who was trained in the famous Environmental Archaeology program at Washington State University, first raised my awareness of the importance and promise of the geosciences in archaeological research. Dave also introduced me to the work of Vance Haynes. I vividly remember reading his papers on the Clovis site. Little did I realize I would quite literally follow in his footsteps there.

As Eileen mentioned, I joined the crew at the Lubbock Lake site for the first season, in 1973. In 1974, Eileen and Chuck Johnson gave me the opportunity to pursue a Master's degree while working on the site. A quarter century later I am still working there! Those four years at Texas Tech also led me directly into geoarchaeology. I was constantly encouraged and stimulated along these lines as a result of the spectacular stratigraphy at Lubbock Lake and by course work in geology from C. C. "Tex" Reeves and in soils by B. L. Allen. But Eileen was the one who provided the opportunity to work first on the soils at the site and eventually on all aspects of the geology, an opportunity that led to my broader interests in the geoarchaeology and Quaternary history of the Great Plains. At the same time, we continued to work on a variety of archaeological problems covering all time periods. We've worked together for 25 years now, and I look forward to the next 25.

While at Texas Tech, I realized that if I wanted a career in geoarchaeology emphasizing soils, I needed graduate training in the earth sciences. So I ended up in the Department of Geological Sciences at the University of Colorado, working on a Ph.D. under Pete Birkeland. Pete provided me with a scientific approach and healthy world view that has played a big role in attaining whatever success I've achieved.

During my graduate training I continued to follow Vance Haynes's work and over the years I've had the great fortune to get to know him and to work with him at such spectacular localities as Clovis, Folsom, and Lindenmeier. He has always been generous with his time and ideas, and welcoming to anyone who shares his interests in Paleoindians and geoarchaeology (not to mention military history). I've also benefited on more than one occasion in sharing not only his interests but his name. I can recall very enthusiastic welcomes from complete strangers at several archaeological sites. I am convinced they thought I was the other Vance, coming to sort out their geoarchaeological problems.

In 1986 my work on the High Plains put me in touch with David Meltzer, archaeologist at SMU, who was working on the southern end of the Southern High Plains. Dave invited me to join in his research, and this led to a long-lasting collaboration and friendship. This has been as much fun as it has been intellectually stimulating, even though I'm the one who usually provides the Corn Nuts and fig newtons.

My teaching career started with a position as a visiting professor in geography at the University of Wisconsin, followed by two years in both anthropology and geography at Texas A&M University. A&M is also where I met Diane, my wife, who has shared my interests in archaeology and geoscience (and military history). Diane and our daughter Cora are my reminders that there is life beyond academia and research. I had the opportunity to return to Wisconsin and have been in geography there for more than a dozen years. The department and the university have been, for me, the ideal environment in which to work. In particular, my colleagues Jim Knox in geography and Jim Stoltman in anthropology have been most supportive of my attempts to pursue geoarchaeology in both research and teaching.

To paraphrase a line from Diane's dissertation, this has been a strange journey. When I first became involved in geoarchaeology I never thought I would end up in a geography department, because my training was in geology and archaeology. But when I joined geography at Wisconsin, the fit between geography and geoarchaeology was obvious and quite comfortable. Geography is an outstanding disciplinary home for geoarchaeology, given the geographic focus on people and the land and on geomorphology, soils, biogeography, and climatology, and given the traditional connection between geography and archaeology. And of course, several of our leading geoarchaeological thinkers and practitioners (and Archaeological Geology Award winners) are geographers. Clearly, a strength of geoarchaeology is its breadth, encompassing geology, archaeology, geography, and other disciplines. I have the impression, however, that in many departments of geology and anthropology, geoarchaeology is not viewed as a legitimate subdiscipline. Not enough big money for geology and simply a tool for archaeology. I hope I am wrong, but in any case, the Archaeological Geology Division and the newly formed Geoarchaeology Interest Group of the SAA are ways to raise the visibility and legitimacy of geoarchaeology at a departmental level.

I must also recognize the role the Archaeological Geology Division played in my career. I became secretary soon after completing graduate school, thanks to Diana Kamilli, the first secretary. It was one of the best career decisions I made. As secretary, I got to know many geoarchaeologists, including some of the key players in the early days of the division: Rip Rapp, Claude Albritton, Charles Vitaliano, and Bill Farrand, among others. This was an important lesson to me in getting involved in professional service early in one's career.

Several other friends and colleagues have been a source of enthusiasm and support and have worked to keep me honest. In addition to the folks mentioned above, and at the risk of leaving someone out, I thank Art Bettis, Reid Ferring, Grant Hall, Jack Hofman, Bill Johnson, Angela Linse, Les McFadden, Dan Muhs, Rolfe Mandel, and Julie Stein. My graduate-student field assistants have also been a source of inspiration, as well as perspiration, and we've all had a great time in our geoarchaeological endeavors. I thank Peter Jacobs, Ty Sabin, Garry Running, Jim Jordan, and Jemuel Ripley. I wish them and all of my other students the same success and enjoyment I have had.

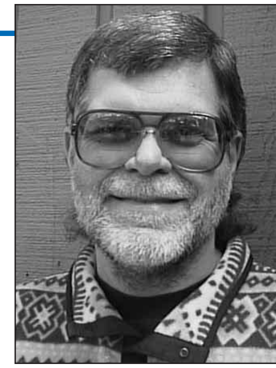
E. B. BURWELL, JR., AWARD

presented to

ROGER T. SAUCIER, LAWSON M. SMITH, WHITNEY J. AUTIN

Saucier

Smith



Autin

Citation by ROY J. SHLEMON

Ladies and Gentlemen:

The E. B. Burwell, Jr., Award is one of the most prestigious given by the Engineering Geology Division of the Geological Society of America. It recognizes authors and editors whose papers significantly advance our understanding of the principles and the practice of engineering geology. Accordingly, it is my honor and pleasure to recognize the recipients of the 1998 Burwell Award: Roger T. Saucier, Lawson M. Smith, and Whitney J. Autin. Our recipients are so honored for their editorship and individual contributions to the 479-page special edition of the journal *Engineering Geology* (v. 45, nos. 1–4; December 1996), entitled *Geology in the Lower Mississippi Valley: Implications for Engineering, the Half Century Since Fisk, 1944.* This monumental work is the outgrowth of a conference held in Vicksburg, Mississippi, in December 1994, some 50 years after appearance of the famous Harold N. Fisk monograph *Geological Investigation of the Alluvial Valley of the Lower Mississippi River.* The 24 individual contributions to the 1996 special edition—some written by our Burwell Award recipients—cover a wide range of topics. These include (1) honors to and syntheses of Fisk's seminal work and its historical application to engineering in the Lower Mississippi River valley; (2) a summary of new concepts and methods to evaluate river response to broad-scale variation in alluvial lithology and to influence of tributary and minor basins; (3) a substantial revision of the late Quaternary chronology based on numeric and relative dating stemming from interdisciplinary geomorphic, archaeologic, and pedologic investigations; and (4) the origin of loess, hydrogeologic framework, paleoecologic aspects, and recognition and potential impact of neotectonism in the Lower Mississippi Valley.

Saucier, Smith, and Autin have, in their respective careers, employed multidisciplinary techniques to understand better the alluvial geology of the Lower Mississippi Valley, and thus to advance the pioneering, applied geology of Fisk. Specifically, from an engineering-geology viewpoint, they individually and collectively analyzed and interpreted thousands of cores, leading to more accurate geotechnical and paleoenvironmental characterization, and to the capability to extrapolate the "micro-stratigraphy" and chronology of Mississippi Valley alluvial sediments. Their work is thus inherently practical, and greatly enhances knowledge about problems and solutions for Mississippi River bank stabilization and channel abandonment.

Roger Saucier took his B.A., M.A., and Ph.D. (1968) degrees from Louisiana State University (LSU) in Baton Rouge, studying under such notable professors as Richard Russell, Fred Kniffen, William McIntire, William Haag, and Clair Brown. The dissertation for his Ph.D., given by the Department of Geography and Anthropology, concerned the origin of Lake Ponchartrain, and it reflects an interdisciplinary background well applied to study of alluvial sediments. His early professional associations were with the LSU Coastal Studies Institute and the American Museum of Natural History, but the bulk of his more than 40-year professional career was at the Army Corps of Engineers Waterways Experiment Station (WES) in Vicksburg. There, he continued his interdisciplinary research efforts, leading to publication of more than 60 papers. Specifically, he mapped alluvial deposits in all parts of the Mississippi Valley; he conducted engineering-geologic investigations for eight major construction sites; and he provided geomorphic analysis for many cultural resources surveys.

Since his retirement from the Army Corps of Engineers, Roger has consulted for many state and federal agencies, as well as for private developers, providing technical information about site selection, foundation conditions, utility-corridor routing, archaeology, and other projects requiring his unique knowledge of landscape evolution, and engineering aspects of fluvial and deltaic deposits. Roger's scientific contributions have long been recognized: he received the Decoration for Meritorious Civilian Service (1973) from the Department of the Army, the Roald Fryxell Award for Interdisciplinary Research (1985) from the Society of American Archaeology, and the Kirk Bryan Award (1997) from the Quaternary Geology and Geomorphology Division of the Geological Society of America.

Lawson M. Smith intimately knows the Mississippi River valley. Raised on the banks of the Mississippi River in Greenville, Mississippi, he spent three years in the Army as a topographic surveyor. He later obtained a B.S. degree from Mississippi State University (1975), a Master's from the University of Southern Mississippi (1977), and a Ph.D. from the University of Illinois at Urbana-Champaign (1983). His dissertation concerned the geomorphology and sedimentology of alluvial fan development in humid climatic regions.

Lawson spent much of his professional career at the WES in Vicksburg, rising through the ranks from geologist to chief of the Engineering Geology Group, and ultimately to senior research geologist. At the WES, Lawson has applied geomorphic theory and methods to civil works and military engineering practice, such as river engineering, wetland restoration, natural hazards identification and mitigation, and cultural resource management. In 1997, he received a year-long Secretary of the Army Research and Study Fellowship, taken at the Colorado School of Mines.

Whitney J. Autin took his B.S. (1976) and M.S. (1978) degrees in geology from Nicholls State University and the University of Mississippi, respectively, and his Ph.D. from LSU (1989). For 18 years he worked for the Louisiana State Geological Survey. In this capacity, he produced many geological maps of Louisiana, frequently and skillfully employing soil-stratigraphic techniques. His work is thus a valuable resource for engineering geologists working in and around the Lower Mississippi Valley.

Whitney is an assistant professor in the Department of Earth Science at the State University of New York at Brockport. There, he continues his interdisciplinary research and teaching in the fields of sedimentology, physical geography, pedology, and environmental geology. His published research has focused on the evolution of the Gulf Coastal Plain and the Mississippi Valley. Now he is expanding his interests into the Lake Ontario Lowlands of western New York.

It is especially fitting that two recipients of the 1998 E. B. Burwell, Jr., Award spent much of their professional careers with the U.S. Army Corps of Engineers, for Edward Burwell himself, one of the founders of our division, was the first chief geologist of the corps! Additionally, the 1998 recipients of the award have done more than increase our knowledge about the geology of the Lower Mississippi Valley. Indeed, their paper provides us with concepts and techniques that are applicable to engineering geology far beyond the Mississippi Valley. That is truly the hallmark of a valuable contribution to science in general, and to engineering-geologic practice in particular.

Response by ROGER T. SAUCIER

I am deeply honored and appreciative to be a part of the team of editors selected to receive the E. B. Burwell, Jr., Award for 1998. We are proud to have our names added to the list of truly distinguished scientists who have been recognized by the Engineering Geology Division.

A graduate of the Universities of Oregon and Cincinnati, Harold N. Fisk in 1935 accepted positions on the faculty of Louisiana State University and the staff of the Louisiana Geological Survey. Under the strong influence of the alluvial geomorphologist, Richard Russell, he became intrigued with Mississippi Valley landforms, processes, and paleogeography. By 1941, his work in central Louisiana caught the attention of the Corps of Engineers Mississippi River Commission (MRC), in Vicksburg, Mississippi, which was struggling to understand fluvial dynamics and river behavior as related to flood control and navigation. Thus began an 11-year period during which Fisk served as a geological consultant to the MRC, producing 29 reports on studies of bank erosion, faulting, levee underseepage, sedimentation, depositional environments, subsurface geology, foundation conditions, fluvial processes, and regional mapping.

Without question, Fisk became the torchbearer of Lower Mississippi Valley geology, and his remarkable 1944 publication, “Geological Investigation of the Alluvial Valley of the Lower Mississippi River” soon became a collector’s item and classic. In my estimation, Fisk’s collective studies demonstrated an extraordinary perception and talent—that is, to make an understanding and appreciation of geological processes an integral part of engineering in an alluvial environment. Perhaps his greatest contribution was to provide civil engineers with practical data for use in engineering design—not just alternative hypotheses and concepts.

The emphatic nature of Fisk’s 1944 report, along with its elaborate detail and extraordinary graphics, had a profound effect on many readers. His river chronology, for example, was “discovered” and accepted by archaeologists as the Holy Grail. The corps, however, recognized that much additional geological work was needed, and it provided years of funding for subsequent refinements and expansions. For more than a decade, I had the privilege of directing and accomplishing a systematic geomorphic and geologic mapping program, which led indirectly to major new discoveries and revised concepts. While I wrote some journal articles and monographs on highlights, the vast majority of the work was largely inaccessible, in limited editions in the gray literature. Only a few brief syntheses were provided, such as a chapter in a DNAG volume.

In 1992, Lawson Smith recognized the need, and opportunity, for a 50-year update of Fisk’s 1944 classic. He obtained the sponsorship of the MRC, and I produced a comprehensive, two-volume synthesis that was published by the corps in 1994. As part of the update effort, the MRC also graciously agreed to sponsor a conference highlighting Fisk’s career and its many contributions. The 1994 synthesis was my interpretation, but we needed an accompanying open forum for further discussion and evaluation of emerging concepts, and a look to the future.

The conference, held in Vicksburg in December 1994, was an outstanding success. Through the efforts of Ellis Krinitzsky, Elsevier agreed to publish the full conference proceedings as a special issue of the journal *Engineering Geology.* The issue appeared in December 1996, and its acceptance and recognition are why we are here today. Lawson Smith, Whitney Autin, and I planned the conference themes, identified papers and speakers, contributed papers ourselves, prepared exhibits, served as moderators, and reviewed all papers. I accepted the challenge of being the principal editor of the 24 papers prepared by 35 authors. These authors are the *real* recipients of this award.

Fisk’s activities for the Corps of Engineers focused on specific engineering geologic problems such as bank caving, underseepage, river diversions, and basin planning. Categorically, most could be classified as construction site selection and evaluation, and foundation engineering. However insightful and visionary Fisk was, he failed to anticipate the tremendous breadth of applications of his contributions.

My award co-recipients and I are of a different school and era—our backgrounds and experiences have been highly multidisciplinary. Our principal goal in organizing the Fisk conference was to reflect on Fisk’s legacy in today’s world of multidisciplinary science. We stressed applications to engineering and environmental geology such as neotectonics and paleoseismology, groundwater production, sediment dynamics, paleohydrology, and geoarchaeology. We could just as well have included applications such as hazardous waste management, wetlands evaluation and restoration, and resource management. In each of these areas, the current state of knowledge has strong links that can be traced directly back to Fisk. Indeed, Quaternary science has come a long way in the past five or so decades, following new paths and facilitated by Fisk’s pioneering efforts.

My 40+ year career has involved a dream that later became a goal. To me, the ultimate recognition of my work would be to receive a prestigious award in each of the three somewhat diverse professional fields that I have worked in—geomorphology, archaeology, and engineering geology. Ten years ago, this seemed like an impossible dream. However, I have been extremely fortunate—perhaps just being at the right place at the right time—to take advantage of some tremendous opportunities. In the past 12 years, I have received awards from the Society of American Archaeology and GSA’s Geomorphology and Quaternary Geology Division, and today, the E. B. Burwell, Jr., Award from this division. My goal has been met, but I am not stopping there! Being in that marvelous stage of life called retirement, I am still just building steam and picking up speed. I believe Fisk gave me a mandate and I intend to continue pursuing it.

Response by LAWSON M. SMITH

What an honor it was to learn of our selection as the recipients of the 1998 E. B. Burwell, Jr., Award of the GSA! Our selection was particularly gratifying when considering how many quality publications there have been in engineering geology over the past several years. I am personally grateful to all who had a hand in the many phases of the project, from conception to selection by the award committee.

Although Fisk’s work in the Lower Mississippi River valley is arguably the foundation for the practice of engineering geology in alluvial and deltaic landscapes, his studies profoundly influenced the thinking and research of a broad spectrum of sciences and civil engineering. Consequently, when we organized the themes and topics of the conference, we invited prominent scientists and engineers who could speak about the significance of Fisk’s contributions and subsequent geological and geomorphological research in the Lower Mississippi Valley and other areas. In contacting the speakers about specific topics, we provided some general guidance about the intended themes and goals of the conference and how we saw their papers contributing to the fabric of a coherent and informative event. We were encouraged by the authors’ enthusiastic acceptance of our invitation and the general topics we suggested. The result is a topically broad collection of papers from the fields of engineering geology, geomorphology, sedimentology, hydrogeology, stratigraphy, Quaternary geology, petroleum geology, coastal and marine geology, seismology, tectonics, civil engineering, soil science, paleoecology, climatology, archaeology, and history. These seemingly disparate disciplines were united by themes inspired by Fisk’s work in the Lower Mississippi Valley.

The conference was held at the U.S. Army Engineers Waterways Experiment Station in Vicksburg, Mississippi, in December 1944, exactly 50 years after the publication of Fisk’s monumental *Geological Investigation of the Alluvial Valley of the Lower Mississippi River* Approximately 90 scientists and engineers from around the United States and several foreign countries heard 31 papers organized into four themes: the historical context of H. N. Fisk’s contributions; modern geological concepts of the Lower Mississippi Valley; Quaternary geology of the region in the context of the North American continent; and future problems and opportunities for research. The enthusiasm of the presenters and authors was reflected in the high quality of the papers, of which 24 are published in the proceedings.

All who have had the seemingly never-ending experience of getting a conference proceedings published can appreciate the value of working with conscientious and talented authors and co-editors and an enthusiastic publisher. Working with the authors was indeed a pleasure, as all were committed to a high-quality contribution. Although Whitney, Roger, and I reviewed and commented on all of the papers, Roger took on the many tasks of shepherding the project and insuring final publication of a volume that we would all be proud of. The result was an interesting and informative collection of papers that we hope will be valuable to engineering geologists, geomorphologists, Quaternary geologists, and others working in the Lower Mississippi Valley. The recent substantial reduction of the price of the volume by Elsevier will, we hope, make the many valuable papers it contains more readily available to a wide range of readers.

Many people deserve my gratitude for their part in this award. Roger and Whitney were, as always, a pleasure to work with. The authors of the papers are, of course, principally responsible for the quality and value of the volume and share immeasurably in the award. The editors of *Engineering Geology,* especially Ellis Krinitzsky, were gracious to offer a special issue of the journal as an outlet for the proceedings. Special thanks go to the Mississippi Valley Division of the Corps of Engineers, notably Tony Young, Larry Cave, and Frank Weaver, for their generous support of the conference. Robert W. Whalin, director of the Waterways Experiment Station, generously provided the support of his organization for the conference.

Brien Winkley, our friend and colleague and my co-author of one of the papers, passed away before this award was announced. Brien was an insightful and talented civil engineer whose global knowledge of rivers and the importance of geologic things was truly remarkable and is sorely missed. Finally and most important, the support of my wife Rachel and our sons Brandtly and Joshua are the foundation and a major inspiration of whatever modest accomplishments I achieve.

Response by WHITNEY J. AUTIN

I am appreciative and flattered to have been chosen as a recipient of the E. B. Burwell, Jr., Award. I thank the Engineering Geology Division of GSA for the award, and Roy Shlemon for his citation. The publication of our volume could not have succeeded without the large number of people who made it a reality. I thank my co-editors Roger T. Saucier and Lawson M. Smith. Without the chemistry of our collaborative effort, the volume certainly would be different. The contributing authors did an outstanding job in preparing their manuscripts and responding to our editorial comments in a timely fashion. I also thank the U.S. Army Engineers, Waterways Experiment Station for funding my participation in the project.

An exhaustive list of professionals worked with me during my career, influencing my thoughts and actions, helping me to improve myself as a scientist. These include my former teachers, my collaborators, and my critics. I thank my family, especially my wife Nancy, who patiently puts up with all of my long hours of work. And if it were not for my parents, who encouraged me to pursue an education, I would probably not have experienced the benefits of becoming a professional and a scientist.

GEORGE P. WOOLLARD AWARD

presented to

THOMAS H. JORDAN

Citation by JEAN-BERNARD MINSTER

It is my distinct honor and genuine pleasure to provide the citation of Thomas H. Jordan as the recipient of the Geological Society of America's George P. Woollard Award for 1998. It is all the more pleasant in view of our friendship over the past three decades, and I have been privileged to work with him on projects that are among the most enjoyable research I have ever done.

The Woollard award, given by the GSA Geophysics division is to honor a geophysicist who has made important contributions to geology. Asking myself how Tom Jordan contributed most importantly to geology, I ordered his publications in some geo-logical fashion, which is not chronological. A first group, of eight papers, is clearly theoretical in nature, full of esoteric equations, dealing mostly with inversion theory and geostatistical concepts. One cannot hold this against him, as everyone should be entitled to do a bit of theory once in a while. The next group, 56 papers, describes a wide variety of seismological investigations. The papers include aftershock studies, analyses of traveltimes and free oscillations, works on attenuation and lateral inhomogeneities in Earth's mantle, descriptions of field work associated with the Ngendei expedition in the South Pacific, and interesting topics such as the penetration of slabs into the lower mantle—but I suspect that most card-carrying geologists would not accept these papers as contributions to geology!

Then we find 15 papers dealing with plate motions and deformations. These range from global plate kinematics to local and regional deformation detected by space geodetic techniques, with more than a few geological inputs. As a co-author of quite a few of these papers, I would certainly be tempted to argue that these represent important contributions to geological science. But I will resist this temptation. The fact of the matter is, from the very beginning, Tom approached this part of his research as a hobby, and one cannot get an award for a hobby.

This leaves us with a much more manageable residue of 45 papers, which I think embody the part of Tom Jordan's research which really justifies this award.

There is a popular tale that certain geophysicists tend to shift the focus of their research to deeper and deeper layers as they wish to indulge in more and more speculation, since it seems safer to deal with pieces of Earth for which there is little ground truth, so to speak. Not Tom Jordan! His first four papers (with D. L. Anderson and C. Sammis) had to do with the composition of the core and mantle. In fact, Tom did not reach the surface until six years later, and the first title in his bibliography which mentions the crust is the sixteenth, with N. Frazer, dealing with crustal structure derived from waveform modeling. Of course, his next paper, a major contribution in *Reviews of Geophysics,* was "The Continental Tectosphere," with which he entered the geological debate with a bold statement challenging conventional wisdom about the nature of lithospheric plates, arguing on the basis of seismic and gravity data, heat flow, and geothermometry that continents have deep roots, and reasoning that there must therefore be substantial lateral temperature and chemical variations throughout the uppermost mantle, and ultimately that convection must involve the lower mantle.

This leads me to bring up an important characteristic of Jordan's research. I expect all of you to know what I mean if I make the distinction between "safe" science and, perhaps, "intellectually challenging" science. The former is often accepted without much argument by the community, but the latter is usually not immediately endorsed, and is often fought over with great energy. The tectosphere argument was clearly in the latter category, and triggered a decade-long debate in the field, which engaged geophyscists, geochemists, and geologists alike. Similarly, when Tom argued in 1977 that there was seismic evidence for slab penetration into the lower mantle beneath the Sea of Okhotsk, he triggered a long series of papers, with numerous points and counterpoints argued forcefully. That study actually built on an earlier 1974 paper with W. Lynn in which they discovered the so-called "Caribbean anomaly," which is so evident in recent tomographic images. Another example was the suggestion in 1990 (with G. Beroza) that very long time series of broad-band seismic records revealed evidence for slow and silent earthquakes. This observation places strong constraints on fault mechanics, but it took some time, and much follow-on work, before the debate became more "classical" science.

Another essential aspect of Tom's work has to do with his own personal style. "Style" was judged to be a critical ingredient in good science by the late Bill Menard, with whom Tom worked on counting seamounts in the Pacific. As an example, to interpret SeaMARC and SeaBeam bathymetry data, Tom and his colleagues (notably his student J. Goff) set up a theoretical stochastic model of seafloor morphology and determined the model parameters by solving an inverse problem. While this is not a classical geological approach, the outcome is pure geology. That, in my view, displays a unique style for doing geomorphology. Tom's style is also apparent in his flair for the dramatic: Who else would pick "structural geology of the Earth's interior" as a title for a major summary paper? From personal experience, I can testify that writing with Tom as a co-author is great fun, because the manuscript is often laced with wonderfully turned bold sentences, some of which survive in the final draft! I will only give you one quote, my favorite Jordan quote of all time, which I know only a few have had a chance to read. It has to do with generalized inverse theory, and with the selection of a norm on the space of possible Earth models—which were taken to be stochastic—by specifying an auto-correlation operator: "The Earth itself is presumably unique, and the mind twists to imagine what a sample ensemble of [the stochastic process used to describe the model] might be (the radial variations of elastic parameters in a number of Earth-like planets taken at random from our galaxy perhaps?)" Talk about thinking big!

Finally, Tom Jordan spends quite a bit of time thinking about the place of solid-earth and geological research in the broader universe of the geosciences. "Earth systems science" has now become a commonplace phrase, and every geo-department in the world offers at least one course on the subject. Nevertheless, that phrase has come to be attached specifically to climate change research, and therefore applies primarily to oceanography and atmospheric science, leaving solid-earth science in the dust. In an effort to counter this, Tom coined the term "rock systems science" and proposed a framework to support discussion and analysis of rock systems. I do not know whether the term will eventually be accepted as generally as "Earth systems science," but I concur with the need for a complementary concept that would cover solid-earth disciplines. I should note that Tom has been following up on this by getting involved in new studies of three-dimensional rock systems in the deep mines of South Africa, work that leads to a whole new set of fascinating stories and, most likely, wonderful scientific papers.

One of the major contributions of G. P. Woollard was his comprehensive work on the gravity anomalies in the circum-Pacific, as part of the International Geophysical Year. Half a century later, we are on the verge of obtaining exquisitely detailed gravity information from the GRACE space mission, and will be able for the first time to study the time dependence of the global gravity field. I will note that the last two papers in Tom Jordan's long list of publications (with co-authors S. Shapiro and B. Hager) have to do with the continental tectosphere and Earth's long-wavelength gravity field. Thus, 23 years later, the tectosphere is alive and well, and its stability and dynamics are being studied by Tom and his colleagues using the gravity field. George P. Woollard would indubitably have approved.

Response by THOMAS H. JORDAN

I appreciate the opportunity to express my gratitude to Gene Humphreys and the members of the Geophysics Division of the Geological Society of America for this honor. I especially thank Bernard Minster for his entertaining citation. Bernard and I shared an apartment, French wines, and a lot more during our salad days as graduate students at Caltech. Our primary scientific interests were in seismology and deep-Earth geophysics, but we also began a scientific collaboration on modeling plate motions that first introduced me to the main issues of geology. At the time, plate tectonics was being established as the paradigm for geological thinking, but Caltech was on the periphery of the revolution. We avidly read the dispatches from the combat zone and could certainly see the smoke, but we had a hard time discerning what was actually happening on the front lines.

Our work on plate motions and plate-boundary deformations thus began as an exercise in self-education, a kind of geological boot-camp. In this endeavor, we had a lot of help from Peter Molnar, who served as our sergeant and taught us about the skills and weaponry of the current battles. The camaraderie of those times secured great lifelong friendships and provided me with the impetus to charge headlong into what has been an exceptionally rewarding scientific career.

I did not know George Woollard well, but I have one particularly fond memory of him. In 1975, I was asked by Chuck Drake of the U.S. Geodynamics Committee to host a Penrose Conference on the topic of the lithosphere-asthenosphere boundary. I agreed because I was eager to discuss the new seismic evidence on continental deep structure and its implications for chemical stabilization of the cratons. (I was not then a member of the GSA. Within a week of my accepting Chuck's offer, a staffer at GSA headquarters called to say that I could not run a Penrose meeting unless I joined the Society, so as a poorly paid assistant professor, I had to write out a check that came very close to bouncing!) The conference was held in Vail, Colorado, in late November, and I invited George to review the gravity data on the depth of compensation as it related to Barrell's original definitions of lithosphere and asthenosphere.

On our way out to dinner after his talk, we crossed an icy parking lot, and I held his arm to keep him from slipping. He turned to me and said sadly, "You know, Tom, sometimes I feel so very old." I asked him why, and he replied, "Because many of my students are dead." I was mulling this unimpeachable evidence when he turned back with a twinkle in his eye and continued, "But other times I realize that I'm really not so old." Again I asked him why, and he broke into a broad smile, "Because one of my professors is still alive!" He was referring to Arthur Buddington, of course, who was then well into his 90s. We picked up our pace and arrived at the restaurant ahead of the group.

Although my recent 50th birthday reminds me how quickly a career can pass, I am fortunate to have most of my professors and students very much alive and kicking, and this award provides me with an occasion to thank them all. Essentially none of my science has been done alone, and I am very happy with that, because working with others, especially students, has been much more fun than any solitary endeavor could possibly be.

The GSA meeting provides a good venue for reflecting on the status of our field of geophysics. I have always considered myself as a particular breed of geologist, one who happens to apply the methods of physics to geological problems. I even once wrote a paper called "Structural geology of the Earth's interior." I have never thought much about the difficulties of straddling these two areas of science, but some events at the 1998 GSA Annual Meeting motivated me to raise the issue. In the geophilosophy session, "Conversations with the Earth," I heard some stimulating (though often disturbing) talks on geology as narrative and the like, primarily by agents of the Continental School. In one, the outgoing president of GSA, Vic Baker, approvingly quoted Mackin as saying, "Anyone who hires out as a geologist and then operates as a physicist is not living up to his contract." Baker's discussion of "theory-directed" versus "nature-directed" science seemed to balk at the notion of quantification and prediction as being major goals of geological study.

On the other side of this divide is the physicist Per Bak, whose modestly titled book *How Nature Works* was recently published. While reading it, I noted the following comments on our profession: "It puzzles me that geophysicists often show little interest in the underlying principles of their science. Perhaps they take for granted that the earth is so complicated and messy that no general principles apply, and that no general theory (in a physicist's sense) can exist… Don't get me wrong. I have the deepest respect for the type of science where you put on your rubber boots and walk out into the field to collect data about specific events…. I just wish there was a more open-minded attitude toward attempts to view things in a larger context."

Well damned if you do and damned if you don't! Actually, I take these criticisms as a cause for great optimism, because such disparagement signals that something really interesting is happening on the interface between geology and physics. This is not the place to go into details, but the tension between Baker and Bak reflects the rise of a new type of scientific program, different from either the hermeneutics of classical geology or the reductionism of modern physics, that concerns the understanding of truly complex natural systems through data synthesis and model-based inference. These geosystems range from the global scales of the core, mantle, and fluid envelopes of Earth (as well as those of the other planets) to the smaller scales of volcanoes, petroleum reservoirs, groundwater systems, and active faults. It is preaching to the choir to tell this audience that the study of such geosystems will be a leading activity of science in the next century.

To Baker I would say that prediction plays an integral role in this new type of empiricism, because it forms the primary step in the iterated cycle of data gathering and analysis, hypothesis testing, and model improvement. Like physicists, we must strive for quantification. To Bak I would simply note that many general principles apply, including self-organized criticality, but only approximately and only in particular contexts. Like geologists, we must respect contingency. So we are indeed in exciting times for the geologist who knows how to use and improve the methods of physics. I am very grateful that you have recognized me as a skunk with these particular stripes.

HISTORY OF GEOLOGY AWARD
presented to

HATTEN S. YODER, JR.

Citation by ROBERT M. HAZEN

It's an extraordinary honor, as well as a daunting challenge, to introduce Hatten S. Yoder, Jr., as the richly deserving recipient of the Geological Society of America's 1998 History of Geology Award.

I've wondered how to tell you about Hat Yoder—to do justice to his remarkable contributions to the earth sciences and to society in general. Here's a man who will be remembered by future historians of science as one of the two or three most distinguished petrologists of the 20th century, perhaps second only to Norman Bowen in originality and insight. Hat's contributions to understanding the origins of metamorphic and igneous rocks have been among the most cited references in the earth sciences, and he has, more than any other scientist, elucidated the origins of basalt. For these contributions Hat Yoder has been justly recognized, with the Roebling Medal, the Arthur Day Medal, the Werner Medal, and the Wollaston Medal, just to name a few of his many honors.

Hat Yoder has an extraordinary record of public service, as well. During World War II he served with distinction on United States naval aircraft carriers on both the European and Asian fronts, rising to the rank of lieutenant commander. Late in the war, he was a meteorological officer on the MOKO expedition to Siberia, as part of a joint Russian-American effort to monitor weather. In fact, Hat has recently written an engrossing history of that remarkable geophysical and political experiment.

Hat Yoder returned after the war to his interrupted education, taking a Ph.D. from MIT in 1948. That same year he began his first—and only—job, as a scientist at the Carnegie Institution of Washington Geophysical Laboratory. In that creative environment, Hat Yoder designed and constructed an arsenal of high-pressure experimental apparatus unmatched in the world, and he applied those tools to the key experiments that unlocked secrets of rock formation. Within a decade he became the youngest geologist ever elected to the National Academy of Sciences.

Given such extraordinary, early success, many scientists would have retreated to the lab, their future assured, content to work in isolation. But Hat used his success to help other people and influence public policy. He has been president and/or councilor of the leading earth science societies and has served on the editorial boards of several of their distinguished journals. He has been a member of the National Research Council's executive committee, as well as the U.S. national committees for geochemistry, for geology, and for history of geology. He has served on a dozen departmental visiting committees across the country. He has advised Congress on issues ranging from natural resources to the overstated hazards of asbestos. And, most important for so many of us in the earth sciences, he was from 1971 to 1986 director of the Geophysical Laboratory, where he continues to nurture and inspire generations of scientists.

In his public service, as in every aspect of his life, Hat Yoder displays an unswerving honesty, integrity, kindness, and dedication to fairness. Indeed, these traits define Hat even more than his scientific brilliance. "Right is right," he insists, and he backs up that conviction with action. He was an early advocate for civil rights since the 1940s, when Washington, D.C., was a largely segregated city. If you get a chance, ask him to tell you the story of how he helped to desegregate the restaurant of D.C.'s historic Willard Hotel. As Geophysical Laboratory director, he championed opportunities for women in science.

Since his retirement, Hat Yoder has continued to work tirelessly in the laboratory, collaborating with dozens of scientists around the world. Today, I count working with Hat Yoder on a joint project related to the origin of life as one of the greatest privileges of my research career. For decades to come, Hatten S. Yoder, Jr. will be honored by his friends and colleagues as an inspiring teacher and mentor.

Hat Yoder's life provides a context for his distinguished contributions to the history of geology. The history Hat does is an outgrowth of the life he leads.

We all know that conflicts occasionally arise between scientists who claim to be historians and historians who claim to know how science "really" works. Throughout his distinguished output of more than 30 historical books, articles, and biographical memoirs, Hat Yoder has displayed his understanding of the important and complementary roles of scientists and historians in documenting the history of our science. Hat brings to the history of geology what the geoscientist does best—unearthing and explaining the experiments and theories of previous earth scientists, whose work laid the foundation for later research.

Hat Yoder has performed yeoman service as biographer of more than 20 famous geologists and petrologists for the *Dictionary of Scientific Biography,* the *Dictionary of American Biography,* the National Academy's Biographical Memoir series, and the soon to be published *American National Biography.* Hat's historical writings also include fascinating accounts of the history of experimental petrology, including a remarkable and insightful timetable of petrology. He used his access to important archival records to contribute more than a dozen papers on the history of Carnegie's Geophysical Laboratory and its staff.

In all this impressive body of work, Hat Yoder has remained close to the petrological science that he knows intimately—to which he himself has played such a significant historical role. He has sifted through countless volumes of laboratory records, correspondence, and scientific writings to lay out, for scientist and historian alike, the raw materials of history. He has presented the past to us with a firm foundation of impeccable scholarship, lucid prose, and an awesome comprehension of the intricacies of rock's varied origins.

It is my great pleasure to present to you an inspirational role model for scientists and historians alike, Hatten S. Yoder, Jr.

Response by HATTEN S. YODER, JR.

Thank you, Bob, for your generous citation; those who know your many works on the history of geology may wonder if our roles should be reversed on another occasion. It was indeed a surprise to learn of this honor from a group of friends who appreciate and enjoy the history of our science. I suspect that most of them pursue history as one would a hobby because it is so enjoyable with very congenial and helpful colleagues.

Geology is described as a historical science. A field geologist spends much time determining the sequence of events, the specific date of an event, the rate of change of events, and attempts to reconstruct those events into a logical progression. The experimental geologist also attempts to reconstruct those processes in the laboratory with due regard for sequence and rates. For adequate rates, we have to deviate a little and raise the temperature of the experiment to beat the geological time scale. I have made many one-month experiments and have published one phase diagram based entirely on one-week runs, but my late colleague Frank Schairer had the patience to carry out a 5-year run just to prove the melting point of that very viscous feldspar we call albite. Fortunately, most experiments require only a few hours or days to reach equilibrium. That is the goal, rarely achieved, in most geological processes.

Today kinetics is the buzzword, and the time for nucleation, diffusion of ions, rate of reaction, cooling of a magma, racemization of organic compounds, and sedimentation rates is now the focus of attention. The time factor is all-important in the geological sciences, but I think more importantly in the progression of ideas. I am a strong believer in teaching every science from a historical viewpoint. The development of an idea—the sequence of perceptions, observations, intuitions that lead to a discovery—is critical to the understanding of a science. Too much time is spent in presenting the overwhelming mass of observations and so little time on the thinking process that generates a concept. Students would be better served if the steps in geological reasoning were spelled out for major concepts, with due regard for the controversial detours, instead of mere presentation of the current consensus.

Probably only a few of you had the privilege of choosing your own thesis topic. It most likely was handed to you because the professor had funding available for that project. The student is thereby deprived of the most critical step in any investigation: the recognition and formulation of the problem itself. Most projects fail at this first stage. If we are to train students to be imaginative, creative, and innovative, they must be given the chance to develop a problem from the beginning. That means they must review the evolution of the ideas then available to the science. Frankly, I miss the historical reviews that used to introduce the subject of a paper. Editors claim you should know that material and, in their words, not waste journal space. No matter how widely read, no one can keep up with the tremendous range of science today. I vote for a return to historical introductions to every new data paper.

As others have alluded, there is more to history than the recitation of the sequence of scientific discoveries. The biographical aspects of the investigators, including their interaction with colleagues, make a major contribution to understanding the development of a concept. The society of colleagues is critical to one's intellectual stimulation and growth. In reviewing the environment in which a discovery is made, I wince at attempts by a few historians to psychoanalyze the investigator as he or she struggles through the invention process. Having produced some 15 biographies, I realize that a large number of fortuitous experiences, many trials and error of judgment, and exposure to a wide array of discussions are critical matters where the evidence of discovery is not as clear cut as we would like. It is akin to the ore prospector who makes the discovery of a potentially commercial deposit, followed by the entrepreneur who establishes its extent and value, and finally the developer who opens the mine and makes the profit. A scientific idea also has its prospector, astute observers who apply the concept, and the promoter who perceives its place in the big picture. All play a role in the discovery and should be recognized for their respective contributions.

The analytical part of history probably has the most lasting value. The evaluation and weighting of publications—a process normally carried out in peer view—in the historical analysis depends again on the test of time. Current history, in my view, is the most difficult of all to judge. After listening to some of the 6,359 papers at this meeting, who can say which represents a breakthrough or a new paradigm, or provides the missing link? Nevertheless, we all sense a new idea when it is presented and feel the joy when a colleague achieves new understanding of a problem. It is the verification and documentation process that requires time and eventually forms the basis of the historical analysis.

Most historians of geology have had formal training in both geological science and the techniques of historical research. As an experimentalist steeped in the traditions of precision, replication, and documentation, I have learned that the historian has even more sophisticated standards and methods for arriving at the truth. The History of Geology Division serves to bring the geologist and historian together so they may share their respective expertise and illuminate the science for public appreciation. My contribution to the promotion of this union has been persuading the American Geological Institute to establish the History of Geology as a recognized specialty and not buried under "Not elsewhere classified."

I am most appreciative of this award. One of my young colleagues put it into perspective when he noted how rare it is for one to be recognized in two fields, but there is no doubt that I have yet to earn the History of Geology Award. My thanks to all of you for your generous reception of the publications to date. The e-mails, faxes, and letters from old friends when they learned of my receiving the award were especially heart-warming and greatly enjoyed. Thank you!

O. E. MEINZER AWARD
presented to
MARY P. ANDERSON

Citation by CHUNMIAO ZHENG

I am privileged to introduce Mary Anderson. I first met Mary in January 1985, just a few days after I arrived at the University of Wisconsin—Madison from China to study hydrogeology with her. Not long after my arrival, Mary gave me one of those big computer tapes and said "Chunmiao, this is a modular flow model recently released by the USGS. It looks pretty good; why don't you install it on our departmental mainframe and try it?" At that time, I knew next to nothing about computers or modeling. After several sleepless nights, I finally got the program working, and along the way learned a few Unix and FORTRAN commands. Mary rewarded my hard work by taking me to see a Shakespeare play, the true passion of Mary and her wonderful husband Charles. Naturally, I was thrilled to see a Shakespeare play for the first time in my life. But I had no idea at that time that I would be stuck with what would later be known as MODFLOW for the rest of my life!

Mary has had a distinguished career at the University of Wisconsin—Madison since 1975, after receiving her Ph.D. from Stanford in 1973 and serving a short stint as an adjunct professor at Southampton College of Long Island University. At UW—Madison, Mary has taught hydrogeology and groundwater modeling to a generation of students, many of whom have become industry leaders and productive researchers. On many occasions, I have discussed the UW hydrogeology program with other alumni; the consensus is always the same—the program's success and prominence are a direct result of Mary's vision and leadership in many research areas, and a unique style of working with graduate students that encourages independent thinking and develops in students a deep-rooted passion for solving real-world problems. Not only have her own students benefited tremendously from her guidance and mentoring, our entire hydrogeology community is indebted to Mary for her numerous professional service activities, including serving as president of the Hydrology Section of the American Geophysical Union and service on the editorial boards of *Geology, Ground Water, Journal of Contaminant Hydrology, Hydrological Processes,* and *Water Resources Research.*

Few people have been more influential than Mary in the transformation of groundwater modeling from an esoteric plaything into a fundamental tool of practicing hydrogeologists. As an original member of Professor Remson's "Stanford mafia", which now threatens to take over the hydrogeologic universe, Mary developed an interest in numerical modeling of groundwater flow systems that led her to publish a pioneering paper on the coupling of the one-dimensional Richards equation with saturated flow equations. Since receiving her Ph.D., Mary has continued to work on all aspects of computer modeling of groundwater systems, and she has made significant contributions to the science of hydrogeology in many areas. Among these are the interaction between groundwater and lakes, the characterization of geologic heterogeneity for purposes of groundwater investigations, the quantification of groundwater recharge, and philosophical issues of model application. While it would take a very long time to describe everything Mary has done, let me briefly touch on the areas cited in the Meinzer Award.

Soon after arriving at UW—Madison, Mary and her students began studying groundwater-surface water interaction at several lakes in northern Wisconsin, as part of the NSF's Long Term Ecological Research (LTER) program. At a time when quantitative analysis was the exception rather than the rule, Mary realized the power of groundwater modeling and used it as a primary tool in her research. The continuing work in this area has led to numerous publications, including the three most recent ones cited for the Meinzer Award: Long- and short-term transience in a groundwater-lake system in Wisconsin (*Journal of Hydrology,* 1993, v. 145); simulating the influence of lake position on groundwater fluxes (*Water Resources Research,* 1994, v. 30, no. 7), both with Xiangxue Cheng; and groundwater inflow measurements in wetland systems (*Water Resources Research,* 1996, v. 32, no. 3), with Randy Hunt and Dave Krabbenhoft. This research by Mary and her students has provided invaluable insights into the role of groundwater in the hydrological, geochemical, and ecological evolution of lakes and wetland systems. Equally important, their work has established a quantitative and multidisciplinary framework for studying groundwater-surface water interactions which combines computer modeling with field measurements of hydrological and geochemical data.

Mary became interested in the influence of aquifer heterogeneity on groundwater flow and contaminant transport early in her career. Her landmark paper "Using Models to Simulate the Movement of Contaminants through Groundwater Systems," published in 1979, pointed out many of the conceptual and numerical pitfalls associated with modeling contaminant transport in heterogeneous aquifers. This paper continues to be cited in journal articles as a framework for the study of contaminant transport. Many of the points discussed in the paper are as applicable today as they were 20 years ago. In 1989, Mary published a paper in the *GSA Bulletin,* "Hydrogeologic Facies Models to Delineate Large-scale Spatial Trends in Glacial and Glaciofluvial Sediments," that represents one of the finest examples of ingenious thinking on how to deal with aquifer heterogeneity; it has had an enormous impact on subsequent research in this area. Later, Mary and her student Erik Webb adapted geologic depositional models to generate internally consistent hydraulic conductivity fields for use in groundwater models. This work led to several publications including the fourth paper cited for the Meinzer Award: "Simulations of Preferential Flow in Three Dimensional Heterogeneous Conductivity Fields with Realistic Internal Architecture (*Water Resources Research,* 1996, v. 32, no. 3). This pioneering work has paved the way for much ongoing research in this exciting area.

The name Mary Anderson has become synonymous with groundwater modeling because of her two popular textbooks *Introduction to Groundwater Modeling: Finite Difference and Finite Element,* first published in 1982 with Herb Wang, and *Applied Groundwater Modeling: Simulation of Flow and Advective Transport,* published in 1990 with Bill Woessner. The exemplary clarity and the clever mixture of concepts and short computer codes in the first book have helped thousands learn the fundamentals of groundwater modeling, and the lucid presentation and careful synthesis of a vast amount of information have turned the second book into the standard reference work for conducting groundwater modeling studies.

I congratulate the Hydrogeology Division Award panel for selecting Mary Anderson as the recipient of the 1998 O. E. Meinzer Award, for few are as richly deserving of this recognition as Mary. Please join me in congratulating Mary for her remarkable achievements both as a researcher and as an educator.

Response by MARY P. ANDERSON

Thank you, Chunmiao, for your generous citation and introduction. I also thank Steve Gorelick and the award committee for selecting me for this honor. I have been tracking the Meinzer Award papers for a long time. In fact, I keep a running list handy for quick reference. To be able to add my own set of four papers to this prestigious list is indeed a tremendous honor.

The collection of papers cited in the award is, I believe, representative of the major themes in research over much of my career. I have been involved in groundwater-lake studies ever since arriving at the University of Wisconsin—Madison in 1975. At that time, Dave Stephenson, my predecessor in the department there, had been engaged in lake studies and generously helped me by sending offers of funding my way and making sure that I was introduced to people with compatible interests and expertise.

Recent contributions to groundwater-lake studies are represented in the two papers with Xiangxue Cheng, which are cited in the award, giving me an opportunity to say a few words about Xiangxue and also about Chunmiao. Chunmiao Zheng was the first student I accepted into the Ph.D. program from China and Xiangxue was the second. Chunmiao is a professor at the University of Alabama and Xiangxue works for Mobil Oil in Dallas. Both are accomplished modelers and in them you see examples of the major theme in my career—groundwater modeling. Chunmiao has developed very popular groundwater modeling software including MT3D. He has co-authored a textbook on transport modeling and is now a well-known modeler in his own right. Xiangxue's Lake Package for MODFLOW, which is the subject of one of the Meinzer papers, has been very well received; a modified version is now marketed by HSI GeoTrans.

Groundwater modeling has been the predominant theme in my career. I suspect that my two textbooks on modeling, published in 1982 and 1992, may also have played some role in the selection for the Meinzer Award. I would like to acknowledge my two co-authors, because I believe that they should share in this recognition. My colleague at UW—Madison, Herb Wang, had the idea for the 1982 book and proposed that we work together on it almost as soon as I arrived in Madison. My other co-author, Bill Woessner at the University of Montana, had the idea for the second book. Over chicken soup in the back room of a bar in Denver, Bill laid out his ideas for a book on groundwater modeling and told me that I should write it.

My foray into the problem of geological heterogeneity is represented by the paper with former student Erik Webb, who is now at Sandia National Laboratories. I had an idea that the arrangement of sedimentary facies was critical in the transport of contaminants but wasn't quite sure how to demonstrate this. Erik found a way after studying the sedimentological literature. He constructed a model that generated facies in braided-stream sediment and demonstrated that the resulting patterns formed preferential flow paths for contaminant movement.

Finally, the fourth paper named in the award is co-authored with Randy Hunt and Dave Krabbenhoft, who are both with the USGS in Middleton, Wisconsin. This paper returns to the subject of wetlands, which I had explored with my first Ph.D. student, Charlie Andrews, who is now president of Papadopulous and Associates. Randy took the lead on the wetlands work cited in the award, and I have had a lot of fun recently as he leads me into analytic element modeling.

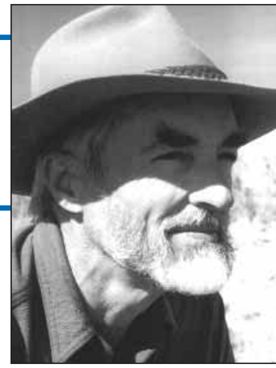
I've mentioned the contributions of five of my former Ph.D. students above. But all eleven of my former Ph.D. students, as well as my five current Ph.D. students, deserve some share in this award. Both ideas and people are key to a career in science. In my own career, several people whom I've already mentioned played critical roles. Earlier, my undergraduate advisor at SUNY—Buffalo, Parker Calkin, helped and encouraged me in many ways. For instance, he urged me to "go West" to pursue graduate work. I took his advice and went to Stanford University, where I was fortunate to find an advisor and a friend in Irwin Remson, who coached me through the Ph.D. and who helped me in many ways then and since. At Stanford, I was also fortunate to meet my husband, Charles. At the University of Wisconsin—Madison, I found a series of mentors who guided me through tenure and later through a tangled labyrinth of university politics and administration.

Professional collaborations are important in most careers in science and they certainly have been in mine. What makes a professional collaboration work is rather intangible; it has something to do with finding complementary strengths that forge a whole from disparate parts. Receiving the Meinzer Award is an honor that I feel I share with those colleagues with whom I have had the pleasure of special professional relationships. Thank you again for this recognition.

G. K. GILBERT AWARD

presented to

JOHN B. ADAMS



Citation by ALAN R. GILLESPIE

The Gilbert Award has been established by the Planetary Geology Division of this Society to recognize "outstanding contributions to the solution of a fundamental problem of planetary geology in its broadest sense, including planetary geology, geochemistry, mineralogy, petrology and geophysics, and the field of meteoritics." It is fitting that we bestow on John B. Adams this prestigious award, in recognition of his lasting contributions in reflection spectroscopy and spectral mixture analysis applied to a dazzling array of planetary and terrestrial problems.

Like Gilbert, John Adams is a geologist of remarkable breadth and insight and, like Gilbert, Adams has a knack for focusing inquiry on the scientifically relevant. Like Gilbert, Adams has been a scientific leader, inspiring all of us to do just a little better by his example of careful study and thorough analysis. In reviewing his career, it is surprising and informative to see how many different arenas of study Adams has touched upon. Planetary scientists, geologists, and remote sensors alike have benefited from his four decades of professional research. In significant ways, these fields have been changed for the better by Adams's astute scientific insight.

Adams earned his Bachelor of Science degree in geology from Stanford University in 1956, and his Master's and Doctoral degrees from the University of Washington in 1958 and 1961. His thesis research, with Peter Misch, was on igneous and metamorphic petrology in the North Cascades. Hoover Mackin was a major influence in teaching Adams the ins and outs of the scientific method.

Upon receipt of his doctorate, Adams received Ford Foundation and U.S. State Department fellowships for a year of postgraduate study at Moscow University, in the USSR. During this time, Adams was introduced by E. A. Kuznetzov to mineral identification by transmission spectroscopy on the petrographic stage.

Returning to the United States, Adams continued his scientific career with the U.S. Army, which in 1962 stationed him at Caltech's Jet Propulsion Laboratory. JPL at this time was a place of remarkable intellectual foment, as the recently launched space program began to hit scientific pay dirt. John was hooked, and he applied his petrological expertise, and the questions raised by Kuznetzov's experiments, to studies of the Moon and Mars.

Adams stayed at JPL for five more years, years in which the early Mariner fly-bys visited Mars and Venus. While working on Ranger and Surveyor, Adams continued his petrologic studies of hydrothermal leaching of terrestrial granitic rocks at high temperatures and pressures. But he had time to consider the extraction of compositional information from telescopic spectra and color pictures of the Moon and Mars. This had obvious implications for the sequential images being taken through different colored filters from Surveyor and the Mariner-class spacecraft, and their potential for identifying mineral and rock constituents of planetary surfaces. Here, Adams made one of those intuitive leaps that seems so obvious in hindsight: he bridged from the idea of using pleochroism of minerals under the petrographic microscope to the idea of using reflectance spectroscopy for remote sensing—this at a time when true multispectral imaging was still years in the future. Roger Burns had done the theoretical groundwork in crystal field theory, Tom McCord had the telescopic data, and Adams hit on the application. The interpretation of remotely sensed images was now on a sound theoretical footing, one that made use of the spectral character of images rather than just photo-interpretation of spatial features. More than any other event, this ushered in the modern age of imaging spectroscopy, still dawning today, at the close of the millennium.

Key papers from this era reflect Adams's impact and breadth: a single-author study of the petrologic significance of absorption bands in Lunar and Martian spectra; with McCord, on the spectral reflectivity of Mars; with McCord and Torrance Johnson, on the composition of Vesta; a single-author study of the remote identification of pyroxenes; and a general treatment of remote identification of rock-forming minerals, in Karr's 1975 book, *Infrared and Raman Spectroscopy of Lunar and Terrestrial Minerals.*

The Moon, Mars, the asteroid Vesta—these and others had begun to yield their secrets. Meanwhile, Adams, now a member of the Apollo science team, had left JPL in 1968 for the College of the Virgin Islands and the Caribbean Research Institute in St. Croix. For the next six years, St. Croix became an unlikely but delightful hotbed of lunar and planetary research. This period saw an enormous outpouring of articles and talks from Adams and his co-workers: 20 in 1975 alone. That year, Adams left the Virgin Islands for the University of Washington, where he received a dual appointment in the Department of Geological Sciences and the Department of Astronomy. He was to remain at the University of Washington for the duration of his active career, but again his research took unpredicted twists and turns.

Adams continued his research into the Moon and planets, but now the igneous petrologist turned remote sensor also began to study weathered terrestrial surfaces and weathering processes in order to develop a deeper understanding of the surface of the Moon and Mars. From spectroscopic studies of palagonite on Hawaii, Adams branched out to consider the rock coatings that he found on Mauna Kea. This deflection launched a two-decade-long study with microbiologists, examining the biologic origin of rock varnish. The papers on this subject, with Randall Perry, and later with Jim Staley, Fred Palmer, Susan Taylor-George, and others, remain the most definitive on the topic.

Adams also identified and solved the mystery of the thin layers of pure silica coating basalt flows in Hawaii, derived from dustings of volcanic ash. This discovery, with graduate students Tom Farr and Brian Curtiss, and with Mark Ghiorso, then an assistant professor, laid much of the ground for the use of multispectral thermal infrared images in the relative dating of volcanic surfaces.

Driven by his efforts to unravel planetary surface compositions, Adams, working with Milton Smith, had begun to treat exposed soils and rocks as linear and nonlinear spectral mixtures of fundamental, spectrally distinct scene components, the identity of which underwent dramatic changes with image scale, resolution, and spectral wavelengths. Thus was reincarnated spectral mixture analysis, which in the 1970s had seen a brief flurry of interest in agricultural remote sensing, to cope with the problem of boundaries between fields of crops. Adams noted that, regardless of image characteristics, for most scenes *all* pixels were spectral mixtures.

Curiously, from today's standpoint, specialists in terrestrial remote sensing were slow to adopt this "new" investigative tool, which they had earlier embraced. Adams's version of spectral mixture analysis was deceptively simple. Complex scenes were reduced to quantitative mixtures of a handful of common constituents, plus leftovers; these spectral leftovers, or residuals, often nearly at the image noise level, sometimes were all that contained sought-after detailed compositional information. Spectral mixture analysis soon became a commonplace in the planetary community, and in a recent manuscript I saw it referred to as the "classical" approach, to be replaced by a new unorthodox (and more complex) form of mixture analysis! Heresy to orthodoxy—we now know the time constant for this transformation: about 15 years!

Milton Smith, Adams's colleague in exploring spectral mixture analysis at the University of Washington, had done his doctoral research on turbulent transfer of energy across the boundary layer in the air above forests. Perhaps his background provided the subtle nudge that now deflected Adams's attention to the application of spectral mixture analysis to vegetated terrestrial surfaces. This deflection, as usual, paid off, and the analytic approach of Adams and Smith is now the centerpiece of a decade-long NASA EOS project studying the hydrology of the Amazon Basin.

Adams retired from his formal teaching duties at the end of 1996. He now lives with his wife, Caryl Campbell, in the Methow Valley, in the North Cascades near his thesis study area. He is working on a new textbook summarizing his nearly four decades of experience in remote sensing.

Grove Karl Gilbert was known for his advocacy of multiple working hypotheses as a hedge against scientific wishful thinking. John Adams has been a staunch advocate of the rigorous use of the scientific method in exploring the largely underdetermined problems in the geology of the surfaces of Earth and the terrestrial planets, as several generations of students and colleagues can attest. Adams's insistence on the multiple-hypothesis approach, incubated in him so well by Hoover Mackin, as well as Adams's ability to cut to the core of complex issues, made his image-interpretation class at the University of Washington one of the most sought after in the geology program. It was viewed by the geology graduate students as necessary preparation for their Ph.D. qualifying exam, because of the solid grounding it gave them in the methodology of scientific inquiry. Adams's emphasis on issues of scale, and of the connection between the field and image—between composition and spectra—may seem like common sense today, but that is in no small part because of his career-long efforts to make them so.

I think G. K. Gilbert would approve of John Adams as a worthy recipient of the award that bears Gilbert's name. It is my honor and privilege to present to you your friend and colleague and the recipient of the 1998 G. K. Gilbert Award, John B. Adams.

Response by JOHN B. ADAMS

I thank Alan for his kind words, and I thank all my friends and colleagues and the Planetary Geology Division of the Geological Society of America for this award. It is a special honor to receive this recognition in the name of G. K. Gilbert, who was a pioneer in what we now call the field of planetary geology.

As a student, I knew that G. K. Gilbert had been one of the finest American field geologists, but I was not aware that many years earlier he had studied the moon and even conducted experiments to support his hypothesis that lunar craters were created by meteoroid impacts. My first encounter with planetary geology happened in the early 1960s when I joined the fledgling Planetology Group at Caltech's Jet Propulsion Laboratory. The group included Bob Speed, Jim Conel, Al Loomis, and Doug Nash, from whom I learned a great deal over the next few years. Bob, our leader, somehow had convinced the engineering-oriented JPL administration that they needed geologists to explore the moon and planets. In 1962 JPL was still trying to hit the moon with a crash-landing Ranger spacecraft. Within six years, Rangers had successfully radioed back close-up pictures, Mariners had photographed Venus and Mars, lunar orbiters had sent back pictures of the lunar landscape, Surveyors had landed at several places on the moon and the Apollo manned landing was imminent. This was a pretty heady place to begin one's career, and it had a lasting impact.

Our Planetology Group was involved in a number of these first probes of the solar system, but we also were able to pursue our own research. The setting was ideal. We were too young and rowdy to be given many administrative responsibilities; therefore, we had time to think and experiment. Resources, in comparison with school days, were lavish. And I was learning fast from my colleagues and from the nongeologists that we interacted with on a daily basis. As the excitement of planetary exploration grew, we began to work more with the geologists at Caltech who had anticipated the changing scientific landscape by creating a broadly interdisciplinary department. Graduate students who emerged out of this crucible (an apt metaphor) included many future colleagues, such as Alex Goetz, Tom McCord, Tom McGetchin, Hugh Kieffer, Torrance Johnson, and Larry Soderblom.

I had been thinking about the Moon and Mars and to what extent colors of the surfaces could tell something about geology. I suspected that telescopic spectra could be used for remote sensing of planetary surfaces, but there were few laboratory data that were relevant and there were even fewer telescopic spectra of sufficient quality to interpret with confidence. Also, the mechanisms for resonance in visible and near-infrared spectra of minerals were poorly understood. Nevertheless, I began making laboratory spectral reflectance measurements of terrestrial materials and meteorites.

By a wonderful coincidence, Roger Burns, soon of MIT, opened the door to understanding the physics of optical absorption in minerals with his classic book on crystal-field theory, and my search for better telescopic spectra of the Moon and Mars led to graduate student Tom McCord at Caltech. He had built a new spectrophotometer and had acquired some excellent data at the Mt. Wilson observatory. When I saw his spectra I brashly announced that I thought I could interpret his measurements in terms of mineralogy, and we began a collaboration that has lasted ever since.

By the end of the 1960s, McCord had gone off to MIT to become a professor, and I had taken a last lungful of LA smog and moved to St. Croix in the Virgin Islands. Friends and colleagues were convinced that I was sailing off the edge of the known world, at least scientifically, but the Caribbean provided a quiet place to do the needed systematic spectroscopic and analytical work on minerals, meteorites, and lunar samples. McCord, Torrance Johnson, and I discovered that the spectra of certain basaltic achondrites closely fit the telescopic data for the large asteroid Vesta. It's interesting that a few years earlier Lee Silver at Caltech had brought his achondrite samples to me at JPL to see whether the spectra fit those of the moon. Little did we know then that the real connection was with Vesta and, later through other lines of evidence, with Mars.

Soon, McCord and I had two tigers by the tail: asteroids and the Moon. Vesta had opened a door to a more ambitious test of the connections between asteroids and meteorites. Samples from the Apollo and Soviet missions allowed us to test the ability of telescopic spectra to measure mineral compositions at landing sites and elsewhere on the Moon. McCord had assembled a dynamic group of students at MIT who were skilled at making telescopic observations as well as doing laboratory work. Mike Gaffey took on the large task of measuring the spectra of meteorites and asteroids. Carle Pieters, Roger Clark, Bob Singer, Bob Huguenin, Mike Charette, and others attacked the Moon and Mars. Airfare from Boston to St. Croix was cheap and when sleet rattled the windowpanes at MIT, it was not hard to convince anyone to make the trip to the Caribbean to work with me on lunar and other samples. So, enthusiasm was high, the papers poured out, and we all experienced one of those rare times when the funding was generous, the restrictions were minimal, and the science was hot.

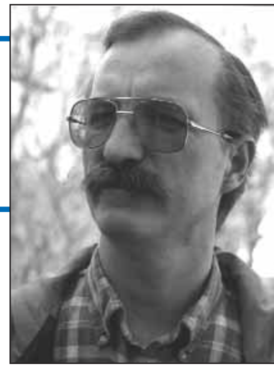
By the end of the 1970s, McCord and several of his students had moved to the University of Hawaii, and I had become a professor back at the University of Washington. Reflectance-spectroscopy had become mainstream for planetary remote sensing. It was a source of great satisfaction to me to see geology being done using this technique. For example, Carle Pieters found that dunite had been brought to the surface in the central peaks of the lunar crater Copernicus. Jim Head, Carle Pieters, Tom McCord, Stan Zisk, and I used a combination of remote-sensing techniques to investigate and map the geology of several areas on the Moon and Mars. At Washington, my first Ph.D. students, Diane Evans, Tom Farr, and Brian Curtiss, and I worked on Mars analog soils and weathering coatings on rocks.

In the post-Apollo era there was a growing awareness that Earth, too, is a planet and, needed some serious attention to environmental problems. Remote sensing was becoming an essential tool for large-scale measurements and monitoring, but little use was being made of spectroscopy. My attention now shifted to terrestrial surfaces and processes.

The smartest thing I ever did after returning to the University of Washington was to hire Milton Smith and Alan Gillespie. Together, we built an exciting research environment in the Remote Sensing Laboratory of the Department of Geological Sciences. With our students, we worked on an amazing variety of subjects, from weathering of rocks to desert landscapes to Amazon forests. We also thought a lot about ways to fuse spectroscopy and imaging, which led us to explore spectral mixture analysis, a technique that has since found many applications in planetary geology.

Early this year my colleague at the University of Washington, Joanne Bourgeois, wrote an excellent article for *GSA Today* on G. K. Gilbert, highlighting his ability to bridge across traditional disciplines. It gives me great pleasure to think that without knowing it, I followed quietly in his giant footsteps. Thank you again for the honor you have given me in the name of this great geologist.

KIRK BRYAN AWARD
presented to
VANCE T. HOLLIDAY



Citation by ROLFE D. MANDEL

The 1998 Geological Society of America Kirk Bryan Award is presented to Vance T. Holliday, professor in the Department of Geography at the University of Wisconsin, for his monograph *Stratigraphy and Paleoenvironments of Late Quaternary Fill on the Southern High Plains,* published in 1995 as GSA Memoir 186. Although Vance's book is ostensibly a report on a five-year systematic study of ten dry valleys or "draws" on the Southern High Plains of Texas and New Mexico, it is really a culmination of more than 20 years of research in the region. Since the completion of his dissertation in 1982, Vance has continued to focus on the late Quaternary soils and stratigraphy of the region. His efforts have led to many outstanding publications in books and prestigious journals. However, it is Memoir 186 that brings all of this work together in a coherent synthesis that provides a key to understanding the late Quaternary soils, stratigraphy, paleoenvironments, and human history of the Southern High Plains.

Vance Holliday has devoted a good part of his life to deciphering the complex record of late Quaternary landscape evolution on the Southern High Plains. In doing so, he has built on the foundation laid down by Glen L. Evans, a contemporary of Kirk Bryan and a great Quaternary scientist in his own right. Although Vance's main focus has been on the Holocene and late Pleistocene, he has shed considerable new light on the entire Quaternary history of the Southern High Plains.

In Memoir 186, Vance used data gleaned from more than 400 cores and exposures at 110 localities to document the late Quaternary geomorphic evolution and stratigraphic record of the draws. This information, combined with archaeological, paleobotanical, paleontological, and stable-carbon isotope data, provides a key to understanding the paleoenvironmental evolution of the region over the past 12,000 years. In addition, Vance builds an important radiocarbon-based alluvial chronology for the Southern High Plains, and he uses it to demonstrate that there were synchronous, regional, geomorphic and soil-forming events in the draws. Memoir 186 is a remarkable piece of interdisciplinary research that sets the standard for regional studies of Quaternary landscape evolution.

A case can be made that Kirk Bryan indirectly had a hand in Vance Holliday's career. Born in San Antonio, Texas, Vance attended San Antonio College from 1968 to 1970 and majored in architecture. It did not take him long to realize that he would become an architect with no sense of design. Faced with this situation, Vance took a trip to Austin in 1969 and visited the Anthropology Department at the University of Texas. It was during this visit that he encountered E. Mott Davis, an archaeologist who, as a graduate student at Harvard, worked closely with Kirk Bryan. Davis encouraged Vance to pursue his nagging interests in archaeology at the University of Texas, which Vance did in 1970. While he was at UT, several individuals, including the late David Dibble, were influential in steering Vance toward interdisciplinary archaeology. However, it was Mott Davis who preached the gospel of Kirk Bryan, and Vance heeded the 11th commandment: thou shalt know the geologic context of archaeological deposits.

While most Texans, including myself, have great appreciation for the song "Happiness Is Seeing Lubbock in the Rear View Mirror," Vance Holliday has listened to other tunes. In 1973, he headed north to be a member of the first archaeological field crew at the Lubbock Lake site in Yellowhouse Draw. He eventually moved to Lubbock in order to pursue an M.A. in museum science, with a minor in soil science, at Texas Tech University. His Master's thesis, "Cultural Chronology of the Lubbock Lake Site," set the stage for his dissertation, "Morphological and Chemical Trends in Holocene Soils at the Lubbock Lake Archaeological Site, Texas," which was accomplished at the University of Colorado under the guidance of his advisor and mentor, Peter Birkeland. Subsequently, Lubbock has served as a launching point for Vance's research on the draws that crosscut the Southern High Plains.

Lubbock, Texas, is situated in the middle of the Llano Estacado, a broad, flat region that is dreadfully hot and dry in the summer and bitterly cold in the winter. Strong winds sweep across it year round, raising thick, reddish-brown clouds of silt that evoke vivid images of the Dust Bowl days. The monotony of the landscape is broken only by small playas and the occasional stream valley or draw. The significance of the playas and draws, however, cannot be understated. Freshwater sources are rare on the uplands of the Southern High Plains; hence, the playas and spring-fed draws are beacons to life in this region. These localities have attracted animals and prehistoric hunters and gatherers over the past 12,000 years, and Vance has been drawn to them to unravel the stratigraphic and archaeologic records that they harbor.

It seems very appropriate that Vance Holliday is receiving an award named for Kirk Bryan. Bryan has often been described as a diehard field geomorphologist who loved to get his hands dirty. The same can be said of Vance. He is happiest when he is in the field describing an outcrop or examining a core, regardless of the scorching temperatures and blowing dust. Moreover, there are few workers out there today who so well carry on the research tradition established by Kirk Bryan. Vance's book, GSA Memoir 186, is thoroughly interdisciplinary and broadly synthetic, addresses important issues of Quaternary stratigraphy, environment, and geochronology, and makes significant contributions to other disciplines, especially archaeology. This is the type of research that Kirk Bryan relished and promoted.

I think that Vance Holliday's efforts reflect the spirit and the standards of the Kirk Bryan Award, and that both the Geological Society of America and past award recipients should be proud to recognize him in this way. It is a great pleasure and honor to introduce my friend and colleague, Vance T. Holliday, for the 1998 GSA Quaternary Geology and Geomorphology Division Kirk Bryan Award.

Response by VANCE T. HOLLIDAY

Going all the way back to my graduate school days at the University of Colorado, the Kirk Bryan Award has been considered the Holy Grail in recognition of Quaternary research. I am deeply honored to receive this award and truly humbled to have my work ranked with my Quaternary mentors and heros. My sincere thanks and appreciation go to Rolfe Mandel and the Kirk Bryan Panel of the GSA Quaternary Geology and Geomorphology Division. In many ways over the years, I have been fortunate to literally follow in Kirk Bryan's footsteps. And the list of past recipients includes many folks who directly or indirectly influenced my work and my career, including Robert Ruhe, Lee Gile, John Hawley, and my Ph.D. advisor, Pete Birkeland.

As Rolfe mentioned, I began my career as an archaeologist at the University of Texas, and was directed along an interdisciplinary path by the late Mott Davis on the anthropology faculty. Not only was Mott influenced by Kirk Bryan, but Mott's grandfather was William Morris Davis and his son was the late Jonathan Davis, a noted Quaternary geologist and geoarchaeologist in his own right. As an undergraduate I didn't realize what heavy-duty intellectual roots I was exposed to, but now I am certainly quick to claim them!

The work reported in Memoir 186 had its roots in my involvement with the Texas Tech Museum Lubbock Lake archaeological project, which I joined just after its beginning in 1973. I started on the project as an archaeologist, but over the years my interests grew to include the soils and stratigraphy of the site and now encompass the upper Cenozoic history of the Great Plains. My particular interest in the late Quaternary record of the draws culminated with GSA Memoir 186. Eileen Johnson, C. C. "Tex" Reeves, and B. L. Allen, all at Texas Tech, sparked and encouraged this interest.

Any research venture spanning so many years and so many miles inevitably will involve many individuals and agencies. Whatever success I achieved in this work is due in large measure to the assistance of these people and organizations, and it is with considerable pleasure that I publicly acknowledge their support. A full set of acknowledgments is provided in the book, but I must reiterate some thanks. Funding for the research was provided largely by the National Science Foundation, with additional support from the University of Wisconsin Graduate School.

Prior to 1988, the research was under the auspices of the Lubbock Lake Project, directed by Eileen Johnson at Texas Tech University. That work was supported by a variety of organizations, including NSF, the Moody Foundation, West Texas Museum Association, and Texas Tech University. I thank GSA for accepting the manuscript for their book series, and Sharon Schwoch and Amy Arnett in the GSA editorial department for their hard work in shepherding it through the system. And my gratitude goes to Diane, my wife, for enduring my absences. However, my summer field work did allow her to survive a gross anatomy class and also to complete her dissertation.

Several of my graduate students worked as field and lab assistants on this project: Peter Jacobs, Ty Sabin, and Garry Running. I am indebted to them for their hard work, good humor, and insights. We had a lot of fun cruising the High Plains.

I also thank several colleagues whose expertise contributed directly to the research and whose work appears in the book: Steven Bozarth on phytoliths, Scott Elias on insects, Rick Forester on ostracodes, Herbert Haas on radiocarbon dating, Stephen Hall on pollen, Raymond Neck on molluscs, and Barbara Winsborough on diatoms.

I am indebted to Eileen Johnson, director of the Lubbock Lake Project and my long-term research partner, for her many years of moral and financial support, particularly between 1988 and 1992, when she provided considerable logistical assistance for my work on the draws. David Meltzer, archaeologist at Southern Methodist University, provided crucial logistical assistance on the southern Llano Estacado and was a stimulating research partner. Our work together on the southern draws led to a most enjoyable and, I hope, permanent professional partnership, and a highly valued friendship.

Other colleagues provided additional assistance and advice, and two stand out: Vance Haynes has always been ready and enthusiastically willing to share his insights on the stratigraphy and paleoenvironments of the Clovis site and eastern New Mexico in general. Tom Gustavson also shared his experience and many ideas regarding the longer-term landscape and especially drainage evolution of the region.

Beyond the specifics of this project, I must also acknowledge four individuals whose work in the 1940s and 1950s provided a solid geological and archaeological foundation for my research. The monograph is dedicated to these four men who led the way: E. H. Sellards, Glen Evans, Earl Green, and Grayson Meade. It has been a particular privilege to know Glen, Grayson, and Earl.

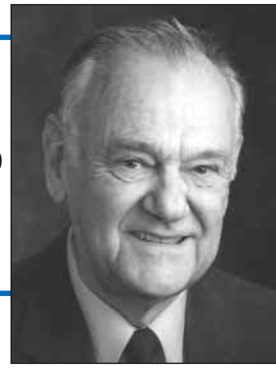
More than anyone else, however, this book strongly reflects the influence of my Ph.D. advisor, Pete Birkeland in the Department of Geological Sciences at the University of Colorado. This includes the way I approach my field work and the attitude I try to bring to my writing and teaching. I am also trying to emulate Pete's model for balancing career and family. Pete instilled in his students an appreciation for scientific rigor and objectivity, and hard work. More significantly, he showed us that the most important thing about our interpretations is that we arrive at them honestly and that a lot of what we do may ultimately be proven wrong, but that is OK. Perhaps Pete's biggest impact on me was confirmation of my notions that field work and research could and should be fun. He was quietly emphatic that our work probably wasn't worth doing unless we enjoyed it and that it shouldn't be taken too seriously. This was and remains in stark and refreshing contrast to the graduate-education-as-suffering-misery-and-indentured-servitude approach found in some departments. I remember being at a conference when I was a graduate student and talking to another student from a large, well-known program in Quaternary studies. He asked where I was going to school. When I told him, he looked at me somewhat wistfully and said, "Oh—Colorado. You are the ones that have fun." Indeed we did. My education at CU was one of the great experiences of my professional life. I thank Pete along with Bill Bradley, Ted Walker, and Ed Larson for their enthusiasm, wisdom, and good humor.

As Rolfe noted, my work and my career are field-based. On behalf of all of us in Quaternary geology and geomorphology who are literally "in the trenches," I acknowledge and thank the Kirk Bryan Award committee for continually recognizing this aspect of earth science research. For those of us who dig our own soil pits and pull our own cores, doing what we want to do rather than going for the hot topics and the big money, and for those of us who are not high tech, this is energizing and encouraging. I thank you.

STRUCTURAL GEOLOGY AND TECTONICS DIVISION CAREER CONTRIBUTION AWARD

presented to

ALBERT W. BALLY



Citation by B. CLARK BURCHFIEL

It is a great honor for me to present the recipient of the Career Contribution Award for the Structural Geology and Tectonics Division of the GSA for l998, because in my opinion there is no other geologist more deserving of this award than Albert "Bert" Bally. Bert is one of those rare geoscientists who has made internationally recognized contributions to industry, academia, and government, reflected by his recognition this year (1998) as the Sidney Powers Medalist, the highest award of the AAPG, and by this award from GSA.

Bert was introduced to geology through his father, a research botanist, who had an excellent understanding of geology and took him hiking, introducing him to the geology of the volcanoes around Rome. Upon his return to Switzerland, he attended high school and then enrolled at the University of Zurich, where he completed his Ph.D. work in l953 on a study in the Apennines.

Following his Ph.D., Bert came to the United States on a fellowship at Lamont and in l954 took a position with Shell Oil Company, from which he retired in l981. At Shell he began by mapping in the foothills of the Canadian Cordillera, moved to Houston in 1966 as manager of geological research at the Shell Belaire Research lab, became the chief geologist (USA) in 1968, exploration consultant in 1976, and finally senior exploration consultant in l980. Since Bert's contributions to industry have been rewarded with the Sidney Powers Medal, and well reviewed by citationist Marlan Downey, I focus here on Bert's contributions to geoscience in general.

During his tenure at Shell, he was author or co-author of several papers that greatly influenced the entire geoscience community. The first paper that comes to mind is the Bally, Gordy, and Stewart paper of 1966, which documented not only the thin-skinned nature of the Canadian Cordilleran fold-thrust belt, but also quantitatively demonstrated the large magnitude of thrusting and its implications for lithospheric processes in general. It remains a textbook example of how to analyze fold-thrust belt tectonics, and it remains the most influential paper on fold-thrust belts of the past several decades. The fundamental concepts developed in this paper influenced many of his later papers, published with his students and colleagues, such as the marvelous work on the Melville Islands, Canada, fold-thrust belt with Harrison, and the development of the thought-provoking concept of the orogenic float with Avé Lallemant and Oldow.

On a very different subject, Bert's l975 paper "A Geodynamic Scenario for Hydrocarbon Occurrences" is a global view of sedimentary basin types, but also treats hydrocarbon-bearing basin dynamics in a plate tectonic framework. It was followed by two later versions in l980, one by Bert, and a second by Bert and Sig Snelson, his long-time colleague at Shell. At about the same time, Bert published, with T. D. Cook, the *Stratigraphic Atlas of North and Central America,* a compendium of maps forming a fundamental reference for all workers interested in the evolution of the sedimentary cover and paleogeography of the North and Central American continent.

During the late l970s, while at Shell, Bert was the chairman of an ad hoc panel organized by the National Academy of Sciences to investigate the geological and geophysical research needs on the continental margins. The report of this panel set the scientific focus for the exploration of the continental margins and how drilling on them could assist, in concert with geophysical studies, to answer major scientific questions about their formation and evolution. This report shows Bert's great insight in how to meld geology and geophysics—a hallmark of all his research and teaching.

Bert published another important set of large-format volumes upon his entrance into the academic world at Rice University in l981 as the Henry Carothers Wiess Professor of Geology. The first three volumes were on the seismic expression of different structural settings, followed by three volumes of the *Atlas of Seismic Stratigraphy.* These books have been extremely important as teaching tools in the academic world, where access to seismic data and courses on the interpretation of seismic reflection profiles are often limited.

Bert has long had an interest in the geology of the Gulf of Mexico, pointing out that this province is another example of a passive margin, but with great structural and stratigraphic complexity due primarily to gravitationally induced deformation. Listric normal faulting and its influence on sedimentation has been known for a long time, but the extreme movement of salt into allochthonous sheets at higher stratigraphic levels was not appreciated until about 10 years ago. Bert has continually asked where these types of passive margins are in the geological record. As always, he is one step ahead of the crowd. In a recent paper on the Betic Cordillera, he and his co-workers point out the importance of allochthonous salt caught up in a fold and thrust belt, showing how such an interpretation can resolve very complex structural relations.

Bert Bally has received about an equal number of scientific awards from industrial and academic groups. He also served as president of the GSA in l988, and he was instrumental in founding the Society's International Division. During Bert's earlier tenure on Council, GSA was considering what should be done for the 100th anniversary of the Society. Bert suggested a series of volumes on the geology of North America, which later became known as the Decade of North American Geology project, or DNAG. Those of us who toiled for a decade on this project sometimes had mixed emotions about it, but when I look at the row of DNAG books on my shelf, I must admit it was a very useful and influential undertaking. Bert will be the first one to tell you that this project could not have been completed without the extraordinary guidance of Pete Palmer.

And yes, he is related to the Ballys of the Bally shoe company, but I know for a fact that he has never been a shoe salesman. It is my pleasure to present to the GSA Structural Geology and Tectonics Division one of the original members of the Swiss geoscience mafia, and the "father" of DNAG, Albert "Bert" Bally, our l998 recipient of the Career Contribution Award.

Response by ALBERT W. BALLY

I am deeply honored to be asked to join the illustrious ranks of previous award winners. I warmly thank the folks who proposed me for the award and the leaders and members of the Structural Geology and Tectonics Division of GSA. What can I say? As a generalist–petroleum geologist, I feel that I am a most unlikely recipient of your award. Let me briefly reflect on some of the early influences that may have nudged me in the direction of structural geology and tectonics.

As a student, I was exposed to the teachings of some great alpine geologists such as Rudolf Staub and Paul Niggli. Four years as assistant to my favorite mentor, Wolfgang Leupold, gave me a headstart in petroleum geology, structural geology, and micropaleontology. He also got me deeply involved in engineering projects in the Penninic zone of the Ticino. Leupold was a universal genius who combined his profound technical know-how with a great culture, which ranged from playing Bach on his harmonium to singing with a tender voice but with much brio directly from the partitura of Mozart's "Abduction from the Seraglio" and to composing bastardized German-English limericks.

My brief stay at Columbia University and Lamont exposed me to the ideas of Walter Bucher, Marshal Kay, and Maurice Ewing. As a good Swiss, I knew that continental drift was a fact of life, but somewhat surprisingly, my new mentors at Columbia told me that this definitely was not the case. Only during extensive drinking sessions with Bruce Heezen did we explore the mobilistic alternatives. As some of you know, I specialized as a micropaleontologist, and at Lamont I spent much of my time counting and separating left-coiling from right-coiling *Globorotalia truncatulinoides* in an early effort to look at global change. It was my fate that the lack of research funds put an end to all this.

Finally, I had to make money! I joined the Shell Oil Company and, together with my wife and children, I was immediately shipped to Calgary. My wife Nelly (now deceased) shared with me the adventures associated with our introduction to the Canadian West and, 12 years later, to Texas. I always remember her with much gratitude, for without her devoted support it would have been impossible to pursue my professional career with so much joy.

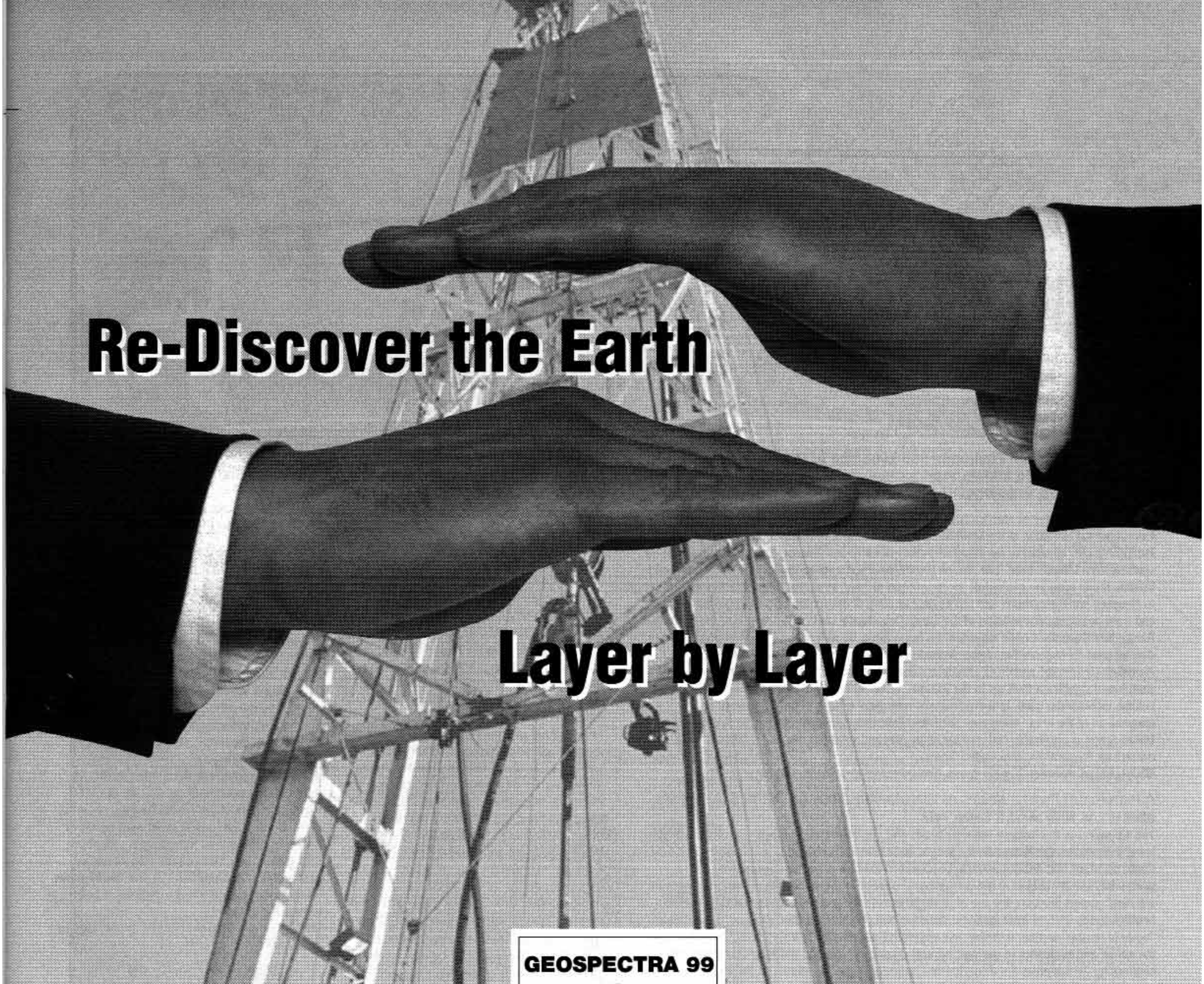
Because of my alpine education, Shell Canada instantly recast me as a structural geologist and generously gave me six months to explain the structure of the Canadian Rockies. I was asked to look at reflection seismic profiles, with a serious admonition from our geophysical elders that a "plain vanilla" geologist really should not and could not interpret a seismic profile. Fortunately some of my younger geophysical contemporaries realized that the seismic data had to fit the surface geology and that some of my background came in handy. This was the beginning of my career-long interest in reflection seismic profiles and of my collaboration with geophysicists.

The work in the foothills led to dry holes as well as economically successful discoveries. It was followed by a large mapping campaign covering the external folded belt of the eastern Canadian Cordillera from British Columbia to the North Slope. For about five years, Shell Canada organized a fleet of eight helicopters with ample fixed-wing support for this project. Eventually, we found ourselves also exploring the eastern and western Canadian offshore. My tectonic fellow travelers at that time included Pete Gordy, Peter Gretener, Lee Slind, Peter Ziegler, Coen Kiewiet de Jonge, Ken Glennie, and, in later years, Felix Frey and many others. We always maintained contacts with the Shell Development Lab in Houston, where following King Hubbert's and Willy Hafner's recommendation, the first Career Contribution Awardee, John Handin, set up a distinguished structural group that focused on rock deformation. Over the years, a lively dialogue developed between "operational" structural geologists like Kaspar Arbenz, Jim Clement, Sig Snelson, Dick Nicholas, Hans Widmer, and Handin's research group, which included Don Higgs, John Prucha, Dave Stearns, Mel Friedman, Hugh Heard, Neville Carter, and others.

The early 1950s in Calgary were heady times for structural petroleum geologists. For the first time, we could directly map the base of a décollement folded belt, which allowed us to construct what today are known as balanced cross sections. Clint Dahlstrom (who won this award in 1991), together with Gerry Henderson, worked for the competition, but, always respecting the limits of confidential propriety, we often met to discuss our problems. Bill Gussow, also with the competition, was a great idea man, gadfly, and very special mentor for me. Ray Price, the new kid on the block, had just finished his thesis in the Flathead area and was a bright star on the horizon. During these years, we all liked to show off the geology of the Rockies to visiting luminaries, including Bob Douglas of the Canadian Survey, Walter Bucher, Maurice Ewing, U. de Sitter, A. Gansser, E.Wegmann, R. Trümpy, and V. Bellousov just to mention a few.

Looking back, I was exceptionally lucky to be exposed to so many brilliant mentors and outstanding colleagues during my early years. For this I am most grateful. Clark said more than enough about my activities since I was transferred to Houston in the mid-1960s, and there is neither space nor time available to name the many other colleagues who tried in later years to influence and balance my stubborn structural preconceptions. However, allow me to add a very special note of thanks to all my colleagues at Rice University, particularly Hans Avé Lallemant and John Oldow, who in the early 1980s welcomed me so generously. Our very different backgrounds complemented each other, and our friendship provided a great opportunity to compare and contrast, with the required sense of humor, academic and industry mind-sets. A big thank you also goes to my students (the barrio kids!) and visiting researchers who made my stay at Rice so fruitful and interesting.

I am now happily retired. I am particularly grateful to my wonderful wife Elaine for bringing so much joy and good companionship into this stage of my life and for encouraging me to keep going. I trust you all will hear more from me in the future because I am not yet done with all that I want to do. Thank you all again for this great honor.



GEOSPECTRA 99

International Trade Fair for Geotechnology and Applied Earth Science

A trade fair as plentiful as the earth itself. And as futuristic as the entire Geo industry itself. GEOSPECTRA 99 presents the entire spectrum for geotechnology and applied earth science. From deposit prospecting and exploration to rock engineering, tunneling, soil excavation and foundation. From geothermal energy to geosensors. From geoinformation technology and geoconsulting to geoengineering.

You will experience the complete range of products for technology, processing and equipment. Whether it is subsurface investigation, exploitation and protection of natural resources, geo-environmental technology, the use of former mine locations, remote sensing or geoinformation technology – GEOSPECTRA is the authority in all these areas.

• Subsurface investigation • Subsurface development and utilization – rock engineering and tunneling, soil excavation and foundation • Raw materials – prospecting and exploration, oil and gas, minerals and soils • Geothermal energy • Geosensors/ geo-environmental monitoring • Preventive geo-environmental technology • Waste disposal technology and land remediation Geotechnical and geoscientific software/geoinformation technology • Remote sensing, photogrammetry, surveying and cartography • Early warning systems and risk management • Geoconsulting/ environmental planning • Geoengineering

Excerpt from the list of exhibits

In time for the new millennium GEOSPECTRA is an integral part of the Technology Forum International, comprised of five thematically related trade shows: GIFA (foundry technology), METEC (metallurgical technology), THERMPROCESS (thermal processing technology) and MINETIME (mining technology).

Order your entrance passes and show directories in advance of the show at a 20 % discount!

Technology Forum International

GIFA 99 | METEC 99 | THERM PROCESS 99 | MINETIME 99 | GEOSPECTRA 99

June 9-15, 1999 Düsseldorf, Germany

Experience the future of our planet layer by layer. Düsseldorf awaits you!

For show information:
Messe Düsseldorf North America
150 North Michigan Avenue
Suite 2920
Chicago, IL 60601
Tel. (312) 781-5180
Fax (312) 781-5188
http://www.mdna.com

For hotel and travel information:
Travel Trade International
Tel. (212) 674-3476
Fax (212) 674-3477

Lufthansa
Official Airline

Messe Düsseldorf North Americ

CORDILLERAN SECTION, GSA
GSA Centennial 1899–1999
95th Annual Meeting

Berkeley, California
June 2–4, 1999

http://socrates.berkeley.edu/~earthres/GSApage.html

Century of the Pacific Rim: The Past as Prologue to the Future

Join us for three days of outstanding scientific meetings at the University of California, Berkeley, with the spectacular scenery of the San Francisco Bay area as a backdrop. The weather in June is usually sunny and mild, temperatures ranging from 50 to 70 °F. Cool fog or rain is a possibility.

The scientific program, which commemorates the first meeting of the GSA Cordilleran Section, held in the Bay Area in December 1899, will take place June 2–4, 1999, preceded by a Welcoming Party on the evening of June 1. The Centennial meeting is hosted by the Department of Geology and Geophysics, the Museum of Paleontology, and the Earth Resources Center of UC Berkeley. Cosponsors include the Association for Women Geoscientists San Francisco Bay Area Chapter, Paleontological Society, Seismological Society of America, San Francisco Section of the Association of Engineering Geologists, and Society of Economic Geologists.

The centennial theme focuses on the impact of Cordilleran geoscience on the global geological framework, over the past 100 years, and in the future.

TECHNICAL PROGRAM

The technical program will open on June 2 with a plenary session featuring a talk on "Cordilleran Geology in Year 101 and Beyond: Expanding or Shrinking Frontiers?" by Gregory A. Davis of the University of Southern California, 1998–1999 Cordilleran Section chair. Oral and poster sessions will follow.

Oral sessions will allow 12 minutes for presentation and three minutes for discussion. Equipment for each technical session consists of two 35 mm carousel projectors for 2″ × 2″ slides and one overhead projector for transparencies. If you need video projection or computer display equipment, you must specifically request it with your abstract. Please bring your own carousel tray, identified with speaker's name, session, and speaker number, to the session room before the start of the session. A speaker ready room will be available.

Posters will be on display for four hours, and authors will be present for two hours. Each poster booth will contain two 4′ × 8′ boards. Posters will share Pauley Ballroom with the exhibits.

Most technical sessions will include both invited and volunteered papers. In addition to the 26 sessions listed below, additional sessions will be scheduled on the basis of submitted abstracts.

General questions should be addressed to the program co-chairs, Eldridge Moores, Dept. of Geology, University of California, Davis, CA 95616, (916) 752-0352, moores@geology.ucdavis.edu; or George Brimhall, Dept. of Geology and Geophysics, University of California, Berkeley, CA 94720-4767, (510) 642-5868, brimhall@socrates.berkeley.edu.

Cordilleran Centennial Symposia and Technical Sessions

1. Cordilleran Geology, Past and Future: Impact on Global Geological Framework. Eldridge Moores, UC Davis, (530) 752-0352, moores@geology.ucdavis.edu.
2. History of the Cordilleran Section and Its Geoscientists. William Berry, UC Berkeley, (510) 642-3925, bberry@uclink4.berkeley.edu; Michele Aldrich, Hatfield, Massachusetts, 73061.2420@compuserve.com.
3. The Franciscan Complex: Archetype or Atypical Subduction Complex? Sarah Roeske, UC Davis, (530) 752-4933; roeske@geology.ucdavis.edu; John Wakabayashi, Hayward, California, (510) 887-1796, wako@tdl.com; Alison Till, USGS, Anchorage, Alaska, (907) 786-7444; atill@tundra.wr.usgs.gov.
4. Geochronology from a Cordilleran Perspective: Pioneering Methods and Applications. Paul R. Renne, Berkeley Geochronology Ctr., 2455 Ridge Rd., Berkeley, CA 94709, (510) 644-1350, prenne@bgc.org.
5. Earthquake Processes: Seismological Society of America Symposium. Barbara Romanowicz, Doug Dreger, Tom McEvilly, UC Berkeley, (510) 643-5690, barbara@seismo.berkeley.edu; dreger@seismo.berkeley.edu; tom@seismo.berkeley.edu.
6. Great Earthquakes in the Cordillera: The Geologic Record, Facts, Myths and Fiction. Bill Lettis, Wm. Lettis & Assoc., 1777 Botelho Dr., Walnut Creek, CA 94596, (925) 256-6070, lettis@lettis.com.
7. Cordilleran Plutonism in the Americas. Susan DeBari, Dept. of Geology, Western Washington University, Bellingham, WA 98225, (360) 650-3588, debari@cc.wwu.edu; Brendan McNulty, California State University, Dominguez Hills, (310) 243-3412, bmcnulty@dhvx20.csudh.edu; Calvin Barnes, Texas Tech University, (806) 742-3106, gical@ttacs.ttu.edu.
8. Tectonics and Volcanism of Western Mexico. Ian Carmichael, UC Berkeley, (510) 642-2577, ian@socrates.berkeley.edu; Joanne Stock, California Institute of Technology at Pasadena, California.
9. Evolutionary History of Pacific Rim Biota: Paleontological Society Symposium. Jere Lipps, Museum of Paleontology, University of California, Berkeley, CA 94720-4780, (510) 642-9006, jlipps@ucmp1.berkeley.edu; Carol M. Tang, Arizona State University, (602) 965-9878, tang@asu.edu.
10. Faunal Change, Ocean-Climate History, and Pacific Margin Evolution. James Ingle, Dept. of Geological and Environmental Sciences, Stanford University, Stanford, CA 94305, (650) 723-3366, ingle@pangea.stanford.edu.
11. Cambrian of the Cordillera: A symposium in honor of A. R. Palmer. Linda B. McCollum, Dept. of Geology, MS-70, Eastern Washington University, Cheney, WA 99004, (509) 359-7473, fax 509-359-2213, lmccollum@ewu.edu; Stew Hollingsworth, Grand Junction, Colorado, (970) 241-6484, stewholl@aol.com.
12. Global Eocene Plate Reorganizations—The Sea-Land Connection. Steven C. Cande, Scripps Institution of Oceanography, MC 215, University of California, San Diego, CA 92093-0215, scande@garess.ucsd.edu.
13. Estuaries and Coast Watersheds of the Pacific Rim. B. Lynn Ingram, UC Berkeley, (510) 643-1474, ingram@socrates.berkeley.edu; Roger Byrne, UC Berkeley, (510) 643-9170, arbyrne@uclink4.berkeley.edu.
14. El Niño Revisited—Projections, Predictions, Preparations, and Policy. Scott Burns, Dept. of Geology, Portland State University, P.O. Box 751, Portland, OR 97207-0751, scott@ch1.ch.pdx.edu.
15. The Effect of Stratigraphic Controls on Subsurface Contaminant Remediation. Seena Hoose, 10394 Bret Ave., Cupertino, CA 95014, (408) 252-5811, hoose@ix.netcom.com.
16. Engineering Geology and Natural Hazards in the Cordillera. Nick Sitar, Dept. of Civil and Environmental Engineering, University of California, Berkeley, CA 94720, (510) 643-8623, nsitar@ce.berkeley.edu; Bob Wright, Harlan, Tate & Associates, San Francisco, (415) 626-0765, rhww@earthlink.net.
17. Sharing Information Through Technology. Jim Locke, Dept. of Geology, College of Marin, Kentfield, CA 94904, (415) 485-9526; jim@marin.cc.ca.us; Judy Scotchmoor, UC Berkeley, (510)642-4877; judys@ucmp1.berkeley.edu.
18. Undergraduate Research Posters. (Council on Undergraduate Research). Susan DeBari, Dept. of Geology, Western Washington University, Bellingham, WA 98225, (360) 650-3588, debari@cc.wwu.edu. Poster mode only.

Pacific Rim Symposia on Ore Deposits and Mine Restoration. (Sponsored by the Berkeley Earth Resources Center.) George Brimhall, Dept. of Geology and Geophysics, University of California, Berkeley, CA 94720-4767, (510) 642-5868, brimhall@socrates.berkeley.edu.

19. McLaughlin Symposium on Mining Geology. Diane Wolfgram, Dept. of Geological Engineering, Montana Tech, Butte, MT 59701, (406) 496-4353, Dwolfgram@mtech.edu.

20. Recent Ore Exploration and Discovery in the "Ring of Fire." Eliseo Gonzales-Urien, Placer Dome Inc., 2085 Hamilton Ave. #150, San Jose, CA 95125, (408) 377-3538, 76214.3227@compuserve.com; Hugo Dummett, BHP Minerals, San Francisco, (415) 774-2526, Dummett.Hugo.HT@bhp.com.au.
21. China Geology and Metallogeny. Xuane Mo, China University of Geosciences, 29 Xueyuan Road, Beijing 100083, China, 10-6231-2244 x3106, mxx@sky.edu.cn.
22. Impacts and Remediation of Base-Metal Mining. Charles Alpers, USGS, Placer Hall, 6000 J St., Sacramento, CA, 95819-6129, (916) 278-3134, cnalpers@usgs.gov.
23. Impacts of Hydraulic Mining and Placer Gold Processing. Mike Hunerlach and Charles Alpers, USGS, Placer Hall, 6000 J St., Sacramento, CA 95819-6129, (916) 278-3134, cnalpers@usgs.gov.
24. Circum–North Pacific Metallogenesis. Shunzo Ishihara, shunso@gsj.go.jp, and Warren Nokleberg, USGS, MS 901, Menlo Park, CA 94025, (650) 329-5732, wnokleberg@isdmnl.wr.usgs.gov.
25. Environmental Impacts of Lode Gold Mining. Roger Ashley, USGS, 345 Middlefield Rd., Menlo Park, CA 94025, (650) 329-5416, ashley@usgs.gov.
26. Mercury in the Environment: The Importance of Historic Mining. Jim Rytuba, USGS, 345 Middlefield Road, Menlo Park, CA 94025, (650) 329-5418, jrytuba@usgs.gov.

FIELD TRIPS

Preregistration deadline: *April 30, 1999.*
Cancellation deadline: *May 7, 1999.*

The intriguing geology of northern and central California, well displayed in outcrops that range from sea cliff to alpine mountainside, has played an important role in shaping concepts in earth sciences for the past century. A field guide will be published by the California Division of Mines and Geology.

Field trips will depart from and return to the UC Berkeley campus. Trip fees include transportation, lunch, refreshments during the trip, and a guidebook. Lodging (double occupancy) is provided for multiday trips; meals are included for some trips. You must be registered for the meeting to participate in a field trip.

The following trip descriptions are much abbreviated. Full descriptions are given on our website: http://socrates.berkeley.edu/~earthres/GSApage.html, or www.geo.berkeley.edu/geology. For additional information, contact the field trip leader or field trip chair Steve Graham, Dept. of Geological and Environmental Sciences, Stanford University, Stanford, CA 94305-2115, (650) 723-0507, graham@pangea.Stanford.edu.

Premeeting

1. Sierra Nevada Gold Deposits. Two days, Saturday–Sunday, May 29–May 30. See also postmeeting trip #9. David Lawler, Farwest Geoscience Foundation, 48 Shattuck Sq., Ste. 108, Berkeley, CA 94704, (510) 549-9694, lawler@webbnet.com; David Jones, and Greg Wilkerson. All meals are included. Limit: 20. Cost: $265.

This trip will visit several active placer and lode mines, where bedrock and economic aspects will be discussed in detail.

2. Accretionary Tectonics of the Western Sierra Nevada. Three days, Sunday–Tuesday, May 30–June 1. Richard A. Schweickert, Dept. of Geological Sciences, Mackay School of Mines, University of Nevada, Reno, NV 89557-0138, (702) 784-6901, richschw@unr.edu. Breakfast and lunch are included; dinner is on your own. Limit: 40. Cost: $300.

This trip will focus on tectonics and crustal evolution of the western Sierra Nevada metamorphic belt between Sonora and Auburn.

3. Sutter Buttes Volcano. Two days, Monday–Tuesday, May 31–June 1. Brian Hausback, Dept. of Geology, California State University, Sacramento, CA 95819-6043, (916) 278-6521, hausback@csus.edu. Breakfast and lunch are included; dinner is on your own. Limit: 30. Cost: $180.

We will examine the field relationships of volcanic rocks exposed at the Pleistocene Sutter Buttes, including domes and pyroclastic deposits of rhyolitic to andesitic composition.

One-Day Trips

4. The Geology and Wines of Napa Valley. Tuesday, June 1. David G. Howell, USGS, MS 902, Menlo Park, CA 94025, (650) 329-5430, dhowell@octopus.wr.usgs.gov; Jonathan R. Swinchatt. Limit: 40. Cost: $65.

We will review the geologic history of the Napa Valley and how this history has influenced the factors—topography, climate, and soil—that create the microenvironments that vintners exploit so well in creating a wide variety of wines.

5. Classic Subduction Complex: Franciscan Complex of the San Francisco Bay Area. Tuesday, June 1. See also postmeeting trip #16. John Wakabayashi, 1329 Sheridan Lane, Hayward, CA 94554-4332, (510) 887-1796, wako@tdl.com. Limit: 35. Cost: $60.

This trip affords participants the opportunity to see several major features of the world's most famous subduction complex, the Franciscan Complex.

6. Neotectonic and Quaternary Geology of the San Gregorio Fault Zone, Santa Cruz and San Mateo Counties, California. Tuesday, June 1. Gerald E. Weber, 614 Graham Hill Rd., Santa Cruz, CA 95060, (408) 426-1367, jweber@earthsci.ucsc.edu; William R. Lettis, Jeffrey M. Nolan, Jennifer Thornberg. Limit: 35. Cost: $65.

We will examine the geologic evidence used to estimate slip rates and recency of movement along the San Gregorio fault zone.

Postmeeting

7. Mesozoic Convergent Margin of Central California. Four days, Saturday–Tuesday, June 5–8. Raymond V. Ingersoll, Dept. of Earth and Space Sciences, University of California, Los Angeles, CA 90095, (310) 852-8634, ringer@ess.ucla.edu; Kent Ratajeski, Allen F. Glazner; Mark P. Cloos. Breakfast and lunch are included; dinner is on your own. Limit: 32. Cost: $305.

This comprehensive trip examines all components of the late Mesozoic convergent margin, including arc, forearc basin, and subduction complex.

8. Economic Geology and Environmental Issues at Mercury-Gold Deposits and the McLaughlin Gold Deposit, California Coast Range. Two days, Saturday–Sunday, June 5–6. James J. Rytuba, USGS, MS 901, 345 Middlefield Rd., Menlo Park, CA 94025, (650) 329-5418, jrytuba@mojave.wr.usgs.gov; Dean Enderlin, Dianne Whyte. All meals included. Limit: 35. Cost: $175.

We will review the geology and environmental geochemistry of mercury and gold deposits in the northern part of the California Coast Range mercury mineral belt.

9. Sierra Nevada Gold Deposits. Two days, Saturday–Sunday, June 5–6. See also premeeting trip #1. David Lawler, Farwest Geoscience Foundation, 48 Shattuck Sq., Ste. 108, Berkeley, CA 94704, (510) 549-9694, lawler@webbnet.com; David Jones, Greg Wilkerson. All meals included. Limit: 20. Cost: $265.

See premeeting trip #1.

One-Day Trips

10. San Andreas Fault Zone near Point Reyes: Late Quaternary Deposition, Deformation, and Paleoseismology. Saturday, June 5. Karen Grove, Dept. of Geosciences, San Francisco State University, San Francisco, CA 94132-4001, (415) 338-2617, kgrove@sfsu.edu; Tina Niemi. Limit: 25. Cost: $65.

Participants will get up-close views of the San Andreas fault and associated sediments and geomorphic features in the scenic Point Reyes area.

11. Sedimentology and Facies Architecture of High-Density Sediment–Gravity-Flow Deposits, Paleocene, Santa Lucia Range, California. Saturday, June 5. Kai Anderson, Dept. of Geological and Environmental Sciences, Stanford University, Stanford, CA 94305, (650) 723-0507, anderson@pangea.stanford.edu. Limit: 25. Cost: $65.

We will inspect and discuss the sedimentology and stratigraphic architecture of the Wagon Caves Rock, a prominent mesa-like exposure composed of coarse-grained, thick-bedded, deep-marine sandstones that sits near the top of a 1.5-km-thick deep-marine Paleocene sequence exposed in the central Santa Lucia Range.

12. Representative Industrial Mineral Mines of the San Francisco Bay Region. Saturday, June 5. Don DuPras and Susan Kohler, California Division of Mines and Geology, Industrial Minerals Division, 801 K St., MS 08-38, Sacramento, CA 95814, (916) 323-0111. Limit: 20. Cost: $65.

We will visit three large representative construction-related industrial mineral mining operations that serve the San Francisco Bay region: Radum Quarry, Wilson Quarry, and Permanente Limestone Quarry.

13. Earthquakes on the Calaveras Fault: Fact or Fiction? Saturday, June 5. Keith Kelson, William Lettis & Associates, Inc., 1777 Botelho Dr., Ste. 262, Walnut Creek, CA 94596, (925) 256-6070, kelson@lettis.com; David Oppenheimer, David Manaker. Limit: 45. Cost: $65.

This trip will provide an overview of the geology, seismology, paleoseismology, and geodetic deformation associated with this 140-km-long crustal structure.

14. Geology and Natural History of Coastal Northern California (Tomales Bay, Bodega Bay and the Russian River

Cordilleran *continued on p. 38*

Cordilleran *continued from p. 37*

Regions). Saturday, June 5. Jere Lipps, Museum of Paleontology, University of California, Berkeley, CA 94720-4780, (510) 642-9006, jlipps@ucmp1.berkeley.edu. Limit: 45. Cost: $90.

We will explore the Mesozoic terranes, the San Andreas fault zone in Tomales and Bodega Harbor, and the Pleistocene marine Millerton Formation of Tomales Bay, as well as the plant and animal communities encountered along the way.

15. Sequence Stratigraphy and Mining History of the Black Diamond Mines Regional Preserve. Saturday, June 5. Raymond Sullivan, Dept. of Geosciences, San Francisco State University, San Francisco, CA 94132-4001, (415) 338-7730, sullivan@sfsu.edu; John Waters, Morgan D. Sullivan. Limit: 23. Cost: $65.

We will explore the geology in the underground workings of what was, in the 1800s, the largest coal mining operation in California.

16. Classic Subduction Complex: Franciscan Complex of the San Francisco Bay Area. Saturday, June 5. See also premeeting trip #5. John Wakabayashi, 1329 Sheridan Lane, Hayward, CA 94554-4332, (510) 887-1796, wako@tdl.com. Limit: 35. Cost: $60.

See premeeting trip #5.

17. Depositional and Other Features of the Merced Formation in Seacliff Exposures South of San Francisco. Sunday, June 6. H. Edward Clifton, Conoco Inc., Permian 3050, P.O. Box 2197, Houston, TX 77252-2197, (281) 293-6775, h-edward.clifton@conoco.dupont.com; Ralph Hunter. Limit: 18. Cost: $60.

Focus will be on depositional facies that range from shelf depth to eolian dune and their implications relative to sea-level history and tectonism in this area over the past 2+ million years.

18. Del Puerto Ophiolite: Its Petrology and Tectonic Setting. Sunday, June 6. Russel C. Evarts; Robert G. Coleman, 2025 Camino Al Lago, Menlo Park, CA 94025, (650) 854-3641, coleman@pangea.stanford.edu; Peter Schiffman. Limit: 33. Cost: $65.

We will examine outcrops of the major ophiolite components, including mantle peridotite, plutonic complex, volcanic rocks, and depositionally overlying sedimentary rocks.

19. Hayward Fault—Source of the Next Big One? Sunday, June 6. Sue Hirschfeld, Dept. of Geological Sciences, California State University, Hayward, CA 94542-3088, (510) 885-3000, shirsch@gauss.sci.csuhayward.edu; Glenn Borchardt, James Lienkaemper, Pat Williams. Limit: 42. Cost: $60.

We will follow the fault along the eastern side of San Francisco Bay, to view the sites that provide the latest information on segmentation, the history of earthquake activity, and geologic slip rate.

20. Hills, Hollows, and Channel Networks: Linking Field Studies and Digital Terrain Modeling. Sunday, June 6. William E. Dietrich, Dept. of Geology and Geophysics, University of California, Berkeley, CA 94720-4767, (510) 642-2633, bill@geomorph.berkeley.edu. Limit: 30. Cost: $60.

We will review past and ongoing research on processes controlling runoff, erosion, and landscape form in the grass and brush lands of Marin County.

WORKSHOPS

1. Digital Geological Mapping Using GPS and Laser Range Finders. Saturday, June 5, 8:30 a.m.–5 p.m., Cost: $200. Limit: 20. George Brimhall, Earth Resources Center and Dept. of Geology and Geophysics, University of California, Berkeley, CA 94720-4767, (510) 642-5868, brimhall@socrates.berkeley.edu.

Digital field mapping using portable pen-based PC computers supported by meter-scale GPS and laser range finders is revolutionizing the practice of field geology. This workshop will introduce mappers to state-of-the-art digital software and hardware. The workshop is evenly divided into tutorials and hands-on practice in digital field mapping in the Berkeley Hills.

2. Preferred Orientation and Anisotropy in Deformed Rocks. Saturday, June 5, 8:30 a.m.–5 p.m. Rudy Wenk, Dept. of Geology and Geophysics, University of California, Berkeley, CA 94720-4767, (510) 642-7431, wenk@seismo.berkeley.edu. Cost: $100.

The development of anisotropy has become of increasing interest to structural geologists for unraveling the strain history and to geophysicists for the determination of seismic properties. This workshop, for beginners, is evenly divided into hands-on experiments with sophisticated instrumentation, computer analysis of the data, and modeling of underlying processes. Fee includes lunch, coffee, and a copy of the Berkeley texture package BEARTEX.

3. Roy Shlemon Mentors in Applied Geology Program, a workshop for upper-level undergraduate and graduate students. Saturday, June 5, 8:30 a.m.–12:30 p.m., followed by lunch (included, with the mentors). This workshop will address practical aspects of engineering and environmental geology. The program is targeted to students soon to be looking for a position in the "real world." Cost: $10. Contact Janet Sowers, Wm. Lettis & Assoc., 1777 Botelho Dr., Ste. 262, Walnut Creek, CA 94506, (925) 256-6070, fax (925) 256-6076, sowers@lettis.com.

K–16 EDUCATIONAL PROGRAMS

We encourage teachers to attend many facets of the meeting (symposia, workshops, lectures, field trips). However, because of end-of-the-year activities in the schools, we have concentrated all of our K–16 programs in a single afternoon. Three separate strands will be offered, as listed below. All will be held 1–5 p.m. on Thursday, June 3, 1999.

A teacher resource room will be open to provide information on new education programs and sample curriculum materials, and all teachers will receive an annotated version of the full meeting program to enable them to make appropriate selections for their needs. There will be no additional fees for the workshops, and registration will be reduced for all K–12 professionals. For further details, contact Judy Scotchmoor (510) 642-4877 or judys@ucmp1.berkeley.edu.

Activities for the K–6 Classroom

From Pebbles to Moon Rocks. Observing rocks to seriate, group, and classify and identify relationships among earth materials. Sue Jagoda, FOSS, Lawrence Hall of Science.
Geosciences and the Arts. Using the arts and humanities to generate interest in the geosciences. Ray Pestrong, San Francisco State University.

Applications for Grades 7–12

Exploring Earth Dynamics with the Bay Area Earth Science Institute. Exploring plate tectonics and the hazardous and exciting consequences to learn about continental drift, faulting, seismic waves, and volcanoes. Ellen Metzger and Randy Hollenkamp, BAESI.
Learning from the Fossil Record. Using fossils to make inferences about paleoecology and paleoenvironments. Judy Scotchmoor, UC Museum of Paleontology.

New Uses of Technology for Grades 8–16

Using Image Processing in Earth Science Teaching. NIH Image (freeware software) and its application in earth science–related content activities. Ed Geary, GSA.
Using Multimedia in the Classroom: Geoscience Education Through Interactive Technology (GET-IT). Using earthquakes, volcanoes, and hurricanes to explore earth and physical science concepts. Ed Geary, GSA.

An introduction to GIS for use in geology and earth science classes; an explanation of GIS technology and its applications in the classroom. Ann Johnson and George Dailey, ESRI.
Earth Science Virtual Field Trips for the K–12 Classroom. Evaluating virtual field trip sites and their use in planning, teaching and learning in earth science. Janet J. Woerner, California State University, San Bernardino.
Explorations Through Time. Involving students in research projects through interactive World Wide Web learning modules. Judy Scotchmoor, UC Museum of Paleontology.

STUDENT AWARDS AND SUPPORT

The GSA Cordilleran Section will give awards for the best graduate and undergraduate papers (oral or poster). Papers will be considered for any of the symposia or discipline sessions listed, and students should submit their abstracts on the standard form. The student must be both first author and presenter and should follow the guidelines for speakers sent out by GSA. We invite professional attenders to participate in this recognition of outstanding student work by volunteering to act as judges (judges will get a complimentary breakfast). Contact Doug Dreger, Dept. of Geology and Geophysics, University of California, Berkeley, CA 94720-4767, (510) 643-1719, dreger@seismo.berkeley.edu.

The Cordilleran Section can offer partial support for travel of GSA Student Associates of the Section who are presenting papers at the meeting. Apply to Cordilleran Section Secretary Bruce A. Blackerby, Dept. of Geology, California State University, Fresno, CA 93740, (209) 278-2955, bruceb@csufresno.edu. Applications should include certification that the student is presenting a paper and is a GSA Student Associate as of February 28, 1999. Applications must be received by *March 31, 1999.*

MULTIMEDIA DEMO THEATER

A computer laboratory will be provided for participants during the meeting to access

Cordilleran *continued on p. 40*

PREREGISTRATION FORM

GSA Cordilleran Section

Berkeley, California
June 2–4, 1999

Please print clearly • THIS AREA IS FOR YOUR BADGE

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

Employer/University Affiliation

City State or Country

Mailing Address (use two lines if necessary)

City State

ZIP Code Country (if other than USA)

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

(A) GSA (B) AWG (C) AEG (D) PS (E) SS (F) SEG

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

Name as it should appear on your guest's badge

City State or Country

Please inform us by May 7 of any special considerations that you or your guest require.

☐ I will need special considerations.

( ) - **Business Phone**

( ) - **fax**

( ) - Home Phone

Preregistration Deadline: April 30, 1999
Cancellation Deadline: May 7, 1999

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

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

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

Card Number

Signature Expires

FOR OFFICE USE

A ______ V ______ M ______
CK# ______

	DR	CR
Bal. A/R 1233		
Ref. A/P 2006		
Refund ck#		

PREREGISTRATION FEES

	Full Meeting	One Day	Qty.	Amount
Professional Member*	(10) $100 ☐	(11) $60 ☐	__	$ ______
Professional Nonmember	(14) $110 ☐	(15) $60 ☐	__	$ ______
Student Member*	(30) $ 30 ☐	(31) $20 ☐	__	$ ______
Student Nonmember	(32) $ 40 ☐	(33) $20 ☐	__	$ ______
K–12 Professional	(60) $ 25 ☐		__	$ ______
Guest or Spouse	(90) $ 15 ☐		__	$ ______

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

GUEST EVENT

	Date	Fee	Qty.	Amount
1. Sausalito, Muir Woods Tour	June 3	(101) $ 38	__	$ ______

SPECIAL EVENTS

	Date	Fee	Qty.	Amount
1. California Council of Geology Organizations Lunch	June 2	(301) $ 17	__	$ ______
2. AWG Breakfast	June 3	(302) $ 4	__	$ ______
3. GSA G&PP & Education Comm. Mtg. & Breakfast	June 3	(303) $ 5	__	$ ______
4. GSA Cordilleran Section Business Meeting Lunch	June 4	(304) $ 13	__	$ ______
5. Paleontological Society Lunch	June 4	(305) $ 13	__	$ ______

WORKSHOPS

	Date	Fee	Qty.	Amount
1. Digital Mapping Using GPS and Laser Range Finders	June 5	(601) $200	__	$ ______
2. Preferred Orientation & Anisotropy in Deformed Rocks	June 5	(602) $100	__	$ ______
3. Roy Shlemon Mentors Program	June 5	(603) $ 10	__	$ ______

FIELD TRIPS

	Date	Fee	Qty.	Amount
1. Sierra Nevada Gold Deposits	May 29–30	(401) $265	__	$ ______
2. Accretionary Tectonics of W. Sierra Nevada	May 30–June 1	(402) $300	__	$ ______
3. Sutter Buttes Volcano	May 30–June 1	(403) $180	__	$ ______
4. Geology and Wines of Napa Valley	June 1	(404) $ 65	__	$ ______
5. Classic Subduction Complex: Franciscan	June 1	(405) $ 60	__	$ ______
6. San Gregorio Fault Zone	June 1	(406) $ 65	__	$ ______
7. Mesozoic Convergent Margin of Central California	June 5–8	(407) $305	__	$ ______
8. Economic Geol. & Environ. Issues at Hg-Au Deposits	June 5–6	(408) $175	__	$ ______
9. Sierra Nevada Gold deposits	June 5–6	(409) $265	__	$ ______
10. San Andreas Fault Zone Near Point Reyes	June 5	(410) $ 65	__	$ ______
11. Sedimentology & Facies Architecture	June 5	(411) $ 65	__	$ ______
12. Representative Industrial Mineral Mines	June 5	(412) $ 65	__	$ ______
13. Earthquakes on the Calaveras Fault: Fact or Fiction?	June 5	(413) $ 65	__	$ ______
14. Geology & Natural History of Coastal N. California	June 5	(414) $ 90	__	$ ______
15. Sequence Stratigraphy, Black Diamond Mine	June 5	(415) $ 65	__	$ ______
16. Classic Subduction Complex: Franciscan	June 5	(416) $ 60	__	$ ______
17. Depositional & Other Features of Merced Formation	June 6	(417) $ 60	__	$ ______
18. Del Puerto Ophiolite	June 6	(418) $ 65	__	$ ______
19. Hayward fault	June 6	(419) $ 60	__	$ ______
20. Hills, Hollows, and Channel Networks	June 6	(420) $ 60	__	$ ______

TOTAL FEES REMITTED $ ______

Cordilleran *continued from p. 38*

the multimedia, software, and Internet resources discussed in the companion technical session, "Sharing Information Through Technology," and to experience other geoscience-related computing resources for education.

EXHIBITS

Exhibits will be located in the Pauley Ballroom along with the poster sessions and food concessions. The exhibits area will be open 6–8 p.m. on Tuesday during the Welcoming Party, 8 a.m.–5 p.m. Wednesday and Thursday, and 8 a.m.–noon on Friday. Contact Exhibits Chair Ivan Wong (510) 874-3014, igwongx0@wcc.com, for further information and applications.

GUEST PROGRAM

A special information table will be set up throughout the conference to help guests with plans for sightseeing and taking advantage of the many special cultural and other interests the Bay Area offers. In addition, two special activities are planned.

Guest Reception. Faculty Club, 9 to 11:30 a.m., Wednesday, June 2. An opportunity to meet other guests and learn about local excursions. Speaker is from the Berkeley Architectural Heritage Association.

Sausalito, Muir Woods Tour. Thursday, June 3; tour through the fabled redwoods, lunch on your own, and shop in Sausalito, a picturesque fishing village and artist colony. Guests will return to campus by mid-afternoon by ferry across the Bay. Advance reservations are required; cost is $38.

SPECIAL EVENTS

Welcoming Party. Tuesday, June 1, 6 to 8 p.m., Pauley Ballroom, Student Union. On-site registration will be available, and exhibits will be open. Snacks, soft drinks, and one complimentary drink provided. Cash bar.

The Earth from the Space Shuttle: What the Astronauts See. Thursday, June 3, 8 p.m. Everyone is welcome to this free talk, by William Muehlberger, University of Texas at Austin, illustrated by spectacular shots from the NASA collection. Muehlberger will outline some of the scientific aspects of handheld photography from Skylab, Apollo-Soyuz, and space shuttle missions. The slides show atmosphere, ocean, and land features of the Cordilleran Section and the Pacific Rim as seen from space.

Geology Through the Camera Lens. An exhibit of the beautiful geologic photographs of John Karachewski will be on display in the newly remodeled lobby of McCone Hall (Earth Sciences Building).

BUSINESS MEETINGS

The following business and section meetings will be held on campus in the Faculty Club:

- California Council of Geoscience Organizations (CCGO) Luncheon. Wednesday, June 2, noon–2 p.m. Cost: $17.
- Association for Women Geoscientists Breakfast. Thursday, June 3, 7–8:30 a.m. Cost: $4.
- GSA Geology & Public Policy Committee and Education Committee Joint Breakfast Meeting. Thursday, June 3, 7–8:30 a.m. Cost: $5.
- GSA Cordilleran Section Business Meeting Lunch. Friday, June 4, noon–1:30 p.m. Cost: $13.
- Paleontological Society, Cordilleran Section Luncheon. Friday, June 4, noon–1:30 p.m. Cost: $13.

The State Board of Registration for Geologists and Geophysicists will hold its regularly scheduled meeting at Berkeley during the GSA Cordilleran Centennial Meeting, 8 a.m. to 5 p.m., June 4–5, 1999, in the Tan Oak Room of the Student Union. All Centennial participants are invited to attend the meeting. The board will discuss the role of licensure for the practice of geology in California and other topics.

HOUSING

Reservation deadline: *April 15, 1999*
Changes and cancellations deadline: May 1, 1999

Housing has been reserved in campus units, at two nearby hotels and at one hotel on San Francisco Bay some distance from campus. A large block of rooms has been reserved on campus, but off-campus housing is relatively scarce in the Berkeley area. We strongly urge you to make your reservations early.

Housing on campus and at nearby hotels involves a walk of 5 to 15 minutes to the meeting rooms. No shuttle will be provided. A campus shuttle stops at the most distant housing units approximately every 10 minutes. All facilities are wheelchair accessible. For additional information on housing, contact the housing coordinator (after March 1) at (510) 642-3993 or General Chair Doris Sloan, (510) 642-3703.

On Campus: A large block of rooms has been reserved on the UC Berkeley campus; these rooms are available at modest rates to all participants. Campus housing must be reserved on the housing reservation form and sent to the housing coordinator.

All campus housing units are double rooms with two single beds and shared baths. Some of the bedrooms have shared suites. All units have kitchenettes and laundry facilities. A self-service computer station with IBM PCs and Macs, and Internet access (Netscape, Telnet, Eudora), is located in Stern Hall for Stern and Foothill residents. Parking is available for $20/week or $5/day.

The housing coordinator will assign rooms based on the number of nights you plan to stay. No changes in room or length of stay may be made after the change-cancellation deadline. After the deadline you will be charged for the number of nights reserved. A stay of more than one night includes breakfast.

Rates: Housing rate packages are based on the number of nights reserved. One night: $30/person, double occupancy. Must be reserved for two people, or single occupancy rate ($43) applies. No dining service available. Two nights: $68/person double occupancy; $94/person single occupancy. Three nights: $103/person double occupancy; $142/person single occupancy. For campus housing, payment must be by check or money order payable to 1999 GSA Cordilleran Meeting. Sorry, but we cannot accept credit cards.

Local Hotels: Housing is always in short supply near the university, and early reservations are advised. GSA does NOT handle

HOUSING RESERVATION FORM *(for campus housing only)*

Reservations must be received by April 15.

Arrival Date ______________________ Departure Date ____________________

PERSON REQUESTING HOUSING *(type or print)*

____
Last name First

____
Institution or firm

____
Address

____
City State ZIP Country

(   ) ________________________ (   ) ________________________
Work phone Home phone

RESERVATION IN NAME OF: ______________________________________

NAMES OF ALL OTHER OCCUPANTS:

______________________________ ______________________________

______________________________ ______________________________

SPECIAL NEEDS:

RESERVATION DEADLINE: *April 15, 1999.* Reservations by fax or mail only.

Mail form to: Housing Coordinator (GSA Cordilleran Section Meeting), Dept. of Geology and Geophysics, University of California, Berkeley, CA 94730-4767

Or fax to: Housing Coordinator, Dept. of Geology and Geophysics, 510-643-9980

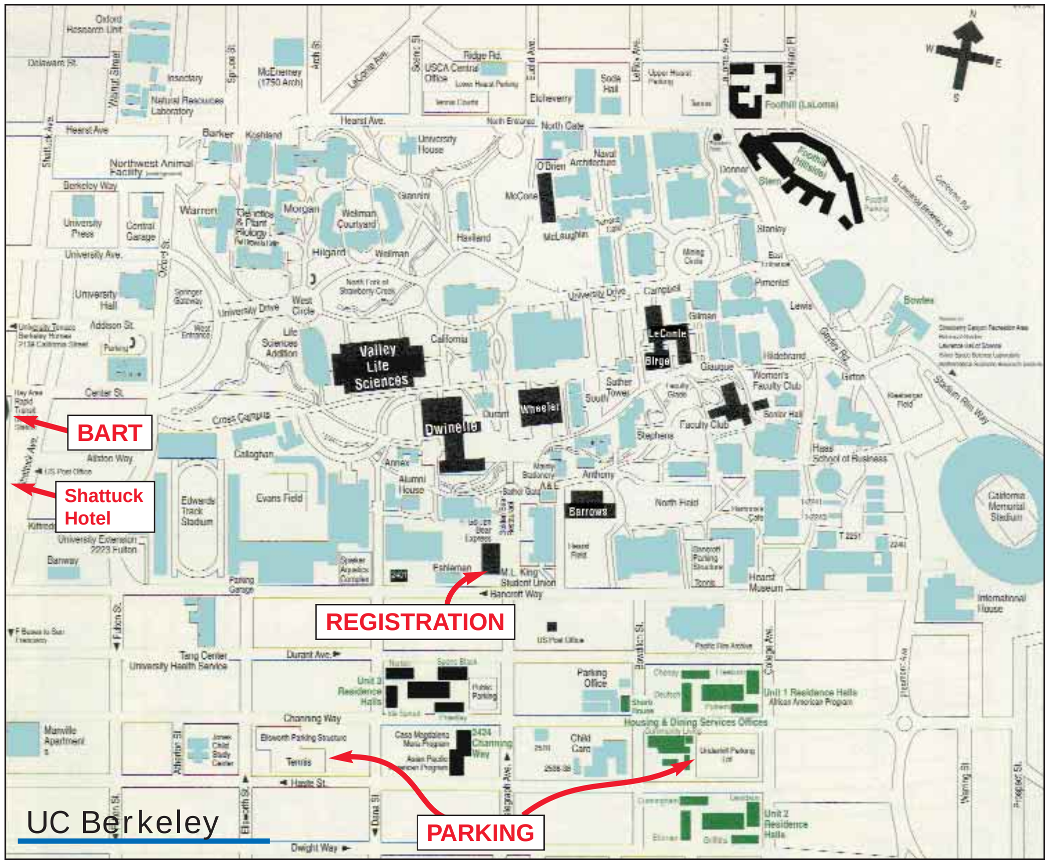
Full payment required. Check or money order only, payable to 1999 GSA Cordilleran Meeting.
Sorry, no credit cards.

reservations for off-campus hotels. You must call hotels directly. Be sure to mention the GSA Centennial to get the special convention rate at these hotels:

• Hotel Shattuck, 2086 Allston Way, Berkeley, CA 94704 (510) 845-7300; fax 510-644-2088. Central Berkeley, 4 blocks from the meeting site; adjacent to BART and campus shuttle. Complimentary continental breakfast. Restaurant in hotel. Parking available 1/2 block away for about $10.50/day. Rates: $69 single, $79 double; $15 additional guest; add 12% hotel tax.

• Hotel Durant, 2600 Durant Ave., Berkeley, CA 94704 (510) 845-8981; 1-800-2DURANT; fax 510-486-8336. Two blocks from the meeting site. Complimentary continental breakfast. Restaurant and pub. Rates: $99 single, $110 double; add 12% hotel tax.

• Radisson Hotel Berkeley Marina. 200 Marina Blvd., Berkeley, CA 1-800-243-0625. At the foot of University Avenue off I-80 at the Berkeley Marina on San Francisco Bay. Coffee makers and phone lines with dataports. Free parking. Restaurant and lounge. Fitness center, pool and sauna. About 2 miles from university. No shuttle service provided. A/C Transit serves the hotel with buses every 20 minutes. Rates: $105 single or double, $10 additional guest (must be arranged in advance); add 12% hotel tax.



GETTING AROUND

By car, take the University Ave. exit east from I-80 to its end at Oxford Street which marks the west edge of the UC Berkeley campus. Consult the attached map or our Web site (http://socrates.berkeley.edu/~earthres/GSApage.html) for detailed directions.

The Oakland and San Francisco airports, about 25 and 45 minutes, respectively, by car from Berkeley are the two air terminals serving the central Bay Area. Door-to-door shuttle service to Berkeley by the Bayporter costs $16 from either airport. Call on arrival: San Francisco (415) 467-1800; Oakland (510) 864-4000. Allow 1–1.5 hours from San Francisco, 45 minutes–1 hour from Oakland by shuttle, somewhat less by rental car. The Bay Area Rapid Transit (BART) system also serves the airports, but takes considerably longer. The Berkeley BART Station (not North Berkeley) is located in central Berkeley, a 10-minute walk to the meeting site.

Parking: Parking on and near the UC Berkeley campus is extremely limited. Attendees from the Bay Area are strongly urged to use BART. Two student lots (Underhill and Ellsworth-Channing —see map) are available for $5/day. Tickets are purchased on site.

PREREGISTRATION

Preregistration deadline: *April 30, 1999*

Preregistration saves you money and helps us to plan the meeting. Preregistration by mail will be handled by GSA headquarters. Use the registration form provided in this announcement. Full payment must accompany the form. Unpaid purchase orders are NOT accepted as valid registration. Charge cards are accepted. If you are using a charge card, please recheck the card number. Errors will delay your registration. The confirmation card will be your receipt for payments. No other receipt will be sent. Badges and packets will be available at the Registration Desk. Guest registration is required for those attending guest activities, technical sessions, or exhibits. Guest registrant MUST be accompanied by either a registered professional or student. A guest is defined as a nongeologist spouse or friend of a professional or student registrant. Students and K–12 teachers must show a current ID in order to obtain reduced rates. On-site registration will be in the Student Union at Bancroft and Telegraph Avenues.

Members pay less! You can join now or at the meeting. Come visit the GSA Membership Services area for new member applications, reinstatements, dues payment, address changes, questions, or concerns.

The *Abstracts with Programs* book may be purchased on site in the registration area. Only a limited number of books will be available at the meeting.

Cancellations, Changes, and Refunds

All requests for registration additions, changes, and cancellations must be made in writing and received by May 7. No refunds will be made on cancellation notices received after this date. Refunds will be mailed from GSA after the meeting. Refunds for fees paid by credit card will be credited according to the card number on the preregistration form. There will be NO refunds for on-site registration and ticket sales.

ACCESSIBILTY

The Cordilleran Section is committed to making every event at the 1999 Centennial meeting accessible to all persons interested in attending. Please indicate special requirements, such as an interpreter or wheelchair accessibility information, on the meeting registration form, or contact General Chair Doris Sloan (address below).

DETAILED INFORMATION

For further information, contact General Chair Doris Sloan, Dept. of Geology and Geophysics, University of California, Berkeley, CA 94720; (510) 642-3703, dsloan@socrates.berkeley.edu. Visit our Web sites: http://socrates.berkeley.edu/~earthres/GSApage.html or www.geo.berkeley.edu/geology. ■

March *BULLETIN* and *GEOLOGY* Contents

The Geological Society of America BULLETIN
Volume 111, Number 3, March 1999

Call for Applications and Nominations for

Geology Co-Editor

GSA is soliciting applications and nominations for the position of co-editor of *Geology*, to serve a three-year term, beginning in June 1999, as one of a two-editor team. Desirable characteristics for the successful candidate include:

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

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

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

GEOLOGY
VOLUME 27
NO. 3
P. 193–288
MARCH 1999

GSA COUNCIL ANNOUNCES NEW AWARD

GSA Public Service Award Established in Honor of Eugene and Carolyn Shoemaker

The first GSA Public Service Award will be presented in 1999, in recognition of outstanding individual contributions to (1) public awareness of the earth sciences, or (2) the scientific resolution of earth-science problems of significant societal concern. The award honors Eugene and Carolyn Shoemaker.

Selection Criteria

The award is for contributions that have materially enhanced the public's understanding of earth science or significantly served decision-makers in the application of scientific and technical information in public affairs and public policy related to the earth sciences. This may be accomplished by individual achievement in one or more of the following areas:

- Authorship of educational materials of high scientific quality that have enjoyed widespread use and acclaim among educators or the general public.
- Acclaimed presentations (books and other publications, mass and electronic media, or public presentations including lectures) that have expanded public awareness of the earth sciences.
- Authorship of technical publications that have significantly advanced scientific concepts or techniques applicable to the resolution of earth-resource or environmental issues of public concern.
- Other individual accomplishments that have advanced the earth sciences in the public interest.

The award honors astrogeologist Eugene Shoemaker and Carolyn Shoemaker. The pair discovered a record number of comets and asteroids. Gene Shoemaker died in a car accident in Australia in 1997 while he and Carolyn were doing research on impact sites.

The award will normally go to a GSA member. It may be presented posthumously to a descendant of the awardee.

Send nominations to:
Becky Bordner
Committees and Medals
Geological Society of America
P.O. Box 9140
Boulder, CO 80301-9140

Nominations must be received by April 10, 1999. Nominations must include a cover letter and biographical information that clearly demonstrates applicability to the selection criteria. ■

UNDERGRADUATE AND GRADUATE STUDENTS:

Check Out the 1999 Roy Shlemon Mentor Program

Are you interested in pursuing a career in the applied geosciences? Ever thought about running your own business? Or wonder how to survive working with lawyers? Find out during the Northeastern, North-Central, and Cordilleran Section meetings. The Institute for Environmental Education is sponsoring a one-day workshop for graduate students and advanced undergraduate students on professional opportunities and challenges in the applied geosciences. This is an excellent opportunity for you to gain insight into the field of applied geosciences, to network, and to receive invaluable career advice.

Northeastern Section Meeting,
March 22–24, Providence, Rhode Island
Shlemon Mentor: *Russell G. Slayback,* President and Chairman, Board of Directors of Leggette, Brashears & Grahan, Inc., Wilton and Trumbull, Connecticut
Sunday, March 21, 9:00 a.m.–5:00 p.m.
Contact: O. Don Hermes, (401) 874-2192

The program will consist of presentations and interactive dialogue about the environmental hydrogeology consulting field—where it has been, where it is today, and what the future has to offer. Preregistration is required.

North-Central Section Meeting, April 22–23
Shlemon Mentor: *Thomas A. Prickett,* President, Thomas A. Prickett & Associates, Inc., Illinois
Saturday, April 24, 1999, 8:00 a.m.–5:00 p.m., Clarion Hotel and Convention Center, Champaign, Illinois
Contact: Dennis Kolata, (217) 244-7004

The program will consist of interactive dialogue about the field of groundwater hydrology and will include the following presentations:

- The life of a Consulting Groundwater Hydrologist
- How to Run a Money-Making Business
- Case Histories of Groundwater Development Projects
- Groundwater Modeling and Litigation

Cordilleran Section Meeting, June 2–4
Speaker, location, date, and time to be announced.
Contact: Doris Sloan

Please don't miss this opportunity. For more information, please contact sections directly, or Stacey Ginsburg at (303) 447-2020, ext. 194, GSA. ■

New *Bulletin* Co-Editor Begins Term

The *GSA Bulletin* has a new science editor, Allen Glazner, University of North Carolina, Chapel Hill. Glazner, who has begun a four-year term as co-editor with John Geissman (University of New Mexico), replaces Lynn Walter (University of Michigan), whose term as science editor ended with the close of 1998.

Glazner, a professor of geology at UNC, Chapel Hill since 1981, received his B.A. in geology from Pomona College, and his Ph.D. from the University of California, Los Angeles. He has been a member of GSA since 1982 and was named a Fellow in 1990. He currently holds the Samuel Shepard Jones Professor of Geology chair at UNC, Chapel Hill. His research interests are in tectonics, igneous petrology, and geology of the southwestern United States.

The science editors for GSA publications work closely with headquarters staff in Boulder, Colorado, to ensure that submitted manuscripts are critically reviewed and in appropriate format for the journals or books. The *Bulletin* editors enlist a panel of Associate Editors to help them determine what papers will be published in the journal; the science editors and Associate Editors handled 176 papers submitted in 1998. Most *Bulletin* science editors have served terms as Associate Editors (Glazner was an Associate Editor for two terms, from 1989 through 1994). ■

Glazner

Note: All manuscripts submitted to the journal must be sent to *Bulletin*, Geological Society of America, 3300 Penrose Place (for courier mail) or P.O. Box 9140, Boulder, CO 80301-9140, *not* directly to the science editors.

GeoTrip

From Pacific Islands to Snake River Rapids: The Geology of Hells Canyon, Oregon and Idaho

June 17–25, 1999 • 9 days, 8 nights

Scientific Leader: *Tracy Vallier, Lewis-Clark State College, Lewiston, Idaho*

Field trip leader *Tracy Vallier* began his studies in Hells Canyon 35 years ago and recently completed a guidebook, *Islands and Rapids: A Geologic Story of Hells Canyon,* published by Confluence Press, Lewis-Clark State College, Lewiston, Idaho. Tracy retired in 1997 from the U.S. Geological Survey, where he worked as a marine geologist with interests in island arcs and deep-sea processes. Before joining the USGS, Tracy taught at Indiana State University and worked with the Deep Sea Drilling Project at Scripps Institution of Oceanography. He taught at Whitman College in Walla Walla, Washington, during autumn 1998, and he is now an adjunct professor at Lewis-Clark State College in Lewiston, Idaho.

Description

One hundred miles of rugged outcrops are exposed in Hells Canyon of the Snake River between Oxbow, Oregon, and the mouth of the Grande Ronde River in Washington. Arguably the deepest major river canyon in the lower 48 states, the Snake River flows more than 8,000 feet below the highest peak of the adjacent Seven Devils Mountains. Explore the viscera of an Early Permian through Middle Jurassic volcanic massif that formed along the magmatic axis of the Blue Mountains island arc. See the dike zones that crystallized beneath the volcanoes, visit volcano-root plutons, study the Permian, Triassic, and Jurassic strata that include a 500-meter-thick Upper Triassic limestone, and put your hand on the Permian-Triassic unconformity. Review the evidence that the pre-Tertiary rocks are exotic to North America. Lava flows of the Miocene Columbia River Basalt Group that overlapped the exotic terrane now perch on canyon rims and, in places, line the steep canyon walls near river level. The canyon is growing deeper as uplift outpaces stream erosion. Landslide, slump, avalanche, alluvial fan, terrace, Bonneville flood, and Mazama ash deposits chronicle the late Quaternary and Holocene. Indian and European histories complement the geology and add to the breadth of the trip. This is an exceptional hiking and rafting trip for the physically fit person to see Hells Canyon and to learn about its geology. June is a beautiful time to visit the canyon, and the weather should be cooperative. Bears, cougars, wild sheep, turkeys, eagles, deer, and elk are among the animals that might be seen. Bring a bathing suit and fly rod if inclined to swim or fish.

Hells Canyon. *Photo by Tracy Vallier.*

Fee and Payment *GSA Member: $1,400 Nonmember: $1,500*

Based on 17 people. The trip may cost more if there are fewer registrants. A $200 deposit, due with your reservation, is refundable through April 1, 1999, less $50 processing fee. Total balance due May 1, 1999. Minimum age: 21.

Included: All meals beginning with dinner on June 17 and ending with lunch on June 25. Transportation by bus from Boise to Halfway and from Heller Bar back to Boise. All river equipment including tents, dry bags, sleeping bags, sleeping pads, and geological reading materials, including, *Island & Rapids—A Geologic Story of Hells Canyon,* by your leader, Tracy Vallier.

Not included: Airfare to and from Boise, Idaho.

GeoHostel

Geology of the Lewis and Clark Expedition—The Three Forks of the Missouri River to the River of No Return, Montana and Idaho

SOLD OUT

REGISTER TODAY!

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

Name

Institution/Employer

Mailing Address

City/State/Country/ZIP

Phone (business/home)

Guest Name

GSA Member #

CALL TODAY FOR MORE INFORMATION:
1-800-472-1988, x134, or (303) 447-2020, e-mail: ecollis@geosociety.org, fax: 303-447-0648, check for updates: http://www.geosociety.org

	Deposit Per Person	No. of Persons	Total Paid Deposit
GH991—Hells Canyon	$200	____	$________
GH992—Dillon —SOLD OUT—	$100	____	$________
	TOTAL DEPOSIT		$________

☐ I've enclosed no deposit, but I'm interested. Please send information.

☐ VISA ☐ MasterCard ☐ American Express

Credit Card # Exp. Date

Signature

MAIL OR FAX REGISTRATION FORM AND CHECK OR CREDIT CARD INFORMATION TO:
1999 GSA GeoVentures,
GSA Professional Development Department
P.O. Box 9140,
Boulder, CO 80301-9140
fax 303-447-0648

MAKE CHECKS PAYABLE TO: GSA 1999 GeoVentures

Call For Nominations

National Awards for 2001

Deadline: April 30, 1999

Nominations for the national awards described below are being solicited for 2001. Each year GSA members have been invited to participate by recommending possible candidates.

Those who wish to make nominations are urged to do so by sending background information and vitae, and specifying the award for which the candidate is being submitted by April 30, 1999, to the GSA External Awards Committee, P.O. Box 9140, Boulder, CO 80301, (303) 447-2020, fax 303-447-1133. The nomination process is coordinated by AGI on behalf of its member societies, and a roster of candidates will be finalized by the AGI Member Society Council at its spring 2000 meeting for nomination to the respective offices sponsoring the national awards.

William T. Pecora Award. The Pecora Award, sponsored jointly by NASA and the Department of the Interior, is presented annually in recognition of outstanding contributions of individuals or groups toward the understanding of Earth by means of remote sensing.

National Medal of Science. The medal is awarded by the President to individuals "deserving of special recognition by reason of their outstanding contributions to knowledge in the physical, biological, mathematical, engineering, or social and behavioral sciences."

Vannevar Bush Award. The Vannevar Bush Award is presented from time to time to a person who, through public service activities in science and technology, has made an outstanding contribution toward the welfare of mankind and the nation.

Alan T. Waterman Award. The Waterman Award is presented annually by the NSF and National Science Board to an outstanding young researcher in any field of science or engineering supported by NSF.

For complete descriptions and criteria, see http://www.geosociety.org/aboutus/admin/awards.htm#s7. ■

Ocean Geoscience Lectures

The Joint Oceanographic Institutions/U.S. Science Advisory Committee (JOI/USSAC) Distinguished Lecturer Series brings the results of Ocean Drilling Program research to students at the undergraduate and graduate levels and to the earth science community in general. During the 1999-00 season, JOI/USSAC will accept applications from U.S. colleges, universities, and nonprofit organizations to host talks given by the speakers listed below. Applications are available online at www.joi-odp.org/USSSP or from: Joint Oceanographic Institutions, 1755 Massachusetts Avenue, NW, Suite 800, Washington, DC 20036-2102; tele: (202) 232-3900; e-mail: joi@brook.edu. Applications are due April 16, 1999.

Building the ocean crust: Easy as 1,2,3?
Dr. Rodey Batiza, University of Hawaii

Recovery from the Cretaceous-Tertiary mass extinction
Dr. Steven D'Hondt, University of Rhode Island

Magnetization of the oceanic crust: Applications to crustal formation and Earth's magnetic field
Dr. Jeffrey Gee, Scripps Institution of Oceanography

Deformation and fluid flow in subduction zones: Toward an understanding of the seismogenic zone
Dr. Gregory Moore, University of Hawaii

The link between ocean circulation and global warmth of the Early Pliocene
Dr. Ana Christina Ravelo, University of California, Santa Cruz

Drilling for methane ice: Gas hydrates in continental margins
Dr. Carolyn Ruppel, Georgia Institute of Technology

1999 GSA Section Meetings

SOUTH-CENTRAL SECTION — March 15–16, 1999, Lubbock, Texas. Information: Calvin Barnes, Dept. of Geosciences, Texas Tech, Lubbock, TX 79409-1053, (806) 742-3106, gical@ttu.edu.

NORTHEASTERN SECTION — March 22–24, 1999, Providence, Rhode Island. Information: O. Don Hermes, Dept. of Geology, University of Rhode Island, Green Hall, Kingston, RI 02881, (401) 874-2192, dhermes@uriacc.uri.edu.

SOUTHEASTERN SECTION — March 25–26, 1999, Athens, Georgia. Information: Samuel E. Swanson, Dept. of Geology, University of Georgia, Athens, GA 30602-2501, (706) 542-2415, sswanson@uga.cc.uga.edu.

ROCKY MOUNTAIN SECTION — April 8–10, 1999, Pocatello, Idaho. Information: Scott S. Hughes, Dept. of Geology, Idaho State University, 785 South 8th Ave., Pocatello, ID 83209-8072, (208) 236-4387, hughscot@fs.isu.edu. *Preregistration deadline: March 5, 1999.*

NORTH-CENTRAL SECTION — April 22–23, 1999, Champaign-Urbana, Illinois. Information: Dennis R. Kolata, (217) 244-2189, fax 217-333-2830, kolata@isgs.uiuc.edu. *Preregistration deadline: March 19, 1999.*

CORDILLERAN SECTION — June 2–4, 1999, Berkeley, California. Information: Doris Sloan, Dept. of Geology & Geophysics, University of California, Berkeley, CA 94720-4767, (510) 642-3703, dsloan@socrates.berkeley.edu. *Preregistration deadline: April 30, 1999.*

Published on the 1st of the month of issue. Ads (or cancellations) must reach the GSA Advertising office one month prior. Contact Advertising Department (303) 447-2020, 1-800-472-1988, fax 303-447-1133, or E-mail: acrawford@geosociety.org. Please include complete address, phone number, and E-mail address with all correspondence.

Classification	Per Line for 1st month	Per line for each addt'l month (same ad)
Situations Wanted	$1.75	$1.40
Positions Open	$6.50	$5.50
Consultants	$6.50	$5.50
Services & Supplies	$6.50	$5.50
Opportunities for Students		
first 25 lines	$0.00	$2.35
additional lines	$1.35	$2.35
Code number: $2.75 extra		

Agencies and organizations may submit purchase order or payment with copy. Individuals must send prepayment with copy. To estimate cost, count 54 characters per line, including all punctuation and blank spaces. Actual cost may differ if you use capitals, centered copy, or special characters.

Situations Wanted

GEOSCIENTIST, proven, cost effective experience, seeks contract/retainer in ground water, oil & gas, environmental and natural resource projects, US and Abroad. Respond (318) 981-4678.

Positions Open

LABORATORY DIRECTOR -- COLLEGE OF MINES AND EARTH RESOURCES, UNIVERSITY OF IDAHO, MOSCOW, ID 83844-3025

The College of Mines and Earth Resources at the University of Idaho invites applications for a full-time Laboratory Director to work on the Moscow, Idaho campus. This person is in charge of all operations in a modern analytical laboratory in McClure Hall. The successful applicant should be very knowledgeable about the theory, operation, and maintenance/repair of modern x-ray and electron beam instruments (TEM, SEM, XRD, XRF) including related software packages. The director is expected to offer instruction on the theory and practice of these instruments.

An M.S. or Ph.D. in the fields of mineralogy, materials science, metallurgy, or a related discipline is preferred. Interested persons should send a letter of application, curriculum vitae, separate statements of research interests and experience and the names, addresses, telephone numbers, and e-mail addresses of three references to: Dr. Mickey Gunter, Search Committee Chair, Geology and Geological Engineering, College of Mines and Earth Resources, University of Idaho, Moscow, ID 83844-3022; e-mail: gunter@uidaho.edu; phone:(208) 885-6195; Fax 208-885-5724.

Search and selection procedures will be closed when sufficient qualified candidates have been identified, but not before May 15,1999. Salary range is $35,000-$40,000 annually.

A complete position description should be reviewed at http://www.uidaho.edu/hr/.

To enrich education through diversity the University of Idaho is an equal opportunity/affirmative action employer.

EXECUTIVE DIRECTOR -- QUATERNARY SCIENCES CENTER DESERT RESEARCH INSTITUTE

The Desert Research Institute (DRI), an independent environmental research campus of University of NV System, seeks Executive Director who will bring to its Quaternary Sciences Center (QSC) an international reputation for distinction in conducting and/or managing major research related to Quaternary studies, as well as strong leadership, administrative, and personnel skills. QSC, one of five DRI research centers, has 25 faculty and staff, a $3.1 million budget, and research programs in archaeology/anthropology, Quaternary geology, surface process geomorphology, paleoecology, geochronology, landscape dynamics, natural hazards, and remote sensing.

Appointee will promote QSC and the Institute, mentor faculty, support teaching/research collaborations with faculty at the University of Nevada, Reno and Las Vegas, and interact directly with sponsors to advance our strategic goals. Required: advanced graduate degree; understanding of Quaternary sciences and the soft-money research environment; and demonstrated success as a scientific leader with strong record of published research and/or effective administration of national-level scientific research organization(s). For more details, please see the position announcement on our website at www.dri.edu. Salary is competitive, negotiable, and commensurate with qualifications; plus excellent fringe benefits. Submit vitae, letter describing qualifications, and five references with contact information to: Human Resources, Desert Research Institute, 2215 Raggio Prkwy., Reno, NV 89512. Refer to Position #P30-001. Review of applications begins 3/31/99, continuing until position is filled. DRI is an Affirmative Action/EEO employer. We employ only U.S. citizens and those authorized to work in the U.S.

NSF FELLOW IN ENVIRONMENTAL SCIENCE COLBY COLLEGE

COLBY COLLEGE invites applications for a 21-month NSF AIRE Fellowship in Environmental Science. As one of ten NSF AIRE award recipients, Colby College has been recognized as a leader and innovator in creating synergy between its research and educational missions. This position is one of four AIRE Fellowships in the Natural Sciences at Colby. The successful candidate will be expected to work with senior faculty mentors to make contributions to our student research courses in Environmental Science and Science, Technology and Society. The Fellow should have experience with GIS systems and will help enhance our GIS capabilities. Responsibilities will also include developing materials for several student research projects based on local issues that cut across several disciplines. In the second year, the Fellow will teach a January course on GIS and a distribution course in the person's area of expertise. AIRE Fellows will receive some travel and research funds. Applicants should arrange for a vita, statement of teaching and research interest, transcripts and three letters of recommendation to be sent to David Firmage, Director, Environmental Studies, Colby College, Waterville, ME 04901 (dbfirmag@colby.edu). Applicant screening will begin March 15, 1999, and will continue until the position is filled. For more information about the College and the AIRE Fellowship, please see the Colby web page at http://www.colby.edu/NSF_AIRE/. Colby College is an AA/EO employer and encourages applications from women and minorities.

GEOSCIENCES/SCIENCE EDUCATION EMPORIA STATE UNIVERSITY

The Earth Science Department, Division of Physical Sciences, at Emporia State University solicits applications for a nine-month, tenure-track assistant professor beginning August 1999. Position responsibilities include teaching an introductory-level earth science (geology, meteorology, and astronomy) course, a physical science course for preservice elementary education majors, and earth science/geology courses in the appointee's area of expertise. The area of expertise should complement existing strengths in the department -- paleontology, Quaternary geology, GIS/remote sensing, and soil science. Research is expected; science education may be the basis for scholarship. Other qualities considered to be potential strengths are K-12 teaching experience, authoring web pages and experience and/or interest in distance-learning. An appropriate terminal degree is expected at the time of employment; if degree completion is imminent, documentation of that shall be provided to the search committee. Candidates should send a letter of application describing teaching style, experience, and research interests, complete vita, unofficial transcripts, and relevant support materials (i.e., evidence of or potential for excellent teaching). Three letters of reference should be sent under separate cover. Screening will begin March 15, 1999, and continue until the position is filled. Send inquiries and applications to: Ken Thompson, Earth Science, Campus 4030, Emporia State University, Emporia, KS 66801-5087. Phone: (316) 341-5985; fax: 316-341-6055; e-mail: thompsok@emporia.edu; www.emporia.edu. AA/EOE.

SCIENTIFIC LABORATORIES, INC. THREE POSITIONS AVAILABLE

Transmission Electron Microscopists. Boston, MA and Richmond, VA Laboratories. Education: BA/BS Geology or Materials Science. Experience with TEM/EDS required. Have good organizational skills, attention to detail, and a will to work/succeed in our 2 growing environmental labs. While not required with both PLM/TEM experience, the right candidate would be offered a section leader position or more.

Operations Supervisor/TEM Analyst. Richmond, VA Laboratory. Education: BA/BS in Science. Experience with TEM/EDS required. Self-motivated, detail-oriented, resourceful, good organizational skills, strong computer skills (not programming), ability to work with others, understand the priorities of production, and of high quality. This person will supervise and operate the QC functions of our four microscopy labs nationwide.

Polarized Light Microscopist. Boston, MA Laboratory. Education: BA/BS Geology or Related Field. Experience desired, but will train right candidate. Have good organizational skills, attention to detail, and a will to work/succeed in this growing environmental lab in SE Boston.

Benefits packages for each position. Send resume to: SciLab Group, Inc., 117 E. 30th Street, New York, NY 10016 or fax to Pat Berot 212-679-2711.

QUATERNARY GEOLOGIST WISCONSIN GEOLOGICAL AND NATURAL HISTORY SURVEY

The Wisconsin Geological and Natural History Survey (WGNHS) seeks a Quaternary geologist with a strong interest in conducting field-based investigations and communicating the results of investigations to a wide variety of audiences. The position is a full-time, tenure-track position that will be filled at the Assistant Professor level. Applicants should have a Ph.D. in geology with a specialization in Quaternary geology. Candidates with an M.S. degree and a minimum of four years experience will be considered. The successful candidate will have a broad knowledge of Quaternary geology and excellent verbal and written communication skills. In addition the candidates must have experience and training in mapping glaciated terranes such as those of the Upper Midwest.

Knowledge of the application of geophysical or geochemical techniques to investigations of quaternary geology, as well as the application of computer techniques to the three-dimensional analysis of Quaternary materials is desirable. The successful candidate will be expected to initiate and complete projects in a timely manner including planning, budgeting, preparation of proposals, and the reporting of results to scientific, governmental and lay audiences, and work cooperatively with other geology and hydrogeology investigators. Minimum annual salary $37,000 with excellent benefit package. WGNHS is located in Madison, Wisconsin and is a unit of University of Wisconsin-Extension. WGNHS offers many opportunities for collaboration with students and faculty of the University of Wisconsin as well as federal and state agencies. See http://www.uwex.edu/wgnhs for a complete job description and information about the Survey's programs. Apply by April 1, 1999. For information and application materials contact the Cooperative Extension Personnel Office, 432 N. Lake St., Madison, WI 53706, (608) 263-1945, e-mail: hrdpers@admin.uwex.edu. The Wisconsin Geological and Natural History Survey, University of Wisconsin-Extension is an EEO/AA employer.

MINERALOGIST / PETROLOGIST UNIVERSITY OF SOUTHERN MISSISSIPPI

The Department of Geology at The University of Southern Mississippi invites applications for a tenure-track assistant professor position in the general area of mineralogy/petrology starting fall 1999. A Ph.D. is required by fall 1999.

Commitment to excellence in both teaching and research is required. Teaching responsibilities will include mineralogy, optical mineralogy, thin-section petrography, and advanced courses related to the candidate's area of specialization. Interest in teaching field methods is desirable. The successful candidate will be expected to develop a program of research and scholarly activity and supervise graduate student research at the M.S. level.

The department currently includes 6 permanent faculty members and offers a B.S. and M.S. in Geology and a B.S. in Geology with Teacher Licensure. Jointly with the Center for Science and Mathematics Education, advanced degrees in Earth and Environmental Science Education at the M.S. and Ph.D. levels are available. The department collaborates with the Department of Marine Science located at Stennis Space Center and with the College of International and Continuing Education, which has active programs including British Studies and Caribbean Studies. The University of Southern Mississippi is located one hour from the Gulf of Mexico and two hours from New Orleans.

Please submit a letter of application, a statement of teaching and research goals, a resume, copies of transcripts, and the names and addresses of three references to Dr. Gail Russell, Department of Geology, Box 5044, The University of Southern Mississippi, Hattiesburg, MS 39406. Phone: (601) 266-4526; email: gail.russell@usm.edu. Evaluation of applicants will start March 22 and will continue until the position is filled. Applications from minorities and women are encouraged. AA/EOE/ADAI

MISSOURI DEPARTMENT OF NATURAL RESOURCES
The Missouri Department of Natural Resources is currently accepting applications for two Hydrologist III vacancies in Cole County. Minimum of 5 years experience and a degree in geology, hydrology, water resources or closely related area. Contact Personnel Program, Hydrologist III Vacancy, (573) 751-2518 for State Merit Application and additional information. Requests must be received by March 31, 1999.

ST. CLOUD STATE UNIVERSTIY
DEPARTMENT OF EARTH SCIENCES
SCSU invites applications for a tenure-track position at the assistant professor level in the Department of Earth Sciences to start August 1999. Responsibilities include teaching undergraduate physical geology for majors and general education earth science courses. Additional teaching to include one or more of the following upper division courses for majors: mineralogy, petrology, field geology, structural geology, tectonics and geophysics. Additional responsibilities include participation in undergraduate research, appropriate scholarly activity, continued professional development, advising and community service. Qualifications: Ph.D. in geology required; experience in solid earth and field geology and university level teaching preferred. Demonstrated classroom expertise and commitment to excellence in teaching. Evidence of ability to establish a research program involving undergraduates. The successful candidate will have demonstrated ability to teach and work with persons from culturally diverse backgrounds. Send an application, resume and names of three references to: Chair, Department of Earth Sciences, St. Cloud State University, 720 4th Avenue South, St. Cloud, MN 56301-4498. Application materials must be received by April 9, 1999. SCSU is committed to excellence and actively supports cultural diversity. To promote this endeavor, we invite individuals who contribute to such diversity to apply, including minorities, women, persons with disabilities and veterans.

APPLIED GEOHYDROLOGY SUMMER RESEARCH ASSISTANTSHIP — KANSAS GEOLOGICAL SURVEY
Kansas Geological Survey, Lawrence, Kansas. This is a 12-week summer position open to students at any university. Student status is not required. The individual will participate in a variety of field activities in support of KGS research programs. The theme of the activities in the summer of 1999 will be hydraulic test methods. Start approx. 5-15-99. Salary $5,500 for 12-week appointment. Required: Coursework in earth sciences or engineering and interest in hydrogeology. First consideration given to applications postmarked by 3-31-99. For complete description contact Annette Delaney at (785) 864-3965 or http://www.kgs.ukans.edu. For further information contact Jim Butler at jbutler@kgs.ukans.edu. The University of Kansas is an EO/AA employer.

UNIVERSITY OF NORTH CAROLINA AT CHAPEL HILL
GEOLOGIC HAZARDS / ACTIVE TECTONICS
The Department of Geological Sciences at the University of North Carolina at Chapel Hill expects to fill a tenure-track position in the field of geologic hazards/active tectonics beginning July 1, 1999. The rank of this position is open depending on qualifications.

We seek applicants with research and teaching interests in active seismic and volcanic hazards with applications to large-scale earth and environmental systems. Potential applications include volcanology, volcanic and seismic hazard assessment, geodetic measurements of surface deformation and crustal strain, neotectonics, tectonic geomorphology, and links between tectonic and volcanic processes and climate. We are looking for individuals who apply a range of geophysical, geochemical, and remote sensing techniques in their research. We are particularly interested in multidisciplinary scientists who will fit with existing departmental research programs and develop cross-disciplinary ties with other units on campus including the Departments of Geography, Marine Sciences, and City and Regional Planning, and the new Carolina Environmental Program.

Applicants must hold a Ph.D. at the time of appointment and postdoctoral and teaching experience is highly desirable. The successful candidate will be expected to establish a vigorous, externally funded research program and to demonstrate excellence in undergraduate and graduate education.

The department offers a wide range of analytical instrumentation including TIMS, SEM, DCP, and access to instruments (ICP-MS, electron microprobe, gas source mass spectrometers) at Duke University and NC State University through the Triangle Universities Earth Science Analytical Consortium. The university offers access to the NC Supercomputing Center.

Applicants must submit a letter of application, vita, statements of teaching and research interests, and arrange to have four letters of recommendation sent to Timothy J. Bralower, Chair, Department of Geological Sciences, CB #3315 Mitchell Hall, University of North Carolina, Chapel Hill, NC 27599-3315 (bralower@email.unc.edu). Applications must be received by March 22, 1999. For more information on the department and university please visit our web page at http://www.geosci.unc.edu.

The University of North Carolina at Chapel Hill is an equal opportunity/affirmative action employer. Women and minorities are encouraged to apply.

GEOLOGICAL SCIENCES 1999 SEARCH
STRUCTURAL GEOLOGY
UNIVERSITY OF MAINE
The Department of Geological Sciences at the University of Maine invites applications for a tenure-track Assistant Professor position in structural geology/tectonics beginning September 1, 1999. Field-oriented bedrock geology is a priority within the department, continuing a long tradition of taking advantage of our stimulating natural setting. Preference will be given to a field-oriented structural geologist with interests in the following sub-disciplines: tectonics and sedimentation, plate kinematics, and northern Appalachian geology. A Ph.D. is required and preference will be given to candidates with previous teaching and/or research experience. Research activities of the successful candidate will complement existing programs, especially those in petrology, geochronology, and stratigraphy. We expect the successful candidate to develop and sustain a field-oriented research program, supervise graduate and undergraduate student research, and generate funding for these efforts.We seek an enthusiastic and effective teacher, for both undergraduate and graduate courses. Teaching responsibilities will include structural geology, an introductory geology course, and an advanced level course/courses in the individual's field of expertise. The successful candidate must be willing and able to participate in the University's field camp by teaching field geology in an off-road, back-country, traditional field geology setting. Applicants should send a letter of application, statement of reseach and teaching interests and philosophy, curriculum vitae and the names of 3 referees (including addresses, e-mail addresses, and telephone numbers) to: Structural Geology Search Committee Chair, Department of Geological Sciences, Room 111, 5790 Edward T. Bryand Global Sciences Center, University of Maine, Orono, ME 04469-5790. Consideration of applications will begin on April 5, 1999, and continue until the position is filled. Information about our department can be accessed at the world wide web site: iceage.umeqs.maine.edu/geology/home.htm. The University of Maine is an Equal Opportunity/Affirmative Action Employer and encourages applications from women, minorities and other protected groups.

Consultants

GEOSCIENTIST, Seeks contract/retainer as Asset Builder/Manager, proven oil & gas record, US and Abroad, On-shore and Off-Shore. Respond (318) 981-4678.

Services & Supplies

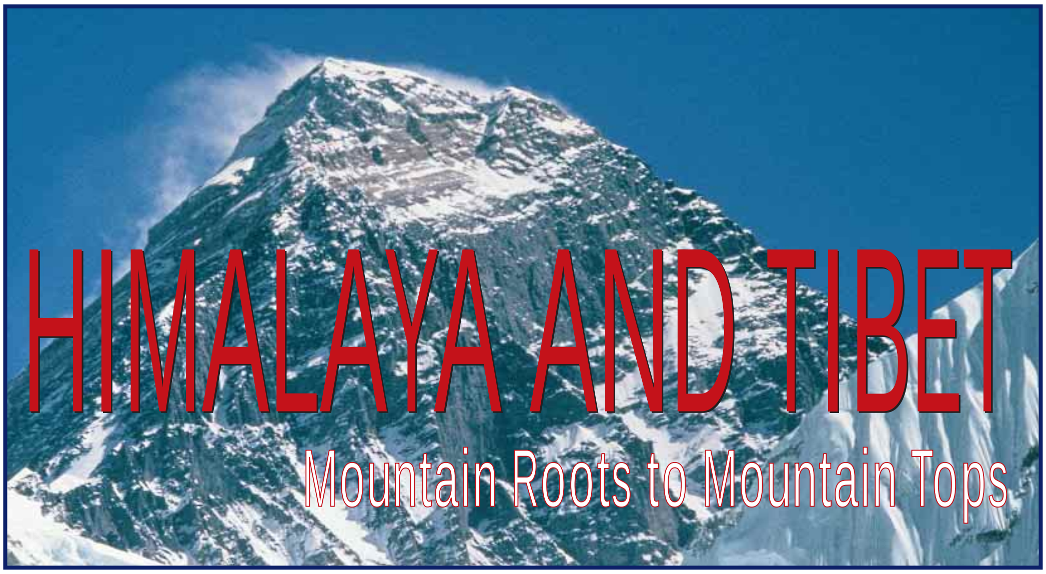
LEATHER FIELD CASES. Free brochure, SHERER CUSTOM SADDLES, INC., P.O. Box 385, Dept. GN, Franktown, CO 80116.

DON'T KILL YOURSELF with the carcinogenic bromides, like tetrabromoethane for mineral separation. Use water-based non-toxic high-density agent Sodium Polytungstate. Density ranges from 1.0 to 3.1 g/ml and up to 4.0 g/ml in combination with Tungsten Carbide. Sometu. Phone (818) 786-7838; Fax 818-786-4343; website: www.sometu.com; e-mail: sometu@aol.com

Opportunities for Students

Research Grants Available. The Colorado Scientific Society invites graduate students to apply for research grants, to be awarded in April 1999. Applicants must be enrolled in a Masters or Ph.D. program at an accredited college or university. Approximately eight grants ranging from $500 to $1200 each, will be awarded for field-oriented research on the geology, geochemistry, and geophysics of the Rocky Mountain region. In addition, grants as large as $1000 are awarded for engineering geology research (with no restriction on the geographic area of interest), and one grant as large as $1000 is offered for studies of the Heart Mountain Fault in northwest Wyoming. Interested students can obtain application forms and grant information directly from the Society website at http://shell.rmi.net/~css/ or by mail from the Chair of the Memorial Funds Committee, Colorado Scientific Society, P.O. Box 150495, Lakewood, CO 80215-0495. Deadline for applications is March 20, 1999.

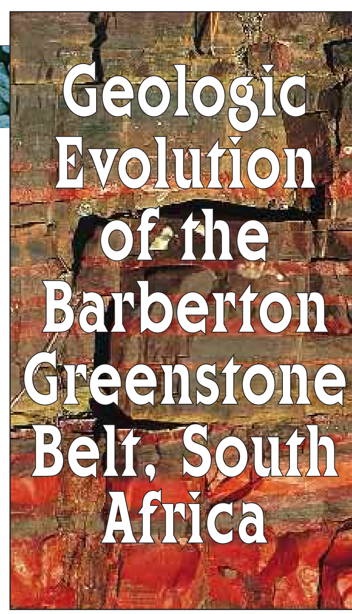
Numerical Modeling of Anisotropic Dispersion and Variable-Density Flow in Fractured Media. Ohio State University. A research assistantship is available (summer, 1999 or earlier) to a student interested in undertaking a Ph.D. study concerned with numerical modeling of anisotropic dispersion and variable-density flow in fractured media. Candidates must have a master's degree in applied science or engineering. Applicants must have a strong background in fluid mechanics, numerical analysis, and scientific programming. Knowledge and experience in non-linear solute transport modeling and Fortran programming language is required. The study will involve modification and development of an existing three-dimensional variable-density flow model (MITSU3D). In addition, it will interact with other laboratory investigations of anisotropic dispersion and variable-density flow in fractured media. For additional information regarding this assistantship, research topic or application procedure, please contact Dr. Motomu Ibaraki, Dept. of Geological Sciences, 125 South Oval Mall, The Ohio State University, Colubmus, OH 43210; phone: 1-614-292-7528; e-mail ibaraki.1@osu.edu.



edited by Allison Macfarlane, Rasoul Sorkhabi, Jay Quade, 1999

More than 30 international authors contributed to the first Himalaya-Karakoram-Tibet (HKT) Workshop held in America. The 11th HKT Workshop, held April 1996 in Flagstaff, Arizona, was a logical outcome of an increasing involvement of North American geologists in the studies of the Himalaya and Tibet over the past two decades. One of the prominent features of this 21 chapter volume is the integration of both "hardrock"and "softrock" geology, paleotectonic and neotectonic history, and endogenic (tectonic) and exogenic (geomorphic) processes in the Himalaya. Fully refereed, seven articles cover the Tibet, Trans-Himalaya, and Tethys unit. The High Himalayan Crystalline zone is the subject of another eight chapters; the final six chapters cover the Himalayan Foreland and its sediments, structures, and landforms.

SPE328, 336 p., softcover, 1 large plate, indexed, ISBN 0-8137-2328-0, $70.00, Member price $56.00



edited by
Donald R. Lowe and Gary R. Byerly, 1999

The Barberton Greenstone Belt contains the oldest well-preserved volcanic and sedimentary rocks known on Earth and provides a unique window on surface environments, biological evolution, and crustal development 3,550 to 3,200 m.y. ago. This volume presents a systematic account of the geology of the Barberton Belt and its implications for interpreting surface conditions and processes on early Earth. The subjects include stratigraphy, structural divisions, sedimentary geology, and biological materials of the entire belt; mafic and ultramafic volcanic rocks and their petrogenesis; the sedimentology and volcanology of ultramafic volcaniclastic units; the depositional and tectonic setting of the oldest known foreland basin sediments of the overlying Fig Tree Group; and the petrology and tectonic implications of the upper syntectonic quartzose clastic sediments of the Moodies Group. An interpretative summary of the overall evolution of the Barberton Belt concludes the book.

SPE329, 324 p., softcover, indexed, ISBN 0-8137-2329-9, $60.00; Member price $48.00

TOLL-FREE 1-800-472-1988
FAX 303-447-1133
WEB WWW.GEOSOCIETY.ORG
Publication Sales, P.O. BOX 9140, Boulder, CO 80301-9140

The Geological Society of America