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INSIDE

The 1995 Hanshin-Awaji (Kobe), Japan, Earthquake

Thomas L. Holzer, U.S. Geological Survey, 345 Middlefield Road, Menlo Park, CA 94025

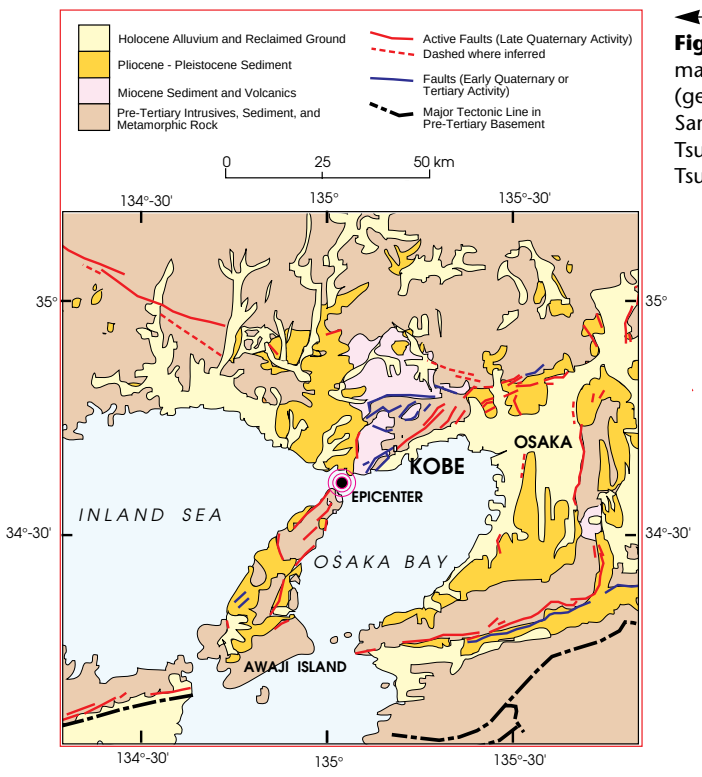

Figure 1. Neotectonic map of Osaka Bay region (generalized from Sangawa et al., 1983; Tsukuda et al., 1982; and Tsukuda et al., 1985).

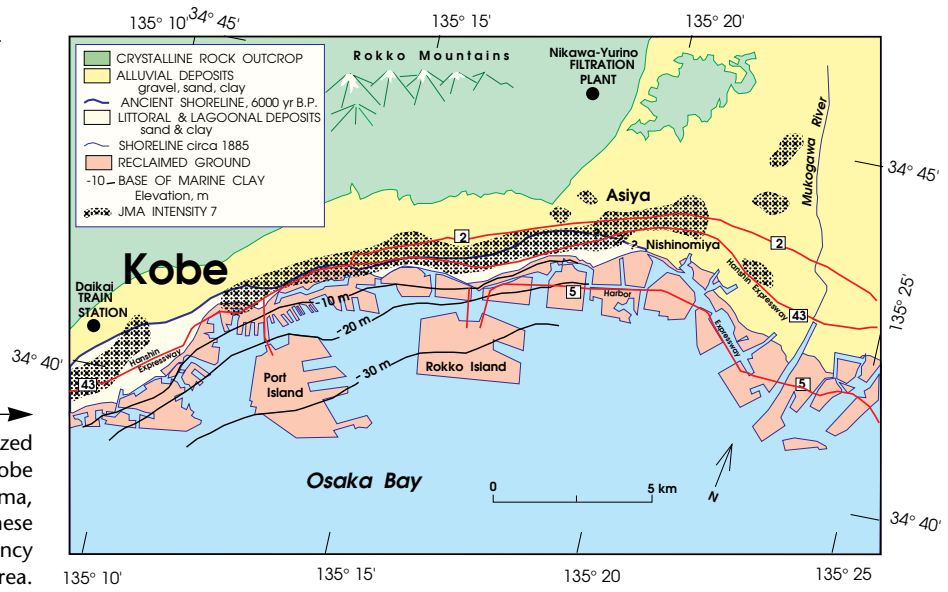

Figure 2. Generalized geologic map of Kobe (from Huzita and Kasama, 1983) and Japanese Meteorological Agency (JMA) intensity 7 area.

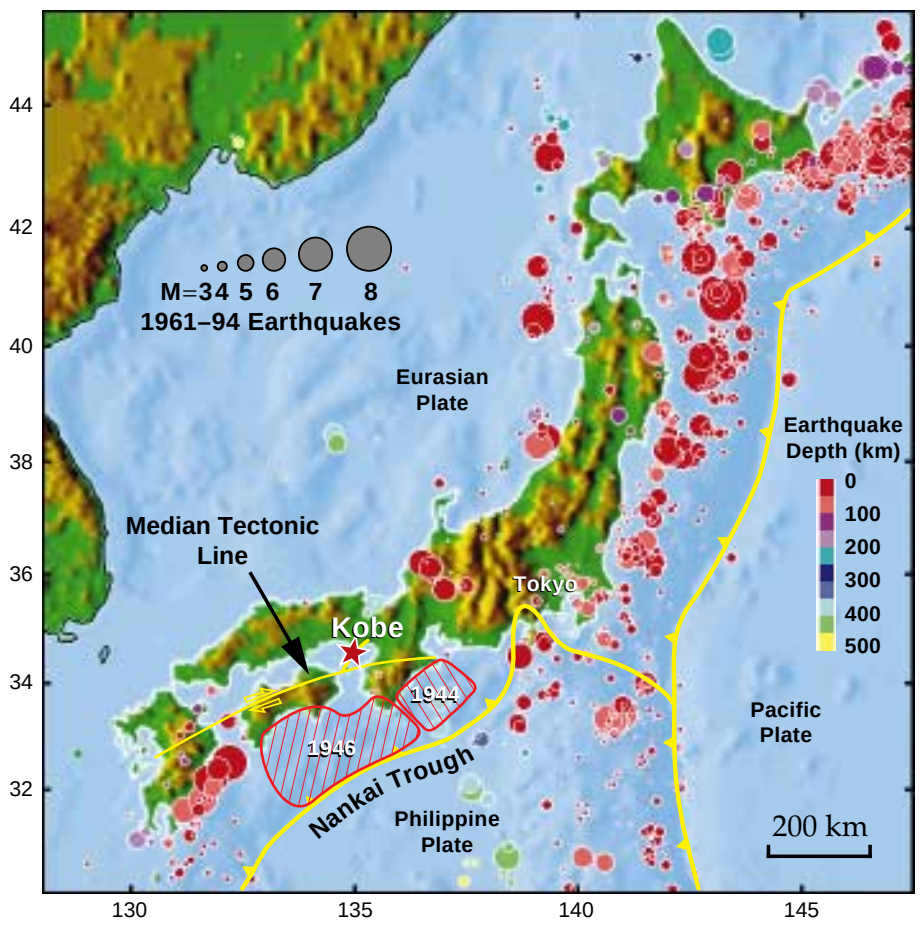

Figure 3. Japan, showing seismicity from 1961 to 1994, location of the 1995 Hanshin-Awaji earthquake, and projected rupture areas of largest historical earthquakes to shake Kobe, which were subduction-zone earthquakes in 1944 and 1946. (Figure prepared by Grant A. Marshall, U.S. Geological Survey.)

ABSTRACT

The January 17, 1995, earthquake that devastated Kobe, Japan, caused about $100 billion in property losses, making it the most expensive earthquake ever to strike an urban area. The earthquake killed 5378 people, damaged or destroyed about 152,000 buildings, and incinerated the equivalent of 70 U.S. city blocks. The earthquake confirms the credibility of predictions of major property losses when urban areas in the United States are subjected to local moderate earthquakes. It also provides an unusual opportunity to study the effects of near-source ground shaking on both the buildings and infrastructure of a modern city and to deduce implications for the United States. Damage to buildings, which accounted for about 60% of the total property loss, was greatest in buildings constructed under older building codes. The concentration of damage in older buildings highlights the need to address the seismic hazard from buildings that do not conform to current code. The infrastructure of Kobe, including expressways, railways, port facilities, and water, gas, electrical power, and sewer systems, also sustained major damage. The massive damage to infrastructure highlights the need to consider the seismic hazard to lifelines; catastrophic failure of one of these systems may undermine the functionality of a city. The lessons from Kobe for the earth sciences are similar to those from the 1994 Northridge and 1989 Loma Prieta, California, earthquakes. Areas subject to either near-source ground shaking or special site effects are at particular risk from earthquakes. Earthquakes become disasters when society is unprepared; society is more likely to prepare when earth scientists map and quantify earthquake hazards.

INTRODUCTION

The January 17, 1995, Hanshin-Awaji, Japan, earthquake, which severely damaged Kobe, a modern city with many engineered structures, is the most expensive earthquake ever to occur. Previous earthquakes such as the 1976 Tangshan, China, earthquake, which killed 650,000 people, have forcefully demonstrated the potential for great loss of life when buildings are not earthquake resistant. The 1995 Hanshin-Awaji earthquake confirms the credibility of predictions of major property losses when urban areas in the United States are subjected to near-source ground shaking. This confirmation should motivate additional efforts to mitigate the earthquake hazard in urban areas in the United States that are underlain by active faults; these areas include Los Angeles, Salt Lake City, San Francisco–Oakland, San Diego, and Seattle-Tacoma. This earthquake also provides a special opportunity to learn about the potential of near-source ground shaking and liquefaction to damage modern engineered structures and urban infrastructure.

Kobe presents interesting direct parallels with cities in the United States. For example, the geology of Oakland, California, which sits atop the highly active Hayward fault, is similar to that of Kobe. Both cities are built on young alluvial deposits and ground reclaimed from adjacent drowned estuaries. Both estuaries have thick accumulations of soft silt and clay. Thus, the earthquake in Kobe is a good analog for what may happen in Oakland. Salt Lake City presents a parallel in public perception of the hazard. Salt Lake City sits atop the Wasatch fault system, which has been documented by earth scientists to be capable of generating moderate earthquakes. As in Kobe, the fault has had only modest historical seismicity, and the public perception of and level of preparation for the earthquake hazard are not as high as in more seismically active areas.

The Earthquake

The Hanshin-Awaji earthquake (M_W = 6.9) occurred at 5:46 a.m. local time on January 17, 1995. The epicenter was located off the northeast tip of Awaji Island in Osaka Bay (Fig. 1). The earthquake ruptured bilaterally along a 35–50-km-long northeasterly trending zone; the northeastern part of the rupture zone passed beneath Kobe. The focal mechanism shows strike-slip motion on a nearly vertical fault. Surface faulting was observed only above the southwest end of the rupture zone, where a 9-km-long segment of the Nojima fault broke the land on the northwest side of Awaji Island. Surface faulting was primarily strike slip, with a maximum horizontal displacement of 1.7 m; locally, vertical offsets

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IN THIS ISSUE

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reached 1.0 m. Seismic profiles in Osaka Bay revealed scarps off the northeast end of Awaji Island with an aggregate length of 7 km. The offshore faults are offset about 5 km to the southeast of the Nojima fault.

Damage was concentrated in a narrow elongate zone (Fig. 2). The earthquake killed 5378 people, injured 33,189 people, damaged 152,297 buildings, and incinerated an area of 671,253 m^2, the equivalent of 70 U.S. city blocks (Asahi Evening News, 1995). Total property losses were about $100 billion.

GEOLOGIC SETTING

Japan is an island arc that has formed on the east boundary of the Eurasian tectonic plate (Fig. 3). The geologic history of Japan is dominated by subduction of the Philippine and Pacific plates beneath the Eurasian plate. In southwestern Japan, subduction occurs along the Nankai Trough. Although most of the seismic energy associated with plate convergence is released along the downgoing slab, Japan also faces a significant onshore earthquake hazard. About eight moderate or larger earthquakes occur per century onshore (Wesnousky et al., 1982).

Geologic mapping in Japan has revealed many onshore or nearshore faults that show evidence of Quaternary activity (Research Group for Active Faults in Japan, 1991). The Hanshin-Awaji earthquake of January 17, 1995, occurred on one of these mapped faults. Kobe is about 250 km northwest of the Nankai Trough and about 50 km north of the Median Tectonic Line (Fig. 3), a major geologic boundary that divides southwestern Japan into a northern "Inner Zone" and southern "Outer Zone." Basement rocks of the Inner Zone consist chiefly

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Slide Set Available on Kobe Earthquake Damage

Here is an excellent tool for educational use: a set of 35 mm color slides compiled by author Thomas L. Holzer, USGS, expanding on this article. These 30 slides, taken by several investigators, document geologic conditions and damage resulting from the January 17, 1995, M 6.9 Hanshin-Awaji earthquake that devastated Kobe, Japan. Views illustrate damage to buildings, transportation facilities, and lifelines. The set includes pictures of liquefaction and ground settling in areas of reclaimed ground, including the Port of Kobe, the third busiest port in the world. Maps show surficial geology, neotectonic setting, and liquefaction areas. Cross sections illustrate the Holocene history of Kobe. The set is supplied with a printed text describing the views.

Order slide set SLI001, *Kobe Earthquake Damage,* from the Geological Society of America, P.O. Box 9140, Boulder, CO 80301-9140, phone 800-472-1988 or (303) 447-2020. Orders may be faxed to GSA at 303-447-1133; please include complete credit card information. List price $47, postpaid by surface mail; GSA members may claim their discount. This is a limited, one-time offer. Orders must be received by September 15, 1995, and will be shipped about September 30.

About People

GSA Member **Alan V. Morgan,** University of Waterloo, Waterloo, Ontario, Canada, was awarded the 1995 John H. Moss Award for Excellence in College Teaching by the Eastern Section of the National Association of Geology Teachers. The 1994 NAGT Ralph Digman Award, for outstanding contributions to earth science education outside the formal classroom, went to Fellow **Yngvar W. Isachsen**, New York State Geological Survey.

The Illinois State Geological Survey has granted emeritus status to GSA Member **Philip C. Reed,** who retired April 30, in recognition of his distinguished service. Reed also received a Groundwater Science Award from the Illinois Groundwater Association this year. The Illinois Survey named Member **William W. Shilts,** formerly of the Geological Survey of Canada, as its new chief.

In Memoriam

Jack E. Harrison
Lakewood, Colorado
June 2, 1995

Wallace B. Howe
Rolla, Missouri

Lawrence S. Matteson
Bridgeport, West Virginia
December 8, 1994

Willis G. Meyer
Dallas, Texas

Alfred O. C. Nier
Minneapolis, Minnesota
May 16, 1994

Bradford D. Pearson
British Columbia, Canada

Peter O. Sandvik
Kiana, Alaska
May 24, 1995

C. Michael Scullin
Martinez, California
June 7, 1995

ANNOUNCEMENT

Travel Grant Program

30th IGC in Beijing, China • August 4–14, 1996

The Geological Society of America is accepting applications for the International Geological Congress (IGC) Travel Grant Program.

This program was established as a final act of the Organizing Committee for the U.S.-hosted 28th IGC held in Washington, D.C., in July 1989. Surplus funds available at the conclusion of the 28th IGC were transferred to the GSA Foundation with the stipulation that income from the fund be used to support the attendance of young geoscientists at future IGCs, until such time as the United States again hosts an IGC. Travel grants will consist of economy airfare to and from China.

To be eligible, an applicant must be a resident or citizen of the United States (includes students); must have a birth date after August 31, 1956; and must have an abstract for inclusion in the program of the 30th IGC.

Official application forms are available from the Grants Administrator, GSA Headquarters, 3300 Penrose Place, P.O. Box 9140, Boulder, CO 80301. Along with the form, applicants must include a copy of the abstract that was submitted to the 30th IGC. Applications must be supported by two letters from current or recent supervisors; students may use faculty members. **Qualifying applications and letters of support must be postmarked no later than September 15, 1995.** Applicants will be notified of results early in 1996. ■

GSA ON THE WEB

What's new on the GSA home page on the World Wide Web? If you haven't yet connected to the Web, the Universal Resource Locator (URL) is **http://www.aescon.com/geosociety/index.html.**

For current information on the 1995 Annual Meeting in New Orleans, go to **Meetings** and choose **1995 Annual Meeting.** This area contains a listing of Symposia and Theme Sessions and has information about Field Trips, Continuing Education, Exhibits, Travel, and Lodging.

If you want to know more about the GSA Employment Service or about becoming a GSA Campus Representative, check the **Membership** section, which also has information on nominating a member to fellowship and on obtaining forms for applying to become a GSA Member or Student Associate.

See the **Geoscience Calendar** section for a listing of meetings of general geological interest.

The **Publications** section has a monthly table of contents and abstracts of articles for the *GSA Bulletin* and *Geology.* Also in this section is a guide for authors preparing manuscripts for submission to GSA publications. *GSA Today* issues are posted here for downloading and viewing.

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of Paleozoic and Mesozoic sedimentary rocks. In the Kobe region, these sedimentary rocks are intruded by large bodies of Late Cretaceous age granite and granodiorite; these intrusive rocks compose the mountainous region north of Kobe.

Downwarping within the Inner Zone during the Cenozoic created sedimentary basins bounded by the basement rocks. Kobe sits on the northwestern margin of one of these basins, the Osaka Basin. This area has subsided at a high rate throughout the Pliocene and Pleistocene and has accumulated a complexly interbedded sequence of Quaternary marine and alluvial deposits; maximum thickness of these deposits is more than 600 m.

Most of Kobe sits on a narrow 2–3-km-wide coastal plain. The landward, or northern, margin of the coastal plain is formed by the Rokko Mountains, and the shoreward margin by Osaka Bay. Surficial deposits of the coastal plain can be divided into two major groups, natural deposits and artificial landfills (Fig. 2). The natural deposits are of two types (Huzita and Kasama, 1983). The inner part of the Kobe Coastal Plain is underlain by an approximately 2-km-wide zone of alluvial deposits. Near the modern stream channels, most of the deposits are coarse grained, in many places containing gravel derived from the Rokko Mountains. These gravelly deposits range from 10 to 20 m in thickness. Interchannel areas are underlain by finer grained materials. The southern margin of the alluvial deposits is a prehistoric shoreline that approximately parallels the modern shoreline. This shoreline is marked by a 4-m-high erosional scarp that was cut at the end of the Jōmon marine transgression into Osaka Bay, about 6000 yr ago. An approximately 1-km-wide flat plain that is underlain by alternating layers of littoral sand and lagoonal clay lies bayward of this old shoreline. These sand and clay deposits, which are only a few meters thick, represent post-Jōmon deposition and progradation of the coastal plain.

More than 27 km² of land has been reclaimed from Osaka Bay along the Kobe shoreline. Artificial fill was derived from several large quarries in weathered granite and Cenozoic sediments east and west of Kobe. The first major reclamation effort filled 529 ha along the shoreline from 1953 to 1970. After these reclamation efforts, two large islands, Port and Rokko Islands, were created. Reclamation of Port Island started in 1966 and filled 826 ha. Rokko Island, which covers an area of 580 ha, was reclaimed from 1973 to 1992. Fill was dumped into standing water that had an average water depth of 12 m. No significant effort was made during reclamation to compact the sandy fill to increase its liquefaction resistance. Pre-earthquake standard penetration test resistance typically ranged from 5 to 10 blows/ft (Nakakita and Watanabe, 1977).

GROUND SHAKING

Ground shaking in the epicentral region of the earthquake was exceptionally well recorded (National Research Institute for Earth Science and Disaster Prevention, 1995). Recorded accelerations equaled or exceeded 0.5 *g* at ten sites. The maximum acceleration was 0.818 *g*, recorded on the north-south component of an accelerometer at the Kobe Oceanic and Meteorological Observatory. Ground velocities were greater than 100 cm/s. Near-source strong ground shaking lasted 10 to 15 s. The amplitude of shaking was unusually high in the period range from 0.25 to 2.0 s.

The attenuation of peak ground acceleration with distance from the source zone is consistent with the recently revised attenuation curves of Boore et al. (1994) (Fig. 4). Near-source values are lower than the near-source values recorded during the 1994 Northridge, California, earthquake, possibly reflecting the difference in source mechanisms. Ruptures on reverse faults, such as Northridge, seem to produce higher levels of ground shaking than do ruptures on strike-slip faults (Heaton and Wald, 1994). Preliminary comparison of the ground shaking at sites underlain by soft soils with that at nearby sites on either firmer soils or rock indicates that shaking was amplified by a factor of 2 at soft soil sites (Borcherdt, 1995). Amplification ratios are independent of the level of shaking, suggesting that site amplification was linear or independent of strain level (Borcherdt, 1995).

GROUND FAILURE

Much of the artificial fill in areas of reclaimed ground liquefied during the earthquake and expelled large volumes of both sand and water. About 17 km² of land area was covered by vented materials. Splatter marks on walls and other structures showed that water fountains reached heights of almost 2 m in a few places and typically reached 0.5 m.

Lateral spreading was widespread along the perimeters of the artificial fills and generally involved failure of

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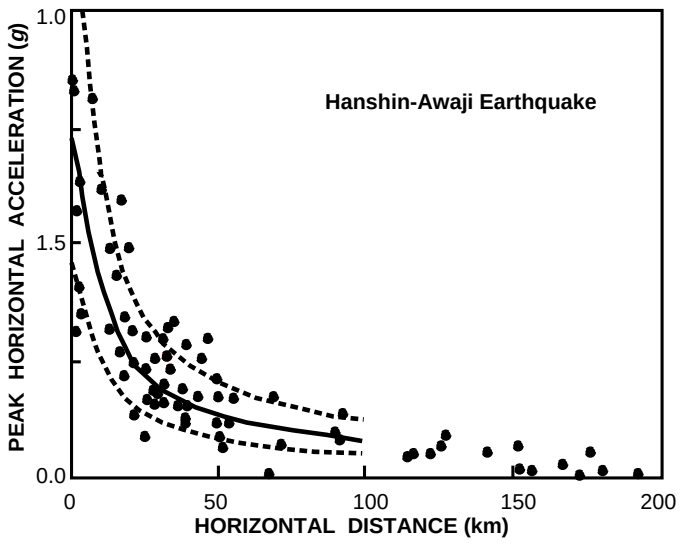

Figure 4. Observed peak horizontal acceleration vs. distance from the surface projection of the seismic rupture surface (modified from Borcherdt, 1995). Value plotted is the maximum of the two recorded orthogonal horizontal components. Attenuation curve is based on statistical correlations of ground-shaking recordings from earthquakes in western North America that were observed at sites with average shear-wave velocities of 180 to 360 m/s in the upper 30 m beneath the site (Boore et al., 1994). Solid curve shows median value; dashed curves are one standard deviation.

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Figure 5. Differential ground settlement in artificial fill beneath the Harbor Expressway near Rokko Island. Postliquefaction consolidation caused ground to settle between bridge columns. Columns extend through liquefied zone. (Photograph by Carol S. Prentice, U.S. Geological Survey.)

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quay walls. Maximum permanent horizontal ground deformation from lateral spreading was about 2 m. Permanent horizontal ground deformation diminished rapidly in severity inland from the quay walls, although areas with ground cracks extended as much as 100 m inland from some walls.

Postliquefaction consolidation and expulsion of particulate matter caused regionally extensive settlements that ranged from 30 to 50 cm and locally exceeded 100 cm. Settlements were easy to detect and measure because many structures built on reclaimed ground are supported by piles or columns that extend through the liquefied zone (Fig. 5).

Despite the rugged terrain of the Rokko Mountains, only a few landslides were reported. Unpublished reconnaissance maps provided by the Geographical Survey of Japan, although they provide limited areal coverage of the mountain front near Kobe, showed only 12 landslides. Most of the landslides were on steep slopes inland from Nishinomiya. The largest and most damaging slope failure was next to the Nikawa-Yurino Filtration Plant (see Fig. 2 for location); this failure killed 34 people. Embankment failures also occurred along streams in the coastal plain.

EFFECTS ON BUILDINGS

Both nonengineered homes and engineered buildings were devastated. About 152,000 buildings and homes were destroyed or damaged. Approximately 60% of the total property loss derived from this destruction. Nearly 90% of the fatalities were caused by collapse of houses. The most comprehensive damage survey was by the Disaster Prevention Research Institute (DPRI), which inventoried damage in a 10 km² area of downtown Kobe. Much of the following information is from their report (Fujiwara et al., 1995).

Most of the destroyed homes were nonengineered wood-frame residences of traditional Japanese design that were built between the late 1940s and the 1970s. Single-family residential construction in Kobe is not regulated by a building code. Two principal styles of residential construction, Shinkabe and Okabe, were popular. These residences typically are either unbraced or lightly braced, one- and two-story, post-and-beam construction with heavy ceramic-tile roofs to resist the winds of typhoons. Most wood connections are by tenon-and-mortise rather than with nails. Resistance to horizontal shaking is further lowered by the absence of interior shear walls and, in cases of mixed use, by open storefronts on the first story. Many collapsed residences so thoroughly disintegrated that there was nothing to suggest that they had ever been more than piles of splintered wood and rubble (Fig. 6).

Many older reinforced concrete buildings also were severely damaged. The DPRI survey in downtown Kobe documented that 1558 reinforced concrete buildings were damaged, and 80 collapsed. A major revision of the building code in 1981, which significantly upgraded seismic resistance requirements, appears to have significantly lessened damage in newer buildings (Fig. 7). Many older reinforced-concrete buildings collapsed in midstory (Fig. 8). Various design problems contributed to this distinctive failure mode, including abrupt decreases with height in the horizontal stiffness of buildings, as well as structural discontinuities. Some discontinuities resulted from a uniquely Japanese approach to enhance the seismic resistance of buildings: encasement of a steel frame into a reinforced-concrete frame. For reasons of economy, steel frames were used only in the lower part of buildings. This is the first earthquake in which midstory collapses at the top of embedded steel frames were observed.

Damage to steel-frame buildings was also worse in pre-1981 buildings. The DPRI survey in downtown Kobe documented 977 damaged and 55 collapsed steel-frame buildings. Many of these buildings were built in the 1960s, when steel shortages and the high cost of structural steel in Japan prompted construction without much regard for seismic-shaking resistance; however, some new steel buildings were damaged. Although most of the damage had been from expected ductile deformation, brittle failures of some steel sections and welds were also observed.

Fires associated with the earthquake incinerated 6913 buildings in an aggregate area of 671,253 m². About 10% of the loss of life was attributed to fire. About two-thirds of the known ignitions were attributed to either leaking gas or electrical problems. Overturned kerosene heaters, candles, and bonfires that were lit after the earthquake to provide warmth caused the other ignitions.

EFFECTS ON INFRASTRUCTURE

In addition to the extensive damage to commercial and residential buildings, the infrastructure of Kobe, including highways, railways, port facilities, waterlines, sewage-treatment facilities, gas-supply lines, and electrical power supply system was badly damaged. The damage and the rate of recovery of the urban infrastructure are important aspects of the earthquake.

Some of the most spectacular images of damage involved the transportation system, both highways and railways. Kobe is serviced by two limited-access highways, the Hanshin and Harbor expressways, both of which are elevated structures. The Hanshin Expressway in Kobe, which was built in the 1960s, was the most heavily damaged; it includes a 600-m-long overturned section. Almost every column of this expressway, which rests on single columns along most of its length, was damaged. Columns of the expressway were short and stiff, causing them to undergo large dynamic forces. Steel reinforcing, particularly the ties that confine the concrete in columns, was inadequate (Comartin et al., 1995).

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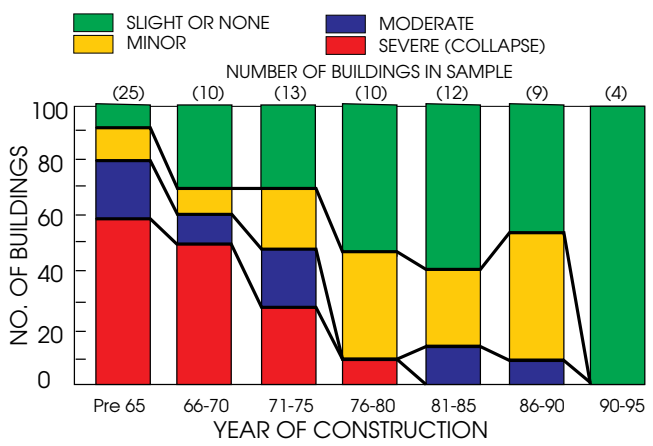

Figure 7. Correlation between damage level and year of construction of reinforced-concrete buildings (Fujiwara et al., 1995). Numbers in parentheses are the size of the sample.

Figure 6. Collapsed Japanese wood-frame home. (Photograph by Carol S. Prentice, U.S. Geological Survey.)

Figure 8. Collapsed sixth story in eight-story Kobe City Hall Annex, a reinforced-concrete building built in the 1960s. Behind it is the 16-story New City Hall, a 1980s steel-frame building that was not damaged and remained functional after the earthquake. (Photograph by Christopher Rojahn, Applied Technology Council.)

WASHINGTON REPORT

Bruce F. Molnia

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

Who's Who In Congressional Science

For those in the federal science and university communities whose livelihood is dependent on congressionally appropriated funds, an up-to-date list of congressional committees and subcommittees that deal with science issues is a significant asset. Knowing the ranking members of these committees is also a plus. Such a list of committees and members was recently prepared and distributed on the Internet by ASLA, the American Geophysical Union's Science Legislative Alert. With ASLA's permission, the list is being reproduced here for GSA members' information. In both the Senate and the House of Representatives, virtually all science activities fall under the jurisdiction of five major committees. Although both chambers have an Appropriations and a Budget Committee, the organization and responsibilities of the five House committees do not fully duplicate all of the functions of the often similarly named Senate counterparts. An examination of the list presented below will show the organizational structure, the responsibility, and the disciplinary control these committees hold over different aspects of U.S. science. The list is organized as follows:

A. House of Congress:
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    a. Subcommittee:
      with the name of the chairman and ranking minority member
      1. Agency or issue of jurisdiction

A. SENATE:
  I. Appropriations Committee:
    Hatfield (R—OR), chairman; Byrd (D—WV), ranking member
    a. Commerce, Justice, State and Judiciary Subcommittee:
      Gramm (R—TX), chairman; Hollings (D—SC), ranking member
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    b. Energy and Water Development Subcommittee:
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      4. National Aeronautics and Space Administration (NASA)
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      6. Office of Science and Technology Policy (OSTP)
  II. Budget Committee:
    Domenici (R—NM), chairman; Exon (D—NB), ranking member
  III. Commerce, Science and Transportation Committee:
    Pressler (R—SD), chairman; Hollings (D—SC), ranking member
    (responsible for NOAA, NSF, and NASA)
    a. Oceans and Fisheries Subcommittee:
      Stevens (R—AK), chairman; Kerry (D—MA), ranking member
      1. Ocean issues—pollution
      2. Fisheries management
    b. Science, Technology and Space Subcommittee:
      Burns (R—MT), chairman; Rockefeller (D—WV), ranking member
      1. Science, engineering, and technology research, development, and policy
  IV. Energy and Natural Resources Committee:
    Murkowski (R—AK), chairman; Johnston (D—LA), ranking member
    (responsible for Department of Energy [DOE] and USGS [part])
    a. Energy Production and Regulation Subcommittee:
      Nickles (R—OK), chairman; Bingaman (D—NM), ranking member
    b. Energy Research and Development Subcommittee:
      Domenici (R—NM), chairman; Ford (D—KY), ranking member
      1. DOE National Laboratories
      2. Global Climate Change
    c. Forests and Public Land Management Subcommittee:
      Craig (R—ID), chairman; Bradley (D—NJ), ranking member
  V. Environment and Public Works Committee:
    Chafee (R—RI), chairman; Baucus (D—MT), ranking member
    a. Clean Air, Wetlands, Private Property and Nuclear Safety Subcommittee:
      Faircloth (R—NC), chairman; Graham (D—FL), ranking member
    b. Drinking Water, Fisheries and Wildlife Subcommittee:
      Kempthorne (R—ID), chairman; Reid (D—NV), ranking member

Washington Report *continued on p. 164*

PUBLICATIONS NEWS FROM GSA

BOOK NOOK

WATCH THIS COLUMN FOR NEWS ABOUT GSA PUBLICATIONS

RECENTLY RELEASED!

REVIEWS IN ENGINEERING GEOLOGY X

CLAY AND SHALE SLOPE INSTABILITY
edited by W. C. Haneberg and S. A. Anderson, 1995
Ten state-of-the-art papers address both empirical and analytical aspects of clay and shale slope instability. Among the topics discussed in detail are limit equilibrium stability analysis, shear strength of clay and clayey colluvium, use of triaxial test data to evaluate viscoplastic slope movements, numerical modeling of pore pressure distribution in heterogeneous soils, rational analysis of rainfall and landslide movement patterns, the effects of hydrothermal alteration on slope stability, mudrock durability and stability considerations, and regional clay and shale slope stability problems in Italy. This volume is a must for researchers and practitioners in engineering geology, geomorphology, geotechnical engineering, hydrogeology, natural hazard assessment, and other fields concerned with clay and shale slope processes.
REG010, 160 p., hardbound, indexed. ISBN 0-8137-4110-6, $60.00

ARCHAEOLOGICAL GEOLOGY OF THE ARCHAIC PERIOD IN NORTH AMERICA
edited by E. A. Bettis III, 1995
Climatic, biotic, and geomorphic changes that had dramatic effects on prehistoric human populations occurred during the early and middle Holocene in North America. This volume focuses on the stratigraphic record of that period, and the controls that sedimentary and pedologic processes have exerted on our perceptions of the associated archaeological record of the Archaic Period. A variety of approaches to investigating and modeling the archaeological geology of the early and middle Holocene in North America are presented. These seven papers summarize what is known of the archaeological geology of the Archaic Period from the St. Lawrence Lowland, through the Mid-continent and Plains, to the Rocky Mountains, and on the continental shelf.
SPE297, 158 p., paperback, indexed. ISBN 0-8137-2297-7, $45.00

LOW-GRADE METAMORPHISM OF MAFIC ROCKS
edited by P. Schiffman and H. W. Day, 1995
Mafic rocks recrystallized to the zeolite, prehnite-pumpellyite, and contiguous facies are found within a large part of Earth's crust, but particularly at divergent and convergent plate margins. Study of these low-grade metamorphic rocks can provide significant insights into understanding the thermal and chemical evolution of diverse tectonic settings, including mid-oceanic spreading centers, accretionary prisms, and island arcs and their adjacent sedimentary basins. Ten papers address the low-grade metamorphism of mafic rocks from a wide range of these settings and employ various research methodologies in problem solving.
SPE296, 174 p., indexed, ISBN 0-8137-2296-9, $50.00

GEOLOGIC AND TECTONIC DEVELOPMENT OF THE CARIBBEAN PLATE BOUNDARY IN SOUTHERN CENTRAL AMERICA
edited by P. Mann, 1995
Presents 17 papers on various aspects of the complex geologic and tectonic development of southern Central America, defined here as the combined land areas of Panama and Costa Rica, and their adjacent offshore areas in the Caribbean Sea and Pacific Ocean.
SPE295, 381 p., paperback, 8 plates on 4 sheets in pockets, indexed, ISBN 0-8137-2295-0, $100.00

PERMIAN-TRIASSIC PANGEAN BASINS AND FOLDBELTS ALONG THE PANTHALASSAN MARGIN OF GONDWANALAND
edited by J. J. Veevers and C. McA. Powell, 1994
After reconstructing Permian-Triassic Gondwanaland, authors writing on South America, South Africa, Antarctica, and Australia profusely illustrate the relevant geology of each sector in maps and time-space diagrams underpinned by robust biostratigraphic and radiometric dating. The work is then drawn together in a stratigraphic-tectonic synthesis, which features the specifically Gondwanan glaciogene and coal facies, the Early and Middle Triassic coal gap, and the interplay of Pangean and Panthalassan tectonics.
MWR184, 372 p., hardbound, ISBN 0-8137-1184-3, $100.00

THE GEOLOGY OF ALASKA
edited by G. Plafker and H. C. Berg, 1994
GNA-G1, 1,066 p., hardbound, w/13 plates in slipcase, and 1 microfiche card, indexed, ISBN 0-8137-5219-1, $135.00

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Peter D. Rowley Receives 1995 Dibblee Medal

Dorothy L. Stout

Peter Rowley in Antarctica.

"A geologist is special because she or he makes geologic maps and in doing so is deeply and fraternally bound to other geologists because each has experienced the excitement of discovery, not only scientific discovery, but discovery of the natural world, and most importantly discovery of self. The importance and the worth of the geologic map is discovery, it is our bond, and it is our immortality." These words of UCLA's Dean Clarence Hall served to introduce the special ceremony presenting the second Dibblee Medal to Peter Rowley, of the U.S. Geological Survey, Denver, Colorado. The first recipient of the Dibblee Medal was Lehi Hintze. The May 4, 1995, event was held in conjunction with the Pacific Section meeting of the American Association of Petroleum Geologists in San Francisco. Hall went on to say, "A field geologist is inventive, masochistic, independent, imaginative, entrepreneurial, artistic, and is bound philosophically and scientifically to his or her fellow field geologists and geologists by geologic maps, thinking in four dimensions, and by understanding the absence of geologic and biologic permanence."

This award presented by the Thomas Wilson Dibblee, Jr., Geological Foundation underscores the importance of geologic field mapping as a means of solving complex geological problems and commemorates the extraordinary geologic mapping achievements of Tom Dibblee.

John Anderson, retired professor of geology at Kent State University and Rowley's long-time friend and nominator, highlighted Pete's career by relating that Peter DeWitt Rowley was born in Connecticut in 1942 where he grew up and received his early education. He received his B.A. in geology from Carleton College in 1964. Also a Carleton alumnus, John had in 1963, just back from Antarctica, recruited Pete as his field assistant for his University of Texas Ph.D. mapping program under J. Hoover Mackin in the southern Marysvale volcanic field in southwestern Utah. "Thus began for Rowley a

Dibblee *continued on p. 158*

GSAF UPDATE

Robert L. Fuchs

Second Century Fund Membership Campaign Begins—Chairs Appointed

Chair Bill Bromery announced the start of the membership phase of the Second Century Fund campaign and the appointment of chairs for each of GSA's six sections. The overall campaign goal is $10 million, and the membership portion of this is $1.5 million.

Bromery, who is president of Springfield College in Massachusetts and a past president of GSA, in announcing the membership campaign, said, "since the Second Century Fund began in 1992, the Committee, the Foundation, and a number of GSA members have worked diligently toward achieving the campaign goal. The results are a testimonial to their work—nearly $4 million in new endowment and program funds from some 140 donors. We have been very pleased by the leadership gifts that are included in these totals, from members, foundations, and companies. The success of a major capital campaign such as the Second Century Fund for Earth • Education • Environment is ultimately achieved through the participation of all members and supporters of an organization, not only through the large gifts. Thus, it is important that GSA's 16,000 earth scientists have the opportunity to support this fund drive. Strong membership involvement is really critical to the continued success and final completion of the Second Century Fund. Outside organizations that are potential contributors frequently examine the internal support that is being generated, using this as a criterion in making their decisions.

"GSA's six Sections have the most direct, local contact with members, and for this reason the Sections will spearhead the membership campaign, beginning in early August. Through their close relationships with students, educators, and the public, the Sections are in an excellent position to extend the Society's research, education, environmental, and outreach programs. Sections need to benefit directly from the funds given by members, so a portion of all unrestricted gifts and pledges will go to Section endowment funds at the Foundation. [Individual Section goals are shown in the accompanying table.]

"Finally, what I find personally very exciting about the membership campaign is the leadership that has been assembled, members who have given extensively of their time to GSA in the past and are willing once again to undertake an important job on behalf of geology. The Second Century Fund Section chairs are Jack Oliver—Northeastern, Bob Hatcher—Southeastern, Lee Suttner—North-Central, Bill Fisher—South-Central, Ken Hamblin—Rocky Mountain, and Bill Dickinson—Cordilleran. Many more are indicating their willingness to work on local committees and help us achieve the goals." ■

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Holly L. O. Huyck

Dibblee *continued from p. 157*

love affair with the geology of the American West that has endured to this day," Anderson said. The next summer Mackin funded Pete for mapping in the Marysvale field. Pete went on to receive his Ph.D. from the University of Texas in 1968. Pete's own dissertation, under Mackin, "involved the geologic mapping at 1:62,500 of the southern Sevier Plateau … some of the most rugged terrain in Utah."

Anderson went on to recount that Pete joined the USGS in 1970 where his major activity has always been geologic mapping. His extensive mapping accomplishments during his 25 years with the USGS include 54 maps, mostly at a scale of 1:24,000 and most in rugged territory, the bulk being "volcanic terranes of great structural and stratigraphic complexity, and all of the very highest quality.… From 1970 to 1986 this activity was largely divided between the Antarctic Peninsula, the oil-shale lands of Utah and the Marysvale volcanic center and Iron Springs mining district of Utah. During these years he also was involved in research at Mount St. Helens following its eruption in 1980, and in the Murdama Basin, Saudi Arabia. Unfortunately, the 1:250,000 mapping that he accomplished during five field seasons in Antarctica remains largely unpublished at that scale because no base maps were made of the areas he worked in. The extent of his mapping can be seen, however, not only on the two 1:500,000-scale maps (of at least 60,000 sq. mi. of previously unexplored mountains) that existing base maps made possible, but also in the articles that he published based on that mapping.… Since 1986, Rowley's mapping efforts have been concentrated largely in the Caliente Depression, Nevada, probably the largest (80×35 km), yet most poorly known, Tertiary caldera complex in the conterminous United States.… Rowley has published more than 80 articles and 30 abstracts dealing with aspects of the geology he has mapped."

Rowley's encouragement of future geologic mappers is illustrated in that, as Anderson said, "throughout his career with the USGS Rowley has done everything he possibly could to encourage and assist the geologic mapping efforts of college students," most of whom have come from Carleton College and Kent State University. "Over the years, Rowley was instrumental in obtaining Survey support for many students, from full support by an appointment as a field assistant to partial support by being provided with a government vehicle while they were in the field." Rowley is "sole author of

Dibblee *continued on p. 159*

LaMoreaux Gift Honored at GSA Headquarters

During the May Council and committee meetings in Boulder, GSA President Dave Stephenson recognized a recent Second Century Fund leadership gift from Phil and Bunnie LaMoreaux. The GSA Council Room, where for more than 20 years numerous deliberations and debates by the representatives of the membership have been formulated into the plans and procedures that guide the Society, has been marked with a plaque that denotes this gift.

"As a fellow hydrogeologist," said Stephenson speaking at the awards reception, "I have always been an admirer of Phil LaMoreaux, whose career parallels the development and growth of hydrogeology. His accomplishments have been some of the key ingredients behind the importance that our discipline has achieved both in this country and throughout the world. The Society has benefited from Dr. LaMoreaux's work on its behalf, particularly his leading role over the years in the Hydrogeology Division, and this additional financial backing during this capital campaign is but one further manifestation of his active and continuous support."

Phil LaMoreaux graduated from Dennison University in 1943 and subsequently obtained a Master of Science degree from the University of Alabama. Since then, his connections with Alabama, both the University and the state, have been close. He taught geology and hydrogeology for 23 years while working as District Geologist with the USGS and later as State Geologist in Tuscaloosa. During his USGS tenure from 1943 until 1961, he rose to Chief, USGS Ground Water Branch, supervising all activities in the United States and its possessions. In 1961 he became Alabama's State Geologist and Oil and Gas Supervisor. After retirement, from 1983 through 1988, he was Director of the Environmental Institute for Waste Management Studies at the University of Alabama. Denison University awarded him an honorary Doctor of Science degree in 1972.

During Phil LaMoreau's time as Alabama State Geologist, the Alabama Survey grew from a small staff to one of the leading state surveys in the nation, with more than 175 employees working on geology, minerals, water, energy, and the environment. The period of his leadership also coincided with the major development of the Jay field and the rapid expansion of Alabama's petroleum industry. As the Oil and Gas Supervisor he was responsible for implementing laws and regulations that controlled this development and directed such operational activities as drilling, testing, plugging, and the protection of water resources.

Phil LaMoreaux founded P. E. LaMoreaux and Associates (PELA), which was incorporated in 1970. For 20 years he led this organization's work in minerals, water, energy, geology, and the environment in the United States and several foreign countries. Throughout this period he was occupied with numerous additional public service activities—scientific, editorial, governmental, and civic. These included editor-in-chief of the *Journal of Environmental Geology,* member of the Environmental Protection Agency's National Drinking Water Advisory Council, president of the American Geological Institute, president of the Association of American State Geologists, and president of the International Association of Hydrogeologists. He is a member of the National Academy of Engineers. Honors and awards include the Distinguished Alumni Award from Dennison University and the American Geological Institute's Ian Campbell Medal, and the Commander's Medal from the U.S. Corps of Engineers.

Dave Stephenson and Bunny and Phil LaMoreaux. Second Century Fund Recognition, Boulder, Colorado, May 1995.

Bunnie LaMoreaux received her B.A. from Dennison University and her M.S. in secondary education and Ph.D. in higher education administration from the University of Alabama. In addition to being active in PELA management, she organized and heads an import company. She has directed various programs at the University of Alabama, including International Student Affairs, Work-Study, and Financial Aid. Bunnie LaMoreaux has been a leader in Tuscaloosa civic and social activities. Recently, she received the Distinguished Alumni Award from Dennison University.

Phil LaMoreaux has long been active in GSA. He was a founder and chair of the Hydrogeology Division, was a member of Council, and is a Foundation Trustee and past Chairman. In responding to the GSA Council Room designation, established by the Executive Committee and Foundation Trustees in recognition of the LaMoreaux gift and his long service to the Society, Phil LaMoreaux noted, "Bunnie and I are very appreciative of this honor that has been extended to us by GSA. The Council Room means a lot to me, for I especially enjoyed my term on Council, and I feel that in a small way this enabled me to participate in the ongoing professional and scientific debate that guides the programs and plans of this prestigious organization." ■

Dibblee *continued from p. 158*

only a few maps, and senior author of so many" because "he always has made every effort to honor or reward those who in almost any way have helped him with his mapping by awarding them a co- or junior authorship."

Anderson related his reasons for nominating him for the Dibblee Medal: "I do so because it seems to me, and those other geologists who support his nomination, that his record of geologic mapping deserves consideration for this high award. Numerically, this record does not, and probably never will, equal that of Tom Dibblee, but then whose does or ever will? The broad range of the areas that Rowley has mapped as well as the quality of his maps, however, live up to Dibblee's high standards. When his other publications are added to the list of his geologic maps, I believe that Rowley's contributions to geologic mapping merit comparison with Dibblee's."

In Rowley's acceptance he was especially appreciative of John and Linda Anderson, who nominated him for the award. He thanked his greatest heroes and most loyal friends, his parents, Art and Barbara; his son, Scott; his daughter, Jill; and his nephew, Chris. He highlighted the role educators played in his successful career, starting with the emphasis placed on field studies at Carleton College derived from its excellent professors, Duncan Stewart, Eiler Henrickson, and Larry Gould. These scholars offered inspiration, high ethics, love of science, infectious enthusiasm, and a love of field work. Rowley added that the continuance of these standards with the present staff make it "the best undergraduate geology department in the country."

Pete's admiration for the legendary Mackin at the University of Texas was clear from his statement that "the only certain genius I ever met and the consummate field geologist, brought me to a new level with his patience, standards, and devotion to science." Mackin's colleagues, Dan Barker, Bob Boyer, and Bill Muehlberger, complemented Mackin "in their high values, extreme competence, and infinite patience with the likes of me." As Pete recounted, "All Hoover's student became field geologists, and most worked with the USGS. One of those former students, Paul Williams, hired me to join him in reconnaissance mapping in Antarctica, of all the blind luck in the last large area of unexplored ranges left on Earth! Surely this was one of the best jobs in the world, and I spent five field seasons at it."

Rowley's work at the USGS has been a learning experience, he noted. "In Denver, I was in the midst of great field geologists and I worked in joint projects with as many of them as I could. These especially included Paul Williams, Tom Steven, Wally Hansen, Ernie Anderson, and Lehi Hintze (last year's Dibblee Medal recipient), as well as other stars in and outside the USGS. One particular philosophy offered hope that I might eventually understand rocks. Hoover Mackin told me in 1967 that 'No geologist is any damned good until he reaches the age of well, how old am I anyway?' So I waited around hoping that wisdom of advancing years would answer my questions about geology. They haven't, but not long ago I learned the reason why from Ernie Anderson's observation, 'Sometimes the more geology I see, the more confused I get.' Combine the two philosophies and you have me—a graying field geologist increasingly aware of what he doesn't know."

On a more philosophical note, Rowley went on to add, "Geologic mapping has always been difficult to sell to non-geologists and especially to politicians, who nowadays control science. Even geologists increasingly fail to realize that geologic maps are basic to the proper evaluation of all mines, water and land resources, the sanitary disposal of wastes, and the analysis of geologic hazards. Even basic geologic data cannot be adequately appraised without competently prepared geologic maps. Geologic maps thus are data bases for the country's geologic framework, and only with the broad view that this framework provides can the country quickly identify local environmental hazards and problems and successfully find resources. They also lead geology because of its firm base in field geology and mapping. Most of the credit for this lead is owed to a diminished number of college and university geology departments, who buck a tide of de-emphasized mapping by other geology departments, the National Science Foundation, and most other funding agencies."

In summing up his feelings, Rowley added, "Geologic mapping nowadays is changing rapidly. Exploring poorly known areas and pursuing mineral and energy resources are giving way to surficial mapping in population centers to identify and mitigate hazards of many types, to evaluate foundation conditions and urban mineral deposits such as gravel, sand, stone, and other construction materials, and to find and protect water supplies. Although purists may not like these changes, this general trend is for the best, and mapping will prove, even more than before, its extreme relevance to the needs of society. Currently I am working in the Las Vegas urban corridor, and surficial and bedrock geologic maps are the things most in demand by land-use and developmental agencies, provided that these organizations are fully involved in planning and funding. But along the way, the USGS and the geologic profession cannot forget what made them important to the public, namely cutting-edge science based on field work. To use a quote attributed to G. K. Gilbert, 'There can be no applied science unless there is science to apply.'" ■

Preliminary Announcement and Call for Papers

SOUTH-CENTRAL SECTION, GSA 30th Annual Meeting

Austin, Texas
March 11–12, 1996

The Department of Geological Sciences at the University of Texas at Austin will host the 30th Annual Meeting of the South-Central Section of the Geological Society of America. The meeting will be held on campus, during spring break week. Scientific sessions start at 8:00 a.m., Monday, March 11, and conclude at 5:00 p.m., Tuesday, March 12.

LOCATION

Austin is located where the Colorado River cuts through the Balcones escarpment, formed by the normal fault system that marks the southeastern edge of the Texas Hill Country. Austin, the 27th largest city in the nation, has a population of 490,000; there are 816,000 in the metropolitan area. The region had the fastest growing economy during the 1980s—expansion driven by growth of high-tech industries. Thirty miles of urban hike-and-bike trails wind their way through more than 11,000 acres of park land. Austin is known by many as the "live music capital of the world"; dozens of night spots line the nine-block stretch of historic Sixth Street.

The city is located along Interstate 35 about 200 miles south of Dallas and 80 miles north of San Antonio. The airport is only a 15-minute drive from campus. Dozens of hotels and numerous fine restaurants are readily accessible by car or taxi. A large food mall and several restaurants within a 10–15 minute walk from the site of the meeting offer lunch. The average temperature in early March is 60°F, with a 20% chance of a rain shower.

CALL FOR PAPERS

Papers are invited for presentation at oral technical sessions, symposia, and poster sessions. Papers dealing with the geology of the South-Central region (Texas, Oklahoma, Arkansas, and surrounding areas) are especially encouraged. Except for special presentations arranged by symposia organizers, oral presentations will be limited to 17 minutes, with 3 minutes for questions. Poster sessions will be set up for four hours, and authors will be available for at least two hours to discuss their work. Abstracts volunteered but not included in a symposium will be considered for regular technical sessions.

Symposia

1. **NAGT Symposium—Astrogeology and Education.** R. E. Boyer, Dept. of Geological Sciences, University of Texas, Austin, TX 78712; phone (512) 471-7228; fax 512-471-9425; E-mail: reboyer@mail.utexas.edu.
2. **Carbonate Rocks and Diagenesis in the South-Central Region.** Brenda Kirkland-George, Dept. of Geological Sciences, University of Texas, Austin, TX 78712; phone (512) 471-5129; fax 512-471-9425; E-mail: kirkland@maestro.geo.utexas. edu; and Jay Banner, phone (512) 471-5016; fax 512-471-9425; E-mail: banner@maestro.geo.utexas.edu.
3. **Caribbean Tectonics.** Larry Lawver, University of Texas Institute for Geophysics; phone (512) 471-6156; E-mail: lawver@utig.ig.utexas.edu.
4. **Coastal Sedimentology and Geomorphology.** Robert A. Morton, Texas Bureau of Economic Geology, Austin; phone (512) 471-1534; fax 512-471-0140; E-mail: morton@begv.beg.utexas.edu.
5. **Fractured Aquifers and Petroleum Reservoirs.** Steve Laubach, Texas Bureau of Economic Geology, Austin; phone (512) 471-1534; fax 512-471-0140; E-mail: laubachs@begv.beg.utexas.edu.
6. **Invertebrate Paleontology of the South-Central Region.** James Sprinkle, Dept. of Geological Sciences, University of Texas, Austin; phone (512) 471-4264; fax 512-471-9425; and Rena Bonem, Dept. of Geology, Baylor University, Waco, TX, 76798-7354; phone (817) 755-2361; fax 817-755-2673; E-mail: bonemr@baylor.edu.
7. **Karst Hydrogeology.** Neven Kresic, Dept. of Geology, Texas Christian University, Fort Worth, TX 76129; phone (817) 921-7506.
8. **Late Cretaceous–Early Tertiary Stratigraphy: K-T Boundary and the Impact.** Dick Buffler, University of Texas Institute for Geophysics, Austin; phone (512) 471-6156; E-mail: dick@utig.ig.utexas.edu.
9. **Origin and Evolution of the Ouachita Embayment.** Ian Dalziel, University of Texas Institute for Geophysics, Austin; phone (512) 471-6156; E-mail: ian@utig.ig.utexas.edu.
10. **Precambrian Evolution of the Southwestern Laurentian Continent.** Calvin Barnes, Dept. of Geosciences, Texas Tech University, Lubbock, TX 79409-1053; phone (806) 742-3102; fax 806-742-0100; E-mail: gical@ttacs.ttu.edu; Sharon Mosher, Dept. of Geological Sciences, University of Texas, Austin, TX 78712; phone (512) 471-4135; fax 512-471-9425; E-mail: mosher@maestro.geo.utexas.edu; and Kent C. Nielson, Programs in Geosciences, University of Texas at Dallas, Richardson, TX 75083-0688; phone (214) 883-2401; fax 214-883-2537.
11. **Principles and Practice of Hydrogeology.** John M. Sharp, Jr., Dept. of Geological Sciences, University of Texas, Austin, TX 78712; phone (512) 471-3317; fax 512-471-9425; E-mail: jsharp@maestro.geo.utexas.edu; Alan R. Dutton, Texas Bureau of Economic Geology, Austin; phone (512) 471-1534; fax 512-471-0140; E-mail: duttona@begv.beg.utexas.edu; and Ridge Kaiser, Harden and Associates, Austin, Texas; phone (512) 345-2379; fax 512-338-9372.
12. **Restructuring Geoscience Education for the 21st Century.** Cosponsored by Midcontinent Section of National Association of Geology Teachers and GSA South-Central Section Geoscience Education Division. Bob Pinker, Johnson County Community College, phone (913) 469-3894); and Phil Kehler, Dept. of Earth Science, University of Arkansas, Little Rock, AR 72204-1099; phone (501) 569-3545; fax 501-569-3271; E-mail: pkehler@ualr.edu.
13. **Ronald K. DeFord Symposium on the Stratigraphy and Structure of Trans-Pecos Texas.** Donald F. Reasor, Dept. of Geology, University of Texas, Arlington, Box 19049, Arlington, TX 76019-0049; phone (817) 273-2987; Page Twiss, Dept. of Geology, Kansas State University, Manhattan, KS 66506-3201; phone (913) 532-6724; fax 913-532-5159; and James Underwood, Kansas State University.
14. **Tertiary Tectonics of the South-Central Region.** Randy Marrett, Dept. of Geological Sciences, University of Texas, Austin, TX 78712; phone (512) 471-4885; fax 512-471-9425; E-mail: marrett@maestro.geo.utexas.edu.
15. **Unsaturated Zone Geology and Hydrology.** Bridget Scanlon, Texas Bureau of Economic Geology, Austin; phone (512) 471-1534; fax 512-471-0140; E-mail: scanlonb@begv.beg.utexas.edu.
16. **Vertebrate Paleontology of the South-Central Region.** Ernie Lundelius, Dept. of Geological Sciences, University of Texas, Austin, TX 78712; phone (512) 471-6556; fax 512-471-9425; E-mail: ernie@maestro.geo.utexas.edu; and Tim Rowe, Dept. of Geological Sciences, University of Texas, Austin, TX 78712; phone (512) 471-1725; fax 512-471-9425; E-mail: rowe@maestro.geo.utexas.edu.
17. **Quaternary Geology and Paleoenvironments.** Tom Gustavson, Texas Bureau of Economic Geology, Austin; phone (512) 471-1534; fax 512-471-0140; E-mail: gustavsont@begv.beg.utexas.edu; and Steve Hall, Dept. of Geography, University of Texas, Austin, TX 78712; phone (512) 471-5116.

POSTER SESSIONS

Three half-day poster sessions are planned. We encourage poster contributions because they permit extended discussion. Please indicate your preferences for a poster session on the GSA abstract form.

The Geology Division of the Council on Undergraduate Research will sponsor a student poster session to showcase senior theses and other undergraduate research projects. First authors must be undergraduate students and are responsible for the bulk of the research, preparation of the poster, and presentation of the results. More information will be published in the November 1995 issue of *GSA Today*.

ABSTRACTS

Abstracts deadline:
November 20, 1995

Abstracts for all sessions must be submitted camera-ready on official 1996 GSA abstract forms. These forms are available from the Abstracts Coordinator, Geological Society of America, P.O. Box 9140, Boulder, CO 80301, (303) 447-2020, or E-mail: ncarlson@geosociety.org.

Send an original and five copies of the abstract (volunteered or invited) to William F. Mullican, Bureau of Economic Geology, University Station Box X, University of Texas, Austin, TX 78712. We encourage participants in symposia to send an extra copy to the convener of the planned session. Abstracts will be reviewed for information content, format, and originality. GSA rules prohibit individuals from presenting more than one volunteered abstract, although they can be coauthors on additional volunteered abstracts. Abstracts submitted for symposia are not affected by this limitation.

FIELD TRIPS

Proposed premeeting and postmeeting field trips are listed below. For details about particular trips, contact the field trip leaders listed. For general questions concerning field trips, contact Sharon Mosher, Field Trips Chair, Dept. of Geological Sciences, University of Texas, Austin, TX 78712, (512) 471-4135, E-mail: mosher@maestro.geo.utexas.edu.

Premeeting

1. **Geology of the Eastern Llano Uplift, Central Texas.** (2 days) Leaders: Sharon Mosher, Dept. of Geological Sciences, University of Texas, Austin, TX 78712; phone (512) 471-4135; fax 512-471-9425; E-mail: mosher@maestro.geo.utexas.edu; Robert Roback, University of Texas, Austin; Joe Reese, Idaho State University; and Daniel Barker, University of Texas, Austin.
2. **Late Cretaceous/Early Tertiary Stratigraphy of Northeast Mexico.** (4 days) Leader: Kristian Soegaard, Dept. of Natural Sciences and Math, University of Texas at Dallas, Richardson, TX 75083, phone (214) 883-2415; E-mail: soegaard@utdallas.edu; Katie Giles, New Mexico State University; and Francisco Vega, Universidad Nacional Autónoma de México.
3. **Cretaceous Stratigraphy of the Austin Area.** (1 day) Leaders: Brenda Kirkland and Jay Banner, Dept. of Geological Sciences, University of Texas, Austin, TX 78712, phones (512) 471-5129 (Kirkland), or (512) 471-5016 (Banner); fax 512-471-9425; E-mail: kirkland@maestro.geo.utexas.edu; banner@maestro.geo.utexas.edu.
4. **Edwards Aquifer.** Central Texas (1 day) Leader: John M. Sharp, Jr., Dept. of Geological Sciences, University of Texas, Austin, TX 78712, phone (512) 471-3317; fax 512-471-9425; E-mail: jsharp@maestro.geo.utexas.edu; and Nico Hauwert, Barton Springs/Edwards Aquifer Underground Water Conservation District.

Postmeeting

5. **Geology of Big Bend Park.** (3 days) Leaders: William R. Muehlberger and Pat Dickerson, Dept. of Geological Sciences, University of Texas, Austin, TX 78712, phone (512) 471-4885 (Muehlberger); fax 512-471-9425; E-mail: patd@maestro.geo.utexas.edu (Dickerson).
6. **Sequence Stratigraphy of North-Central Texas.** (2 days) Leaders: Art Cleaves and Darwin Boardman, Dept. of Geology, Oklahoma State University, Stillwater, OK 74078, phone (405) 744-9246; fax 405-744-7841.

EARTH SCIENCE EDUCATION PROGRAMS

If you would like to organize a session or participate in National Association of Geology Teachers (NAGT) activities, please contact Robert E. Boyer, Education Programs Chair, Dept. of Geological Sciences, University of Texas, Austin, TX 78712, phone (512) 471-7228; E-mail: reboyer@mail.utexas.edu.

PROJECTION EQUIPMENT

All slides must be 2" × 2" and fit a standard 35 mm carousel tray. Please bring your own loaded carousel trays, if possible. Two 35 mm slide projectors and two screens will be available for each oral technical session. Overhead projectors will not be available.

South-Central *continued on p. 161*

New GSA Members

The following 1,098 Members were elected to membership by council action during the period from September 1994 through April 1995 (* indicates transfer from Student Associate to Member.)

Gerard F. Aarons
Inge O. Aarseth
*Arvid Aase
*Timothy Abbe
*Robert H. Abrams
*Christon M. Achong
Celia M. Adams
Mark G. Adams
*Daniel A. Akers
*Penny L. Alano
*Katharine C. Albino
*L. Barry Albright
Bruce D. Allen
*Joseph L. Allen
*Jeffrey M. Amato
*Clifford P. Ambers
*Leslie Ames
Rachel A. Ames
*Alejandro E. Amigo
*Charles B. Andersen
Brian D. Anderson
*Brian G. Anderson
*Gregory J. Anderson
Kai S. Anderson
*Suzanne P. Anderson
*Ulf B. Andersson
*William M. Andrews, Jr.
Kalliopi Angelidaki
*Ryo Anma
*Lori E. Apodaca
*James D. R. Applegate
*Phillip A. Armstrong
*Eve M. Arnold
*Pranoti M. Asher
Richard A. Ashmore
*Soe Aung
*Jennifer M. Ayers
*Edward J. Bacig
*Pamela Seney Baginski
*Rahul Bahadur
*Christopher M. Bailey
David G. Bailey
*David J. Baird
Edward M. Baker
*Elizabeth D. Baker
Nancy A. Baker
Robert M. Baker
Amit Banerjee
*Sanjay Banerjee
*Laura A. Banfield
James E. Bannantine
*Donald C. Barber
*David J. Barclay
*Lisa K. Barlow

Dirk Baron
*Robert C. Barr
Ruth A. Barrett
*Kari N. Bassett
Herbert K. Bates
*Gerald W. Bawden
Anicet A. Beauvais
*Dennis J. Bebel
*Bettie A. Bechtel
*John H. Beck
*Richard A. Beck
*Victoria M. Becker
*Deborah L. Beier
Barbara A. Bekins
*James L. Bela
*Susannah E. Belding
*Ellin Beltz
*Bryan E. Bemis
*Karen G. Bemis
*Lisa M. Benner
*Steven W. Bennett
*J. Bret Bennington
*Sonja L. Benson
Sandra R. Benz
*Amy C. Berger
*Katherine J. Bergk
*Bryan J. Bergmann
*Sandra Bezenek
*Budhendra Lal Bhaduri
*Karen L. Bice
*Damon P. Bickerstaff
Paul Bigelow
*Thomas H. Biggs
Roger G. Bilham
*Frank D. Bilotti
*David A. Bird
*Peter Birkle
Martin Bizzarro
James D. Black
Oliver F. Blein
*Troy A. Blodgett
*Katherine W. Bock
*Brian E. Bodenbender
*Andrew F. Boettcher
*Stefan S. Boettcher
*Irene B. Boland
James R. Boles
*Alison J. Bolton
*Mark Bordelon
*Gilles Borel
*Pamela F. Borne
*Howell Bosbyshell
*Rita M. Bouchard
Joanne Bourgeois

*Nancy E. Bowers
Phillip F. Brease
*William D. Briggs
*Benjamin A. Brooks
*Yvette M. Broussal
*Katherine E. Brown
*Leslie H. Brown
*MaryAnne Brown
*Keith A. Brunstad
*Frank R. Brunton
Debra S. Bryan
*Daniel L. Bryant
George F. Bryant
*J. Daniel Bryant
*Julia G. Bryce
*Brenda J. Buck
*Thomas F. Bullard
*Maria E. Bundy
Donald E. Burch
*Roland Burgmann
*Kathleen Burnham
*Bradford R. Burton
Jennifer L. Butch
*Ilya V. Buynevich
*Jinkui Cai
*Anthony J. Caldanaro, Jr.
*Phyllis A. Camilleri
*Dominic A. Cammarota
*David C. Campbell
*Kathleen A. Campbell
*Steven K. Campbell
*Jesus E. Caracuel-Martin
*Alice A. Cardenas
*Anne E. Carey
*Christopher P. Carlson
*Danielle L. Carpenter
*Kenneth Carpenter
Gerardo Carrasco
*Alejandro Carrillo
*Marco D. Carulli
*Tracey E. Cascadden
*Sebastien Castonguay
James M. Castro
*Donald P. Cederquist
*Alan K. Chamberlain
*Yu-Chang Chan
*Jitesh Chanchani
*Remi Charbonneau
*Xiaobing Chen
Xun-Hong Chen
Yue-Gau Chen
Songlin Cheng
*Chang S. Cheong
*Lars C. Cherichetti

*Barbara B. Cheyney
*Jonathan K. Child
*Karen Chin
*Gregory P. Chludzinski
*James S. Chow
*Chris T. Christensen
*Catherine A. Christoffel
Amy B. Church
Jordi Cires
*Michele Claps
*Timothy L. Clarey
*Douglas H. Clark
Kenneth P. Clark
*M. Brooks Clark
Steven J. Clements
John S. G. Clewett
*William C. Clyde
*Tobi H. Cohen
*Mark R. Colberg
*Annette R. Colgan
*Patrick M. Colgan
*DeNeice M. Collerain
*Nancy E. Collins
William J. Collins
*Kevin B. Colson
*Ronald G. Colyer
*Christopher D. Connors
Kurt N. Constenius
*Paolo Conti
*Sandra K. Cook
*Michele L. Cooke
Holly B. Cooper
Patricia A. Cooper
*Michelle M. Corbin
*David I. Cordero
James M. Coulter
*Erich S. Cowgill
*Juliet G. Crider
*Michael S. Cronin
*Giovanni B. Crosta
*Kurt C. Cupp
Janet H. Curran
*Brian S. Currie
*Lisel D. Currie
Patchin C. Curtis
*Janet A. Cushing
*Timothy S. Dalbey
*Deborah A. Dale
*Gwen M. Daley
*Patricia L. Daniel
Albert D. Daniels
Kimberly S. Darrah
Simon D. Davey
*Gregory L. Davis
James A. Davis
*John S. Davis
*Nancye H. Dawers
James E. Day
*Chris S. de Fontaine
*Pamela J. DeGroat
*Jack E. Deibert
*John A. Dembosky, Jr.

*Jane F. Denny
*Steven R. Dent
Thomas G. DeRoo
*David L. Dettman
*Janet E. Dewey
*Paul V. Dickfoss
*Julie J. Dieu
Stephane Digonnet
*Bill S. Dinklage
*David A. Dinter
*Joshua N. Distler
*Tina M. Dochat
*Eron J. Dodak
*Kenneth J. Domanik
*Jovita B. Dominic
*William J. Domoracki
*Daniel Dorritie
Cornelius L. Downey
*Debra L. Doyle
*Michelle T. Drops
*Carl N. Drummond
*Yue Du
*Mark P. Dubois
Mihai N. Ducea
*Genet I. Duke
*Stan P. Dunagan
Thomas C. Dunaway
*Christopher C. Duncan
*David S. Duncan
Bruce Dunkle
*Richard K. Dunn
*Dolores G. Durant
*Soren B. Durr
Tooba Durrani
*Thomas R. Dwyer
*Janet F. Dyson
*Sam Earman
*Carl W. Ebeling
Roger B. Edgecombe
*Dwaine H. Edington
*Jeffery D. Edson
Albert A. Eggers
*Craig M. Ehde
*Peter Eichhubl
Jennifer L. Eigenbrode
*Roger F. Elconin
Ronald C. Eng
Robert D. English
Robert A. Enos
*Tarja M. Eskel
*Richard M. Essex
*Rachel A. Eustice
*David A. Evans
Timothy S. Evans
*Paul M. Evins
*Timothy J. Fagan
*Peter D. Falk
Raymond P. Fallon
Benjamin R. Farrell
*Remi N. Farvacque
Henry M. Fayard, Jr.
*Mostafa Fayek

*Christopher M. Fedo
*Thomas P. Feeney
*John A. Feltman
Kelly L. Fenhaus
Mark F. Fennel
*Allen H. Fetter
*Lynne W. Fielding
*Edward M. Fincke
*Lisa R. Finiol
Robert J. Finley
*Sue A. Finstick
*Christopher D. Finton
*Patricia J. Fleming
Moritz M. Fliedner
*Frederick A. Flint
Benjamin P. Flower
Peter F. Folger
Joseph M. Foronda
Scott E. Foss
*Kendall B. Fountain
*Robert S. Fousek
*Nicole Fraser
*Charles D. Frederick
*Henry C. Fricke
*Samual J. Friedmann
Karl W. Frielinghausen
Ruth M. Fruland
*Calvin J. Frye
Ronald Fuge
*Shannon K. Fulton-Bowers
Antonio Funedda
*Nicoletta Fusi
Lawrence J. Gaber
*Daniel G. Gall
Stephen P. Garabedian
Michael O. Garcia
*Glenn W. Garneau
Mary L. Garner
*Douglas E. Gay
*Carey A. Gazis
*Donald J. Geddes, Jr.
*Carl-Henry Geschwind
Thomas D. Gibbons
Joris M. Gieskes
*Thomas E. Gill
*Carrie E. Gilliam
*Martha S. Gilmore
*Gary M. Gin
Timothy R. Ginn
*Ruben A. Giral
Wade G. Glandt
*Jonathan M. Glen
*Bosiljka Glumac
Laurent Godin
Bruce A. Goetz
Barry S. Goldstein
*Francisco G. Gomez
*Caitlin Gorman
*Matthew C. Goss

New Members
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A speaker ready room equipped with projectors will be available.

EXHIBITS

Exhibit facilities for business, educational, and governmental institutions will be located in the Lila B. Etter Alumni Center building, about one-half block from the Department of Geological Sciences. On-site registration, many of the symposia, the poster sessions, the welcoming party, and the Texas BBQ will be in this building. The space rental rate is $100 ($50 for nonprofit organizations). Exhibitors are encouraged to be set up during the Sunday night welcome party and the Monday night BBQ.

SPECIAL EVENTS

Welcome Party

Various corporate sponsors will host a welcome party on Sunday, March 10, from 7 to 9 p.m. at the Lila B. Etter Alumni Center.

SPECIAL LECTURE: "Viewing the Earth from the Space Shuttle"

W. R. Muehlberger, University of Texas, Austin, will present this one-hour slide-filled lecture at 5 p.m. Monday, March 11. Muehlberger was the Chief Geologist for the Apollo 17 lunar landing and has taught geology to all space shuttle astronauts. This lecture is open to the general public and should be of interest to all science teachers and many nongeologists.

Texas BBQ and Cash Bar

A catered BBQ will be held in the Lila B. Etter Alumni Center building from 6:30 to 8:30 p.m. on Monday, March 11. Tickets must be purchased in advance. A cash bar will be open during the BBQ dinner.

GUEST PROGRAMS

No formal guest program has been arranged. The 350 acre main campus of the University of Texas has numerous cultural facilities, including the two Archer M. Huntington Art Galleries, the Lyndon B. Johnson Presidential Library and Museum, and the Texas Memorial Museum. All of these are a short walk from the conference site. The Texas Capitol Complex, Governor's Mansion, French Legation, Treaty Oak, George Washington Carver Museum, Laguna Gloria Art Museum, O. Henry Museum, Austin Children's Museum, Austin Nature Center, Barton Springs Pool, Zilker Botanical Gardens, and the 10-mile Town Lake Greenbelt are all a short drive from campus. The Austin Convention and Visitors Bureau and the Historic Landmark Commission sponsor a two-hour walking tour of downtown Austin. A guidebook for a geologic walking tour of downtown Austin is also available. The Sixth Street entertainment district offers a great variety of live music and restaurants.

STUDENT PAPERS AND TRAVEL GRANTS

Awards will be presented to the best oral student paper and best student poster at the meeting. Awards will be based on quality of research and effectiveness of presentation. To be eligible, the abstract must list only student authors who are members of the South-Central Section as of January 1, 1996, and must be identified clearly as a student paper. Limited funds for support of travel expenses for students presenting a paper (oral or poster) at the meeting are available from the GSA South-Central Section. For information, contact meeting chair Mark Cloos. Travel-grant requests must be postmarked no later than February 16, 1996.

PREREGISTRATION

Preregistration deadline: February 9, 1996.

Preregistration by mail will be handled by the Geological Society of America Meetings Department, P.O. Box 9140, Boulder, CO 80301-9140. Registration forms will appear in the November 1995 issue of *GSA Today.*

Please take advantage of the lower registration fees and **register by February 9.** Preregistration fees will be $50 for professional GSA members or members of associated societies participating in this meeting, and $15 for GSA student members. For those not affiliated with GSA or the associated societies, preregistration will be $55 for professionals, $20 for students, and $15 for K–12 teachers. On-site registration will be $5 more for professionals and students. Registration will be held on the campus of the University of Texas at Austin.

Field trip participants must register for the meeting.

GSA is committed to making every event at the 1996 South-Central Section Meeting accessible to all people interested in attending. If you have special requirements, such as an interpreter or wheelchair accessibility, there will be space to indicate this on the registration form, or you can call Mark Cloos, (512) 471-4170. If possible, please let us know by February 9.

Abstracts may be purchased with your GSA membership or on-site in the registration area.

OTHER INFORMATION

More detailed information concerning fees and registration, hotel accommodations, field trips, and other activities will appear in the November 1995 issue of *GSA Today* and as part of the GSA South-Central Section *Abstracts with Programs* for 1996. Questions and suggestions should be referred to the general meeting chair, Mark Cloos, Dept. of Geological Sciences, University of Texas, Austin, TX 78712; phone (512) 471-4170; fax 512-471-9425; E-mail: cloos@maestro.geo.utexas.edu. ■

New Members
continued from p. 161

David Gottfried
*Cathy A. Grace
James E. Graham
*Stephen E. Grasby
*David C. Greene
*William S. Greenwood
*Joe D. Gregson
Gregory Griffin
*Peter G. Griffiths
*Lori Juergens Gross
*Matthew J. Grove
Kristelle R. Groves
Lyn M. Gualtieri
*Jose Dioscoro Guardiario
Charles W. Gulick
*Paula A. Gural
*Larry E. Gustafson
Gabriel Gutierrez-Alonso
*David M. Haasl
Rita Haberlin
*David B. Hacker
*James W. Hagadorn
*Ann M. Hagni
*Katharine K. Hakala
*Larry M. Hakes
Gregg A. Hakkila
*Jeffrey R. Hale
*Brenda L. Hall
*Donald L. Hall
*Douglas B. Hall
Robert B. Halley
*Nelson R. Ham
Lisa B. Hampton
*John M. Hanchar
Bruce A. Handel
*Michael J. Handke
David A. Handwerger
*Robyn E. Hannigan
*Andrew D. Hanson
Kirt L. Hanson
*John P. Hanzas, Jr.
*Alexandre G. Haralampiev
Norman E. Hardy
*Mustafa M. M. Hariri
*Daniel E. Harlov
*Richard W. Harper
*John P. Harris
*Michael S. Harris
Sara E. Hartness
*Erik W. Harvey
*Forrest E. Harvey
*Judith K. Haschenburger
Carl T. Haselman
*George M. Hathaway
*Michael Hauck
*Kay C. Havenor
*James E. Hay
Henry P. Heasler
*Christopher A. Hedlund
Ernst Hegner
*Cherylyn E. Heikoop
*Lisa A. Heizer
Matthew T. Heizler
*Patricia E. Helland
*Catherine M. Helm
*Frances A. Herlity
*Julie D. Herman
*Stephen W. Herman
*Eileen A. Herrstrom
Francisco Hervé
*Niko Herzog
*Eric Hiatt
*Barry J. Hibbs
*Christi A. Hill
*Ginger H. Hinchman
John E. Hiner
*Marc J. Hinton
*Nei-Che Ho
Charles E. Hoelzer
*Steven M. Hoffman
*Phillip J. Hogan
*Diana J. Holford
*Kimberly S. Holland
*JoAnn M. Holloway
*Ann E. Holmes
Joe H. Honea
Emilie E. Hooft
*Donald M. Hooper
*Karin A. Hoover
*Thomas S. Hooyer
Emily E. Hopkins
*James F. Hopper
*Bryce W. Hoppie
*R. Forrest Hopson
*Edward R. Hornibrook
*Robert R. Horning
*Brian K. Horton
*Patrick R. Houle
*P. Kyle House
*Bernard A. Housen
Steven A. Hovan
*Blythe L. Hoyle
*Jean C. Hsieh
Ethan C. Hudson
*Richard O. Hughes III
*Simon R. Hughes
*Christina L. Hulbe
Marc F. Hult
*Lynn Hultgrien
*Michael L. Hulver
*Munir Humayun
*Christopher C. Humphrey
*Dominik Hungerbuhler
*Lewis E. Hunter
*Janet V. Hurley
Kenneth J. Hurst
*Mark T. Hutchison
*Frederick E. Hutson
Rebecca L. Hylland
*Jonathan P. Icenhower
*Linda C. Ivany
*Andrew H. Ivester
*Joanne Jackson
*Peter M. Jacobs
Elizabeth Jacobson
Roger L. Jacobson
Paul C. Jahn
*Jacek Jaminski
*Hyung R. Jo
*Gary G. Johannson
*Annika K. Johansson
*Suku J. John
*Mary K. Johns
*Jenda A. Johnson
*Thomas M. Johnson
*Dennis H. Johnston
*J. Amanda Jones
*Lawrence S. Jones
*Andrew B. Judd
*Steven D. Kadel
*Linda C. Kah
*Leslie M. Kahn
*Sharon L. Kanfoush
*Michael R. Kaplan
*Jonathan D. Karr
*Nancy L. Katyl
Farro Kaveh
Darryn T. Kaymen
*Susan T. Keddie
John B. Keene
*Randall A. Keller
*Michael S. Kelley
*Joseph C. Kelly
*Rachel M. Kelsey
*Tom K. Kelty
Martin J. Kennedy
Sean G. Kennedy
Annie Kersting
*Md. Khalequzzaman
*Nicholas B. Kidd
*Diann S. Kiesel
*Todd R. Kincaid
*Penelope L. King
*Eric Kirby
*Gerd Kirchner
*Paul D. Kirk
Michael D. Kitko
Shoichi Kiyokawa
James E. Klemaszewski
John P. Kmiec
*Robert B. Knowles
*Stephen C. Knowles
*Kevin W. Koepenick
*Doris J. Kovanen
*Marianne Kozuch
*Cynthia L. Kramer
*Haralambos D. Kranis
*Marilyn D.
Kressel-Wegweiser
*Joseph R. Krieg
*Tim J. Kroeger
Roy C. Kroll
Joel Kronfeld
Harold W. Krueger
Joseph M. Kruger
Karla E. Kuebler
*Gerald J. Kuecher
*Stephen C. Kuehn
Jeffrey A. Kuhn
Peter A. Kukla
*Thomas R. Kulp
*Takashi Kumamoto
James S. Kwasny
*Ohmyoung Kwon
*Jean Y. Labbee
*Sylvain Lacroix
*Katherine M. Laddish
*Douglas W. LaFarge
*Peter C. LaFemina
*I. Marianne Lagerklint
Michelle N. Lamberson
Michael W. Lambert
*Lewis A. Land
Leonard J. Lane
*Andreas Lang
Holly Langrock
*Daniel Larsen
Patrick L. Larsen
*Phillip C. Larson
*Debra S. Laudermilch
*Laura M. Lawson
Gary A. Leaf
Michael J. Leary
*Hermann Lebit
*Scott A. Lecce
*Michael A. LeClair
Maria C. Ledesma
*Kyung-Ho Lee
*Steven E. Lee
*Young-Joon Lee
*Mary L. Leech
*Joseph F. Leising
*Edward F. Lener
John C. Lennon
Timothy D. Lentz
*Stephen A. Leslie
*Janet A. Leventhal
*Daniel R. Levish
*Richard H. Levy
*David S. Lewis
Jiang Li
*Li Li
*Olav B. Lian
*Johan Liebens
*Alyson Lighthart
Tsung-Yi Lin
*Jennifer Lindline
*Andrea Lini
*Jonathan K. Linn
Richard F. Livaccari
*Stephen A. Lohse
*William T. Long
*Caroline LoVetere
John S. Lowther
*Francesca Lozar
Li Ma
*David F. MacConnell
*Tyler MacCready
A. James Macdonald
Steven D. Machemer
*Steve E. Macias
*Mary E. MacKay
*Mary Ann Madej
*Todd D. Maguire
*Ravidya N. Maharaj
*Susan V. Maharaj
Keith I. Mahon
*James B. Mahoney
Otis C. Malcom III
*David J. Mallinson
*Natalia Malyk-Selivanova
*Manish A. Mamtani
*Thomas M. Marchitto
*Jonathan A. Marcus
Douglas C. Marcy
*Vanadis M. Mares
Lise D. Maring
*Michelle J. Markley
*John C. Mars
*Francisca C. Martinez-Ruiz
*Daniel R. Martinioni
*Barbara M. Martiny
*Diane Loftus Mas
Russlyn A. Mason
*Christina G. Massell
Maria Mastalerz
John P. Masterson
Kristina Kirkyla Masterson
*Giuseppina Mattietti-Kysar
Friedrich Mauthe
*Kyle R. Mayborn
*Helmut Mayer
*Jason D. Mayfield
Joseph P. McBride
*Carey L. McCaffree
*Tom E. McCandless
Katherine McCarville
*Richard G. McClean
*Vicki S. McConnell
Clifford R. McCrary III
Patricia A. McCrory
*Jason T. McCuistion
*David W. McDonald
*Susan K. McDonald
*Barbara A. McGavern
*Patrick J. McGovern, Jr.
*Joe R. McHam
Roberta McIntyre
David S. McKay
*Thomas E. McKenna
*Rose McKenney
*Brett T. McLaurin
R. Dennis McLerran
*Lisa C. McNeill
*Brendan A. McNulty
*Melanie L. McQuinn
*Christopher A. McRoberts
*Douglas E. McVey
James D. Means
*Edmund W. Medley
Andrew L. Mehlhop
*Lucy Chambers Meigs
*Erik B. Melchiorre
*Ricardo N. Melchor
Avila G. Mendoza
Robert S. Merkel
*Cheryl L. Metz
*Ronald A. Metzger
*M. Ellen S. Meurer
*Tom Meuzelaar
Karen D. Meyers
*Richard A. Meyers
Barbara L. Mieras
*Mark J. Mihalasky
Mitchell G. Mihalynuk
*Horng-Sheng Mii
William J. Mikalik
*Elizabeth J. Miksa
*Adele Militello
*David W. Millen
*Carol Linn Miller
*Donald D. Miller
*Nathaniel R. Miller
Thomas E. Miller
*Gwendolyn C. Miner
*David R. Minor
Roberto S. Molina-Garza
*Lea B. Monaghan
*Connie L. Mongold
*Douglas E. Monrad
*Camilo Montes
*Laura J. Moore
*Nancy C. Moore
*Jean E. Moran
*Sven S. Morgan
*Shirley A. Morikawa
Paul J. Morin
*George A. Morris
Scott E. Morrison
*Lisa S. Morrow
*Lee H. Morse
*P. Graham Mortyn
*David E. Mostoller
Maria C. Moya
*Wolfgang Mueller
Biswajit Mukhopadhyay
*Malay Mukul
*Maureen A. Muldoon
*Barbara J. Munn
Mercedes A. Murillo
*John E. Murnane
*Paul C. Murphey
Ellyn M. Murphy
*Allen B. Murray
Gregory T. Murray
*Valerie M. Murray
*Elizabeth A. Nagy
*Gregory D. Nash
Boris A. Natalin
*Jon L. Nauert
Philip H. Nelson
*Hans C. Neve
*Virginia Anne Newbern
*Egide Nizeyimana
*Paula J. Noble
*Tatsuya Nojima
Scott W. Norcross
Maura S. O'Brien
Sakae O'Hara
Michael J. O'Neill
Claire O. Obordo
*Eric A. Oches
*David W. Oldham
*Carol J. Ormand
Christian D. Osgood
Soichi Osozawa
*Ewa A. Ossowska
*Gregory J. Overtoom
*Pamela R. Owen
*Felix R. Oyarzabal
*Dorothy K. Pak
*William C. Parcell
*Beth L. Parker
*Brian S. Parsons
*Alex L. Pataray
*Lina C. Patino
*Regan L. Patton
Gene J. Paull
*Bruce D. Pauly
Neil A. Pearce
Nicholas J. Pearce
*John A. Peck
*Joel L. Pederson
*Jane N. Pedrick
*Alyssa M.
Peleo-Alampay
*Waldo A. Perez
William T. Perkins
*James J. Peterson
*Preston L. Phillips, Jr.
*Randy S. Phillips
*William M. Phillips
*James C. Pickens
*Scott H. Pike
*Mary E. Pirkl
*Robert K. Podgorney
Colin D. Poellot
*Franck Poitrasson
Barry M. Pollack
Michael M. Pollock
Stephen M. Pompea
*Michael C. Pope
Donald R. Porcelli
*Donna Ann Porter
*Andre Potochnik
*Lee S. Potter
George E. Prater
*Shari J. Preece
*Henry S. Prellwitz
*David E. Price
Linda F. Prosperie
William A. Prothero
*Aurora Pun
*Mazhar Qayyum
*Michael J. Quinn
Meinert K. Rahn
*Jahandar Ramezani Namin
Bryant R. Ramirez
*Frank C. Ramos
Larry B. Randall
*Eugene C. Rankey
Mohammad I. Rasool
*Kent Ratajeski
John P. Rau
Leigh A. Readdy
*Carolyn R. Rebbert
*Robert R. Rector
Patricia L. Reed
*Robert M. Reed
Timothy A. Reed
*Peter W. Reiners
*Ella Reinhard
Mary Ann Reinhart
*David W. Reinhold
Ted R. Repaksy
*Phillip G. Resor
Rene S. Revuelta-Lopez
Patrick H. Reynolds
*Robert W. Reynolds
Armando T. Ricci, Jr.
Alexis Richardson
*Dale L. Ridge
*Rosanna Ridings
*Peter E. Riemersma
Colleen M. Riley
John A. Riley
*Ulrich P. Riller
*Bianca Rimoldi
*Bethany D. Rinard
*Richard M. Risek
*Bradley D. Ritts
*Sergio A. Rivera
*Anthony M. Rizzuti
Keith E. Roberson
*George B. Roberts
*Sheila M. Roberts
Richard E. Robertson
*Dawn M. Robinson
Douglas Robinson
*Ruth A. Robinson
Jose A. Rodriguez
*Lois J. Roe
*Steven Roof
*Gregory T. Roselle
*Elizabeth Rosenberg
*Nan A. Rosenbloom
*Malcolm I. Ross
*Timothy M. Ross
Tina Roth
*Harold D. Rowe
*Jeffrey N. Rubin
*Roland M. Rueber
*Peter E. Rumelhart
*Garry L. Running IV
Michael S. Ruth
*Sandra L. Rutherford
*Woo H. Ryang
Michel Saint Blanquat
*David B. Saja
*Adel M. Saleh
*Isabel Sanchez
*Apostolos E. Sarris
Hiroshi Sato
*Dorothy A. Satterfield
*Bonnie L. Saubert
*Peter E. Sauer
David M. Sayre
*Mary Jo Schabel
*Frauke Schafer
A. L. Schafer-Perini
*Stephen A. Schellenberg
Robert A. Schincariol
*Eric W. Schinsing
*MaryAnn B. Schlegel
*Bennetta L. Schmidt
*Keegan L. Schmidt
*David A. Schneider
Jay A. Schneider
*Kenneth M. Schopf
*Ronald C. Schott
*Madeline E. Schreiber
Dottie Schroder
*Kathleen J. Schuh
*Scott D. Schulhof
*Mark F. Schult
*Mitchell D. Schulte
*Michael Schulz
Brandon E. Schwab
*Albrecht J. Schwalm
*Reed A. Schwimmer
C. Michael Scullin
*Dogan Seber
Jonathan B. Seckinger
*Mark S. Servilla
David K. Sessoms
*Michael J. Seybold
*Abbas Seyedolali
*Saxon E. Sharpe
*Susan Calder Shaw
*Amy Sheldon
*Michael K. Shepard
Judith M. Sheridan
*Anne G. Sherman
Alan M. Shiller
*Stephanie Shipp
James T. Shiroma
*Shahe Shnorhokian
*Tom Shoberg
*Christine M. Shriner
Jennifer L. Shriver
Robert S. Shuris
*Robert N. Sickler
*Robert R. Sickler
*Andrew A. Sicree
*Roger G. Sigler
*William J. Sims
Naomi J. Sinor
Fernando P. Siringan
*Chris Sladek
*William Slattery
David L. Slayter
*Michael P. Sleeman
*Suzanne M. Smaglik
*Kathy Fraracci Smart
*Kevin J. Smart
*Mark G. Smelser
*Chad A. Smith
*Christine H. Smith
*Debra L. C. Smith
Jennifer S. Smith
*Julia K. Smith
*Leslie Turrini Smith
*Loren H. Smith
*Scott D. Smith
*Scott G. Smith
*Susan E. Smith
*Hilde Snoeckx
*Jeffrey A. Snyder
*Ed R. Sobel
*Josef A. Sobieraj
*Linda E. Sohl
*Josep M. Soler
*Lillian Soto-Cordero
*Giacomo Spadini
*Robert P. Speijer
Cyronose D. Spicer, Sr.
*Abraham E. Springer
Tisha C. Springer
Robert F. Stallard
*John-Mark G. Staude
*William L. Stefanov
*Michael Steinmann
*Libby A. Stern
*Sharon M. Stern
Ellen M. Stevens
*John P. Stimac
*Jonathan D. Stock
*Eric C. Straffin
*William H. Straight
David V. Strand
*Martin J. Streck
*Uwe Strecker
*Corey B. Stricker
*Arjen P. Stroeven
Edward A. Sudicky
*Michael P. Suess
*Marilyn W. Sullivan
*Rebecca J. Suman
*Aviva J. Sussman
*Brian J. Swanson
*Donald S. Sweetkind
*Sondra L. Swenson
*Christopher S. Swezey
*Michael P. Sykes
*Naoko Tachibana
*Gary E. Tackman
*Emi Tamada
John A. Tarduno
*Gabor Tari
*Ann M. Tattersall
*David A. Taylor
*Elizabeth K. Taylor
*James Z. Taylor
*Friedrich Teichmann
*Jeffrey H. Templeton
Uri S. ten Brink
*Frank J. Tepley III
*Jane L. Teranes
*David A. Terry
*Dennis O. Terry, Jr.
*William E. Theodore
Robert D. Theriault
*Donald M. Thieme
*Paul A. Thomas
*Robert C. Thomas
*Kay D. Thompson
Stephen D. Thorne
*William H. Thornton
Donald C. Thorstenson
*Anahita A. Tikku
*Basil Tikoff
*Martin J. Timmerman
*Kenneth J. Tobin
*Robert L. Tolliver
*Paul B. Tomascak
*David J. Topping
Thomas Torgersen
*Raymond Torres
*Mary K. Tozer
*Carol J. Treadwell
Matthew Tremblay
*MerriLisa Trigilio
Jeffrey M. Trop
*Charles H. Trupe III
*Dale M. Tshudy
*Annette B. Tucker
*Slawomir M. Tulaczyk
*Elizabeth C. Turner
Mark D. Uhen
*Ruben D. Uribe
Ricardo A. Valls
*Pablo Valverde
David R. Van Alstine
*Marcus R. Van Baalen
*Peter K. Van De Water
*Pieter A. Van Der Beek
*Sytze van Heteren
Peter Van Valkenburg
*Henrita H.
Van Wyngaarden
*Mark R. Varney
*Roderick W. Vasek
*Laura M. Vaugeois
Wendre R. Vaughan
Adam Vecsei
Francisco J. Vega
*George Veni
*Tomaz J. Verbic
*Jan M. Vermilye
*Kirk R. Vincent
*Ronald Voelkel
*James J. Vogl
*David H. Voorhees
Eric T. Vosburgh
H. Niklaus Waber
Femke A. Wallien
Michael D. Waltz
Alain Wang
*Saiwei Wang
Yutian Wang

New Members
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New Members
continued from p. 162

Larry G. Ward
*Jon H. Warner
*Andrew C. Warnock
*Robert B. Watts
*Tamie R. Weaver
Dennis D. Weber
*MaryBeth Wegner
Wes C. Wehr
*Anne I. Weil
*Richard J. Weiland
*Steven P. Welter
*Andrea M. West White
*Kelly A. West
*Thomas E. West
*Laura Reiser Wetzel
Christopher W. Wheeler
Jill A. Wheeler
William A. White
*Jennifer A. Whitebread
*Julia L. Whitelaw
*Carla M. Whittington
Thomas M. Whitworth
*Thomas I. Wilch
*Peter D. Wilf
*Kurt M. Wilkie
*Rick T. Wilkin
*Clark E. Wilkinson
*Christopher P. Williams
*Curtis J. Williams
*David A. Williams
Paul D. Williams
*Steven K. Williams
*Wendi J. W. Williams
*Kathleen Williamson
*Max T. Wills
*Stewart Wills
*Eric Wilson
*Gary S. Wilson
*Pamela A. Winsky
*Robert K. Witbaard
*Russell R. Wolff
*David J. Wood
*Patricia A. Wood
Carla R. Woodworth
*Gregory L. Wortman
Sandra Wyld
*Ida J. Wylie
*Margaret M. Yacobucci
Leslie Yale
Satoshi Yamakita
*R. Aileen Yingst
Fumio Yoshida
*Amgad I. Younes
*Robert S. Young
Scott S. Young
*Michaela N. Young-Mitchell
*George H. Yu
*Roberta H. Yuhas
*J. Douglas Yule
*Judith A. Zachariasen
*Marc D. Zamkotowicz
Ronghua Zhang
*Yang Zhang
*Youcheng Zhang
*Barbara J. Ziegler
Ronald P. Zurawski ■

New GSA Fellows

The following 108 Members were advanced to Fellowship during the months of March 1995 and May 1995.

John B. Anderson
Mary J. Baedecker
Richard C. Berg
Bruce A. Blackerby
Bonnie A. Blackwell
Robert W. Blair, Jr.
Theodore J. Bornhorst
Dennis Burke
Cathy J. Busby
Robert M. Bustin
Philip A. Candela
Marjorie A. Chan
Sankar Chatterjee
Edward H. Chown
James Channing Cole
Robert G. Corbett
Richard Corfield
Ben B. Curry
Peter P. David
Fletcher G. Driscoll
Robert M. Easton
Stewart Eldridge
Edward E. Erb, Jr.
Philippe Erdmer
J. Mark Erickson
Robert J. Finley
Leon R. Follmer
Lawrence W. Funkhouser
John F. Gartner
Gary H. Girty
Alexander S. Glover
Enrique Gomez de la Rosa
Jonathan H. Goodwin
James A. Grant
Richard I. Grauch
Stephen A. Hall
William C. Haneberg
Ardith K. Hansel
Tekla A. Harms
Mark T. Harris
Michael D. Harvey
Syed E. Hasan
Richard T. Haworth
James W. Head III
Gregory S. Holden
Lincoln S. Hollister
Timothy B. Holst
Brenda Houser
James Clyde Hower
William J. Iams
Lubomir F. Jansa
H. Paul Johnson
Wolfgang Kalkreuth
Richard A. Kerr
Myrna M. Killey
Michael M. Kimberley
Simon L. Klemperer
Roy Kligfield
Kenneth E. Kolm
Randolph Allan Koski
Robert A. Larson
P. Patrick Leahy
David J. Leveson
Alvis L. Lisenbee
William W. Locke
Sydney B. Lumbers
Ken C. Macdonald
Helaine Walsh Markewich
David M. Miller
James A. Miller
Alan V. Morgan
Michael J. Neilson
James Nicholls
David A. Okaya
Donnie Franklin Parker, Jr.
Wayne A. Pettyjohn
Hans Olaf Pfannkuch
Walter C. Pitman III
Garry M. Quinlan
L. Bruce Railsback
Jeffrey C. Reid
Edward M. Ripley
James B. Risatti
Delfino C. Ruvalcaba
David A. Sawyer
Charles K. Scharnberger
Walter Schmidt
B. Charlotte Schreiber
Laura F. Serpa
Patricia Ann Sheahan
Barbara L. Sherriff
Russell G. Slayback
Walter S. Snyder
Holly J. Stein
Dorothy LaLonde Stout
Mavis Z. Stout
Anthony J. Tankard
Mitsunobu Tatsumoto
Ren A. Thompson
Eileen Van der Flier-Keller
Cees R. van Staal
Bruce R. Wardlaw
Robert H. Washburn
Stephen W. Wheatcraft
Stanley N. Williams
Wendell E. Wilson
Gary R. Winkler
William W. Woessner ■

New GSA Student Associates

The following 591 Student Associates became affiliated with the Society during the period from September 1994 through April 1995.

Rolf E. Aalto
Adrian G. Abraham
Jared D. Abraham
Steven M. Ager
Ali Ahmadi
Jinho Ahn
Abdul R. Al-Bastaki
John V. Alcott
Carmen M. Alex
Gary S. Alkire
Kenneth C. Ames
Mitchell W. Anderson
Savona L. Anderson
Vivian M. Anderson
Karen L. Andrachick
Chilyere N. Anglin
William K. Annable
Ryoyu Arai
Darrin B. Arthur
Suzanne Astle
Patricia I. Autrey
Sara E. Baetens
Stephanie M. Bain
Edward Bakewell
Janet A. Bakker
Paul E. Baldauf
Neil R. Banerjee
Jesse B. Banks
Marcy R. Barbour
Michael K. Barnes
Michelle J. Barnes
Michael S. Barondeau
Philip J. Bart
Michele L. Bartlett
Chase M. Barton
David L. Bates
Kirby W. Bean
Mary A. Beck
William J. Beck
William C. Beckman
Brandon D. Beierle
Anne A. Bell
Noel P. Bell
Andrei Belopolsky
Lori Bennett
Boyd E. Benson
David A. Benson
Kenneth D. Bergenham
David R. Berger
Michael Berger
Laurie Berkowitz
Janet L. Bertog
Deborah Beryfeld
Mairi M. Best
Chuanxue Bi
Karel A. Bielstein
William R. Birge
Ryan K. Bixby
Glenn Bixler
Kathleen M. Blum
Joseph J. Bouchard
Thomas G. Boyd
John H. Bradford
Christian A. Braudrick
Dianne L. Brien
Derek L. Brooks
Tom D. Brooks
Lucinda A. Brothers
Mikael S. Brown
Nathan R. Brown
Carsten Bruan
Michelle L. Bruce
Kevin A. Bryan
Kristine M. Bryan
Gregory A. Buchanan
Daniel J. Buckley
Nancy Buening
John M. Buffington
Nicholas A. Bulloss
Duncan D. Burford
William M. Burns
Gil S. Butler
R. Scott Calhoun
Elizabeth M. Campbell
Lisa M. Campbell
Denny L. Capps
Richard K. Carey
Debra L. Carlo
Jennifer Carr
Maureen Carroll
Steve Carroll
Karen K. Cecil
Sheri L. Chadwick
Frederick I. Chandler
Clinton B. Chase
Yang Chen
Leonard H. Childs III
Ann M. Christensen
William T. Christner, Jr.
Cindy J. Clapp
Erik M. Clapp
Andrew J. Clark
Jenifer D. Clark
Vickie A. Clark
Leon J. Clarke
Elizabeth R. Clay
Timothy N. Clemmer
Troy W. Clinton
Angie F. Coates
M. Ford Cochran
Brian P. Coffey
Michael T. Coffey
Edward A. Colangelo
Dana Cole
Skye W. Cooley
Kerri H. Cope
Martin A. Cortes
Christopher M. Crescini
Lisa K. Crowder
Karen N. Csonka
Allison I. Cubbage
Paolo Custodi
Terri A. D'Elia
Joshua E. Dalton
Kevin M. Danley
James T. Davenport
Thomas C. Davenport
Stacey B. Davis
Steven A. Deanda
William B. Deobald
Brian D. Desmarais
Elisa E. Detels
Frank J. DiGnazio
B. Christopher Dimeo
Mia L. Dittmer
Stewart A. Dixon
Christian M. Dodd
Jennifer A. Domask
Hailiang Dong
Melissa A. Doro
Therese C. Dowdy
Matthew T. Drake
Vicki G. Drake
Phyllis E. Duke
Ken S. Eden
James M. Eidem
Chris L. Eisinger
Jonathan B. Ellingson
Brian D. Elliston
Donna M. Emsley
Erme Enriquez
Brian R. Erickson
Matthew J. Erickson
Jennifer R. Erxleben
Christy L. Everitt
Babu Evssk
Leigh M. Fall
Roberta Farrage
Vera A. Fernandes
Carlos E. Ferro
Patricio Figeredo
Tanja M. Fitzgerald
Julie A. Fitzke
Sheryl A. Fontaine
Brian M. Forest
Robert E. Forsberg
Cherly A. Foster-Curley
David Francis
Tracy D. Frank
Jessica L. Fridrich
Diane S. Friend
Robert Frodeman
Christy D. Fuksa
Christian P. Gage
Robert R. Gaines
Jacqueline Gallagher
Gary M. Galloway
Shannon S. Garcia
Brenda J. Gasch
Jon P. Gassaway
Adrienne Gaughan
Sarah Gelsanliter
Richard E. Gerber
Christopher N. Gerteisen
Sivajini Gilchrist
Carol Gland
Julie L. Gloss
Victoria G. Goetcheus
David W. Goldsmith
Matthew J. Grabowsky
George W. Grader
Frank M. Graham
Richard F. Graham
Howard L. Grahn
Karen A. Grant
Kory G. Grant
Neal C. Grasso
Shannon L. Greenan
Arthur M. Greene
Mary K. Greene
Todd J. Greene
William J. Greenwood
Nichole J. Gremillion
Russell C. Griebel
Laura L. Griffith
Daniel R. Griffiths
Christopher J. Grimes
William S. Grimes
Eric E. Grossman
Monica M. Gruber
Amelia L. Guianen
Todd M. Gunsher
Saibal Gupta
Christopher K. Gutmann
Betty W. Hadden
Richard M. Halket
Diana P. Hallman
K. Jill Hammond
Jennifer S. Hango
David L. Hanson
Lori M. Hanson
Michael R. Harren
Mary T. Hartman
Brian J. Haug
Carrie D. Hawkins
Darrell W. Hawley
Cynthia L. Hayek
Nicholas W. Hayman
Michael J. Heaney
Sandra Hebert
Lynn M. Hefty
Christopher D. Hemingway
Scott J. Hemingway
Wayne G. Henderson
Thorston W. Henrich
Michael J. Hewitt
Karen S. Hicks
Katrina M. Higgins
Pennilyn Higgins
Sean M. Higgins
Jeffrey R. Hightower
Margaret M. Hiza
Joanna M. Hobson
David L. Hoffman
James F. Hogan
Brook L. Holcombe
Steven M. Holdaway
Joshua W. Holloman
Chris E. Holmden
Kimberly A. Hoy
Trent D. Hubbard
Gordon S. Hull
Jill D. Hunter
Michele L. Huppert
Kristin T. Huysken
Hector Ibarra
Emily L. Inkpen
Jennifer L. Jacob
Jack J. Jansons
D. Erik Janzen
Carlos Jaramillo
Ben C. Jastram
Christopher M. Jengo
Aron D. Johnson
Beth L. Johnson
Christopher M. Johnston
Christopher L. Jones
Steven J. Jusczuk
Julius H. Kahn
Ayako Kameda
Jeong-Won Kang
Helena Karam
Susan Katz
Yvonne A. Katzenstein
Rendy Keaten
Clay R. Kelleher
Jacob Kelly
Oliver K. Kenen
Charles R. Kerton
Michael W. Kerwin
Jonathan T. King
Larry A. Kirkpatrick
Cynthia E. Kissler
Deborah A. Kliza
Catherine Koehler-Cote
Michael S. Kovach
Andrew L. Kozlowski
Scott F. Kreitz
Jeffrey M. Krempasky
Robin E. Kromm
Bruce A. Krug
Jennifer M. Kuehn
Andrika J. Kuhle
Aaron J. Kullman
Jacob A. Kunz
Kim Kutawski
Dwight D. Lamb
Gary M. Lambert
Renee D. Lamoreaux
Michelle M. Lange
Natalie Y. Langley
Charity C. Larson
Daniel J. Larson
Michelle S. Larson
Claudio Latorre
Christopher Laughton
Joanna L. Law
Sean P. Leathem
Brad D. Lee
Cin-Ty A. Lee
Jongman Lee
Martha L. Lee
Andrea Lefever
Lisa M. Leffler
Kathleen J. Lemke
Connie M. Lenhart
Cosmos Lettich
Mary R. Levak-Cohen
Kris A. LeVier
Michael T. Lewchuk
Wen-Hao Li
Viktoras A. Liogys
Xinlan Liu
Brian D. Locke
Darline Lott
Valerie R. Lovan
Michael W. Lowrey
Feng Hu Lu
James J. Luepke
David C. Lund
Wei Luo
Michael P. Mackey
Leah C. MacNeill
Barbara J. Mahler
Sladjana Maksimovic
Scott A. Malcolm
John T. Malone
Khushwant S. Mander
Sten J. Mander
Michael E. Mann
Joseph R. Marcoline
Melissa L. Markell
Donald H. Marshall III
Jennifer P. Martin
Steve L. Martinelli
Peter Martus
Marek Matyasik
Jean A. May-Brett
Sarah E. McCall
Daniel T. McCoy
Brian P. McFarland
Katherine E. McGee
Kim M. McIntosh
Keith A. McKain
Kevin D. McKnight
Sean G. McManus
Matthew C. McMillan
Timothy A. Meckel
Christina P. Medlyn
Lamar Melder
Erwin A. Melis
Brenda A. Melius
Steven J. Memberg
Kristen M. Menking
Yann Merrand
Paula Messina
Greg C. Meszaros
Thomas H. Meyer
Jeffrey K. Miller
Scott R. Miller
Sarah T. Mills
Carrie D. Mitchell
Scott V. Mize
Michael E. Moeller
Stephen J. Mojzsis
Glenn Monahan
Eugene R. Monette, Jr.
Patricia O. Moore
Melaine Moreno
Diana E. Morgan
Judith J. Morlan
Christopher Morton
Robert A. Mullane
Brook R. Mullens
Steppen Murphy
Sandi J. Nash
Wendy E. Naugler
Greg A. Neal
Peter L. Nester
Robyn L. Newell
James T. Newman
Robert D. Newman
Pat H. Nieland
Martin N. Nnaji
Marjorie C. Northrop
Michael E. O'Connell
Yuet-Ling O'Connor
Diane D. O'Connor
Michael L. O'Neal
Brendon S. O'Reilly
Lori A. Oakes-Coyne
Takshi Okunishi
David E. Orr
Shelly A. Orth
Keith M. Ortman
Terrence A. Osier
Jeanette L. Ostergaard
Jozsef Palfy
Christopher L. Palmer
Amy E. Parker
Scott M. Parrish
Mitchell L. Parsons
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CALENDAR

Only new or changed information is now being published in *GSA Today*. A complete listing can be found in the **Geoscience Calendar** section on the Internet: **http://www.aescon.com/geosociety/index.html.**

1995 Meetings

October

October 5–7, **60th Annual Field Conference of Pennsylvania Geologists,** Williamsport, Pennsylvania. Information: Field Conference of PA Geologists, P.O. Box 5871, Harrisburg, PA 17110-0871, (717) 787-2379; or J. H. Way, Lock Haven University, Lock Haven, PA 17745-2390, (717) 893-2081, E-mail: jway@eagle.lhup.edu.

November

November 1–4, **Society of Vertebrate Paleontology,** Pittsburgh, Pennsylvania. Information: Mary Ann Schmidt, Carnegie Museum, 4400 Forbes Ave., Pittsburgh, PA 15213, (412) 622-3287, fax 412-622-8837, E-mail: schmidtm@clp2.clpgh.org.

Short-Course Series

The MODFLOW Groundwater Flow Modeling System

October 17-21, 1995

Instructors:
Peter F. Anderson and Robert M. Greenwald
(Geo Trans, Inc.)

This course focuses on the use of the U.S.G.S. Three-Dimensional Finite-Difference Ground-Water Flow Model MODFLOW and its accompanying programs. Lectures on the principles of ground-water flow modeling and the use of MODFLOW will be complemented by hands-on computer sessions during which participants will work through a series of real-world problems.

For more information contact the IGWMC.

international ground water modeling center

igwmc

Colorado School of Mines
Golden, Colorado 80401-1887
Phone: (303) 273-3103
FAX: (303) 384-2037
800-446-9488

1996 Meetings

February

February 9–23, **13th Australian Geological Convention,** Canberra, Australia. Information: 13th AGC, ACTS, GPO Box 2200, Canberra, ACT 2601, Australia, phone 61-6 257 3299, fax 61-6 257 3256, E-mail: ihodgson@agso.gov.au. See also Internet Web URL http://www.agso.au/ (click on Information button).

March

March 4–8, **International Congress on Environment and Climate,** Rome, Italy. Information: Philip Carrion, International Congress on Environment and Climate, OGS, P.O. Box 2011, Opicina (TS), Italy 34016, phone 39-40-2140-203, fax 39-40-327-307, E-mail: carrion@tango.ogs.trieste.it. *(Abstract deadline: October 15, 1995.)*

June

June 9–12, **North American Paleontological Convention,** Washington, D.C. Information: NAPC-96, National Museum of Natural History, Dept. of Paleobiology–MRC 121, Washington, DC 20560. *(Abstract deadline: January 19, 1996.)*

June 10–12, **3rd International Symposium on Environmental Geotechnology,** San Diego, California. Information: Eleanor Nothelfer, Fritz Engineering Laboratory, Lehigh University, Bethlehem, PA 18015, (610) 758-3520, fax 610-758-4522; E-mail: esnø@lehigh.edu.

June 24–27, **International Airborne Remote Sensing Conference and Exhibition,** San Francisco, California. Information: Robert Rogers, ERIM Conferences, Box 134001, Ann Arbor, MI 48113-4001, (313) 994-1200, ext. 3234, fax 313-994-5123; E-mail: raeder@erim.org. See also Internet Web site http://www.erim.org/CONF/.

September

September 22–27, **Third USA/CIS Joint Conference on Environmental Hydrology and Hydrogeology,** Taskent, Uzbekistan. Information: Third USA/CIS Conference, American Institute of Hydrology, 3416 University Ave. SE, Minneapolis, MN 55414-3328. *(Abstract deadline: September 19, 1995.)*

November

November 10–15, **Workshop on Tuffs—Their Properties, Uses, Hydrology, and Resources,** Santa Fe, New Mexico. Information: Grant Heiken, Earth and Environmental Sciences Division, EES-1, Los Alamos National Laboratory, Los Alamos, NM 87545, (505) 667-8477; fax 505-665-3285; E-mail: heiken@lanl.gov.

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Washington Report *continued from p. 157*

c. Superfund, Waste Control and Risk Assessment Subcommittee:
Smith (R—NH), chairman; Lautenberg (D—NJ), ranking member

B. HOUSE:

I. Appropriations Committee:
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a. Energy and Water Development Subcommittee:
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1. DOE (part)
2. DOI (part)
b. Interior Subcommittee:
Regula (R—OH), chairman; Yates (D—IL), ranking member
1. DOI (part)
2. DOE (part)
c. VA, HUD and Independent Agencies Subcommittee:
Lewis (R—CA), chairman; Stokes (D—OH), ranking member
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2. OEQ
3. EPA
4. NASA
5. NSF
6. OSTP

II. Budget Committee:
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III. Commerce Committee:
Bliley (R—VA), chairman; Dingell (D—MI), ranking member
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b. Health and Environment Subcommittee:
Bilirakis (R—FL), chairman; Waxman (D—CA), ranking member

IV. Resources Committee:
Young (R—AK), chairman; Miller (D—CA), ranking member
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b. Fisheries, Wildlife and Oceans Subcommittee:
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2. NOAA
3. EPA research and development
c. Space and Aeronautics Subcommittee:
Sensenbrenner (R—WI), chairman; Hall (D—TX), ranking member
1. International Space Station
2. NASA
3. Earth remote sensing policy
d. Technology Subcommittee:
Morella (R—MD), chairman; Tanner (D—TN), ranking member

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Despite construction of the newer Harbor Expressway to modern seismic-design standards, many of its bridges slipped off their bearings, and one even collapsed (Fig. 9). Almost every expansion joint along the elevated Harbor Expressway was damaged. The heavy damage to the expressway may be partly explained by its location on reclaimed ground. Soil as it liquefied around the bridge columns was unable to resist the lateral rocking motions of the columns of the elevated roadway (Comartin et al., 1995).

Kobe also relies heavily on three major rail lines for ground transportation. As with the expressway system, most of these rail lines are elevated structures. Damage primarily derived from failure of columns that were built to older seismic-design standards.

The collapse of the underground Daikai Railroad Station in western Kobe (see Fig. 2 for location) is the first collapse of an engineered tunnel from seismic shaking ever reported. The station and adjacent tunnel were built in the 1960s by cut-and-cover techniques in stiff sandy silt. Reinforced-concrete columns in the station, which supported the roof of the station and 4.8 m of overlying soil, buckled, causing 1800 m^2 of land to settle in a 90-m-long elongate depression. Maximum settlement was 2.5 m. Collapse was localized above the 17-m-wide underground station and did not extend into the narrower 9-m-wide running tunnels at either end of the station.

Maritime transportation was also disrupted. The Port of Kobe was badly damaged, and no containerized cargo could be loaded or unloaded. Kobe is the largest foreign-trade port in Japan and the third busiest port in the world. The port contains 152 berths, with an aggregate wharf length of 27 km (Fairplay, 1994). It operates 400 dockside gantry cranes and derricks to load and unload cargo. More than 95% of the shipping berths were inoperable after the earthquake. Approximately 24 km of wharf was damaged.

Damage to quay walls, crane-rail systems, and dockside gantry cranes was caused by permanent ground displacement associated with lateral spreading at the margins of the fill (Fig. 10). Quay walls were typically displaced seaward about 1 to 2 m, and a 2–3-m-deep graben formed on the landward side of the wall. Damage to the cranes was caused by differential horizontal displacement between the seaward and landward crane rails. The seaward crane rail at Kobe typically rests on the quay walls, which are of caisson-type construction, and the landward crane rail rests on either a pile-supported wall or engineered fill. Horizontal displacement, which was greatest at the quay wall, pulled the two crane rails apart, distorting the steel moment frames of the cranes.

Approximately 650,000 customers of the Kobe City Waterworks Bureau lost water service. The disruption resulted from more than 4000 leaks in the main distribution lines and more than 20,000 leaks on private lots. Leakage was so massive that the volume of water in the distribution system dwindled from 338,455 to 94,908 m^3 in a single day. Of the 119 water-distribution reservoirs in the system, 57 completely drained within six hours, and 29 more eventually drained dry. A total of 21 of the distribution reservoirs are dual reservoirs with emergency shutoff valves on one of the reservoirs to ensure local sources of water in cases of disaster. Operation of these valves preserved 33,800 m^3 of water.

Figure 9. Nishinomiya Harbor Bridge where an approach span collapsed. Thomas D. O'Rourke of Cornell University stands astride ground crack caused by liquefaction-induced lateral spreading in bridge foundation.

Most of the pipeline breaks were in alluvial-soil areas and were not associated with permanent ground movements. Piping is primarily ductile iron. The piping system on Rokko Island, the newest area of fill, uses locking slip joints to accommodate permanent horizontal ground movement. No leaks in this system were observed.

Restoration of water service, despite outside assistance, was slow. It took 11 days to repair half the leaks, and only 80% of the leaks were repaired within a month. Repairs were hampered by damage to bureau offices. The bureau's headquarters was located on the collapsed sixth floor of the City Hall Annex (Fig. 8), and the two regional offices were either badly damaged or burned.

Sewage collection and treatment facilities were also damaged. The worst damage was to the sewage-treatment facility for Hagashi Nada, the eastern ward of Kobe, which was crippled by the earthquake. Damage forced discharge of chlorinated but otherwise untreated sewage into Osaka Bay. This sewage-treatment facility was built on reclaimed ground. Damage was caused principally by liquefaction-induced settlement and lateral spreading. Buildings and tanks of the facility are supported by piles that extend through the liquefied zone. Settling ranging from 0.5 to 1.0 m severed buried sewer lines where they were connected to the facility's buildings and tanks.

The Osaka Gas Company suspended service to 857,400 natural-gas customers in Kobe four hours after the earthquake after receiving many reports of leaking gas and when the scope of damage and fire hazard became clear. Most of the damage was to the low-pressure distribution system and occurred primarily at screw joints in this steel pipe system. Damage was extensive in both areas of liquefaction and areas without permanent ground deformation. Only about 90 repairs were necessary in the medium-pressure lines, primarily in hilly areas where repair crews reported ground cracking and in liquefaction areas. The two liquified natural-gas terminals and the high-pressure piping system were undamaged. Total losses were approximately $1.9 billion.

Restoration of gas service became a major challenge for Kobe because many residents depend on it for heating and cooking. A month after the earthquake, service had been restored to only about one-third of the gas customers. Restoration was hampered by the numerous leaks in the low-pressure system and inflow of water and soil into the gas pipes. Traffic congestion and road-surface damage also interfered with repair operations.

About 1 million customers were without electrical power immediately after the earthquake. The blackout resulted primarily from shaking damage to 58 substations and 38 transmission lines (77 to 275 kV). Service was also disrupted by damage to about 900 power poles. Six power generation plants were damaged. Damage to power plants, most of which were located on reclaimed ground, resulted from both shaking and permanent ground deformation. Kansai Electric Power Co. estimated its losses at $2.3 billion, of which approximately 10% was attributed to liquefaction.

Restoration of electrical power was rapid. By one and three days after the earthquake, power was restored to 600,000 and 890,000 customers, respectively. Restoration was completed within a week, although some repairs were only temporary.

Figure 10. Damage to Maya Wharf caused by liquefaction-induced lateral spreading. The quay wall moved outward, causing formation of a graben. The seaward rail for gantry cranes is located on the quay wall, and the landward rail is located on a pile-supported wall behind a graben.

CONCLUSIONS

The 1995 Hanshin-Awaji earthquake confirms that even moderate events can cause major property losses when they occur directly within a modern urban area. Although the engineering design practice and construction in Kobe may differ in detail from those in areas of high seismic hazard in the United States, the concentration of damage in structures built to older building codes should be a particular cause for concern in the United States. Each new earthquake provides an opportunity to learn and to improve the seismic provisions of our building codes, but new codes are not retroactive. This situation permits buildings to remain in service that are not resistant to collapse. Kobe confirms that nonconforming older buildings are a substantial part of the earthquake hazard in the urban environment. If we are to reduce earthquake risk in our cities, we must address the problem of nonconforming buildings.

The 1995 earthquake also highlights the need to consider standards for each part of the infrastructure of a city. Urban infrastructure generally is subject to a lifeline-specific rather than a general standard, including specification of the design earthquake or ground shaking. The disabling of the Port of Kobe and the severe disruption to transportation, water, sewer, gas, and power systems demonstrate the need to ensure the integrity of the whole infrastructure. The chain of postearthquake functionality of a city may well rest on its weakest link.

Earthquakes present a challenging geologic hazard because their mitigation raises a complex range of issues that extends well beyond the purview of the earth sciences. In broad outline, however, the lessons from Kobe for the earth sciences are similar to those from the 1994 Northridge and 1989 Loma Prieta, California, earthquakes. Areas that either have a potential for near-source ground shaking or are susceptible to special site effects are at particular risk in earthquakes (Holzer, 1994). Society is more inclined to mitigate earthquake hazards when the geoscientists are able to specify the degree of hazard.

ACKNOWLEDGMENTS

Much of the information summarized here was obtained from briefings presented by Japanese government agencies and private companies. Briefings were conducted under the United States–Japan Natural Resources Protocol. The U.S. team was led by Riley M. Chung, to whom I am grateful for his conscientious effort to pack as much into a day as possible. I am also indebted to Yasuyuki Koga and Yoshio Ninomiya, who guided us through the heights and depths of Kobe. Yoko Takauchi patiently translated many Japanese documents. Robert D. Brown, Jr., and Mehmet Çelebi critically reviewed the manuscript. Emmett Dingel prepared the illustrations.

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GSA SECTION MEETINGS — 1996

Call for Papers

SOUTH-CENTRAL SECTION
March 11–12, 1996
University of Texas, Austin, Texas

Abstract Deadline:
November 20, 1995

Submit completed abstracts to:
William F. Mullican, Bureau of Economic Geology, University of Texas, University Station Box X, Austin, TX 78712, (512) 471-1534, mullicanb@begv.beg.utexas.edu

SOUTHEASTERN SECTION
March 14–15, 1996
Ramada Plaza Hotel, Jackson, Mississippi

Abstract Deadline:
November 15, 1995

Submit completed abstracts to:
Darrel Schmitz, Department of Geosciences, Mississippi State University, P.O. Box 5448, Misssissippi State, MS 39762, (601) 325-2904

NORTHEASTERN SECTION
March 21–23, 1996
Hyatt Regency, Buffalo, New York

Abstract Deadline:
November 20, 1995

Submit completed abstracts to:
Charles E. Mitchell, Department of Geology, SUNY at Buffalo, 876 Natural Science and Mathematics Complex, Buffalo, NY 14260-3050, (716) 645-6800, glgchuck@ubvms.cc.buffalo.edu

ROCKY MOUNTAIN SECTION
April 18–19, 1996
Rapid City Civic Center,
Rapid City South Dakota

Abstract Deadline:
January 5, 1996

Submit completed abstracts to:
Alvis L. Lisenbee, Department of Geology and Geological Engineering, South Dakota School of Mines and Technology, 501 East St. Joseph St., Rapid City, SD 57701-3995, (605) 394-2463

CORDILLERAN SECTION
April 22–24, 1996
Red Lion Hotel at Lloyd Center,
Portland, Oregon

Abstract Deadline:
December 28, 1995

Submit completed abstracts to:
Richard Thoms, Department of Geology, Portland State University
P.O. Box 751, Portland, OR 97207-0751, (503) 725-3379

NORTH-CENTRAL SECTION
May 2–3, 1996
Iowa State University, Ames, Iowa

Abstract Deadline:
January 17, 1996

Submit completed abstracts to:
Kenneth E. Windom, Department of Geological and Atmospheric Sciences, Iowa State University, 253 Science I Building, Ames, IA 50011-3210, (515) 294-2430, kewindom@iastate.edu

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1995 PENROSE CONFERENCES

August
August 22–27, **Fault-related Folding,** Banff, Alberta, Canada. Information: David Anastasio, Department of Earth and Environmental Sciences, Lehigh University, Bethlehem, PA 18015-3188, (610) 758-5117, fax 610-758-3677, E-mail: dja2@lehigh.edu.

August 31–September 4, **Fine-grained Fault Rocks,** Leavenworth, Washington. Information: Jerry F. Magloughlin, Department of Geological Sciences, 1006 C.C. Little Building, University of Michigan, Ann Arbor, MI 48109-1063, (313) 747-0664, fax 313-763-4690, E-mail: jerry.magloughlin@um.cc.umich.edu.

September
September 28–October 3, **Tectonic Development of the Canada Basin and Surrounding Regions,** Banff, Alberta, Canada. Information: Lawrence A. Lawver, Institute for Geophysics, University of Texas at Austin, 8701 N. MoPac Expressway, Austin, TX 78759-8397, (512) 471-0433, fax 512-471-0433, E-mail: larry@utig.ig.utexas.edu.

October
October 6–11, **Mesozoic Evolution of the Cordilleran Continental Margin in Central and Southern California,** Tehachapi, California. Information: Andrew Barth, Department of Geology, Indiana/Purdue University, Indianapolis, IN 46202-5132, (317) 274-1243, E-mail: ibsz100@indyvax.iupui.edu.

October 14–20, **The Argentine Precordillera: A Laurentian Terrane?,** San Juan, Argentina. Information: Ian W. D. Dalziel, Institute for Geophysics, University of Texas at Austin, 8701 N. Mopac Expy., Austin, TX 78759-8397, (512) 471-0341, fax 512-471-8844, E-mail: ian@utig.ig.utexas.edu. ■

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November 6–9
Ernest N. Morial Convention Center,
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Technical Program Schedule: *September* GSA Today

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1996

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Colorado Convention Center
Marriott City Center

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Technical Program Chairs: *John D. Humphrey and John E. Warme, Colorado School of Mines*
Call for Field Trip Proposals: *Please contact the Field Trip Chairs listed below.*
Charles L. Pillmore, Ren A. Thompson
U.S. Geological Survey, MS 913, P.O. Box 25046
Denver Federal Center, Denver, CO 80225
phones: Charles L. Pillmore, (303) 236-1240;
Ren A. Thompson (303) 236-0929

THEME FOR 1996 ANNUAL MEETING

The scientific theme for the 1996 Annual Meeting is "Earth System Summit." As with past themes, this one has several meanings. In particular, we wish to emphasize that Earth is a complete system whose processes are complexly interrelated at a variety of scales. Second, the theme emphasizes that we are all inhabitants of this complex system; our actions can have significant impact—or be impacted by—its dynamic behavior. Theme sessions and symposia will be offered on aspects of multidisciplinary integrated studies of the Earth System, with special emphasis on the Rocky Mountain, High Plains, and Western Interior regions. We are, therefore, soliciting symposia and theme topics and field-trip proposals that will integrate a variety of disciplines around a broad topic. We envision a coupling of symposia-theme sessions and field trips, in which pre- or postmeeting field trips complement technical sessions presented during the meeting. Examples of such synergy might be "The Yellowstone Volcanic System," "The Rio Grande Rift System," or "The San Luis Valley Hydrologic System."

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Proposals must be received by December 1, 1995. Selection of courses for 1996 will be made by February 1, 1996. For those planning ahead, we will also consider courses for 1997 at that time.

For proposal guidelines or information, contact:
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Continuing Education Coordinator,GSA headquarters
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FUTURE

Denver	October 28–31	1996
Salt Lake City	October 20–23	1997
Toronto	October 26–29	1998
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INDIANA UNIVERSITY, BLOOMINGTON

The Department of Geological Sciences at Indiana University, Bloomington, invites applications for a tenure-track assistant professorship in geobiology starting August, 1996. Research areas of particular interest include biodiversity, global change, paleoceanography, paleoclimatology, and evolutionary history. Candidates should have demonstrable potential as an effective teacher and as a research scientist capable of developing an externally funded research program.

Applicants should submit a vita, summary of interests in research and teaching, and names and addresses (including phone, fax, and e-mail) of three referees by 15 October to the Geobiology Search Committee, Department of Geological Sciences, Indiana University, Bloomington, IN 47405-1403; (812) 855-5581; fax: (812) 855-7899; e-mail: dodd@indiana.edu.

Indiana University is an equal-opportunity, affirmative-action employer. Women and minorities are encouraged to apply.

RESEARCH PROGRAMMER
UNIVERSITY OF ILLINOIS, URBANA-CHAMPAIGN

The Department of Geology seeks to fill a regular full-time position of Research Programmer. The successful candidate will have the responsibility of administering the workstations and microcomputers in the Department; assisting in the maintenance of the Geology Computing Network; and maintaining the Geology WWW site. He/she will also assist in developing teaching software for Geology courses, especially at the introductory level; developing tools for teaching and research in geosciences; assisting in the preparation of proposals to upgrade and maintain the Geology Computing Facility; and conducting training for faculty, staff, and students as needs arise.

A B.S. degree in science or engineering with experience in computer and network administration and data retrieval through the World Wide Web is required. Candidates with a background in geosciences are preferred. Preference will be given to candidates knowledgeable in the following computer languages: UNIX scripts, C++ or C, FORTRAN and HTML. Having an extensive experience in using various graphic packages will be an advantage.

The appointment will be a renewable, 12-month academic professional position. The estimated starting date is October 21, 1995. Salary is commensurate with qualifications and experience.

To ensure full consideration, applicants should send a résumé and the names of three references to: Peter A. Michalove, Department of Geology, University of Illinois, 1301 West Green Street, Urbana, IL 61801; (217) 244-3190; fax (217) 244-4996; e-mail: peterm@hercules.geology.uiuc.edu before September 30, 1995.

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THE WIENER LABORATORY
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DIRECTOR

Applications are invited for the position of Director of The Wiener Laboratory of the American School of Classical Studies at Athens, Greece. Applicants should have an area of expertise in one of the primary areas of the Lab's research programs (geoarchaeology, human skeletal analysis, zooarchaeology) with an established publication record and demonstrated administrative and fund-raising abilities.A strong background in natural science, experience in collaborating with archaeological and Classical scholars, and a commitment to Aegean archaeology is desired. Under the supervision of the Director of the School, the Director of the Lab is responsible for developing and administering the research and workshop programs, collections, and facilities of the Lab as well as maintaining and enlarging established networks with other laboratories and institutions. He/she chairs the local administrative committee and an international science advistory committee. Salary ($30,000–$40,000) commensurate with rank and experience; housing allowance; qualified for TIAA/CREF after two years if not previously enrolled. Term: 1 July 1996 to 30 June 1999, eligibility for renewal. Deadline for applications is 15 November 1995. Applicants must include a letter concerning his/her views on the future direction of the Wiener Laboratory, a curriculum vitae, and the names of three references that may be contacted. Application materials should be sent to the search committee chair: Professor George Rapp, Jr., Director, Archaeometry Laboratory, University of Minnesota, Duluth, MN 55812, USA. Phone: (218)726-7629. Fax: 218-726-6979.

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Applicants should contact the Executive Personnel and Development Branch 703-306-0755 (hearing impaired individuals may call 703-306-0189) to request Announcement EP-95-11 for complete qualification requirements and application procedures. Applications must be received by 09/29/95.

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USGS STAFF AVAILABILITY

The Geologic Division of the U.S. Geological Survey is undergoing a reduction-in-force and reorganization that will release a large pool of well trained, experienced, and productive staff including geologists, geophysicists, chemists, computer staff, cartographic and graphics experts, and a variety of administrative and support staff. Released employees will be available for employment in October 1995.

Potential employers are encouraged to contact regional offices of the Geologic Division for information and resumes of available staff beginning September 1, 1995.

Inquiries should be made through:

Assistant Chief Geologist, Eastern Region
U.S. Geological Survey, Mail Stop 953, Reston, VA 22091
703-648-6660

Assistant Chief Geologist, Central Region
U.S. Geological Survey, Mail Stop 911
Box 25046, Federal Center, Denver, CO 80225
303-236-5438

Assistant Chief Geologist, Western Region
U.S. Geological Survey, Mail Stop 919
345 Middlefield Road, Menlo Park, CA 94025
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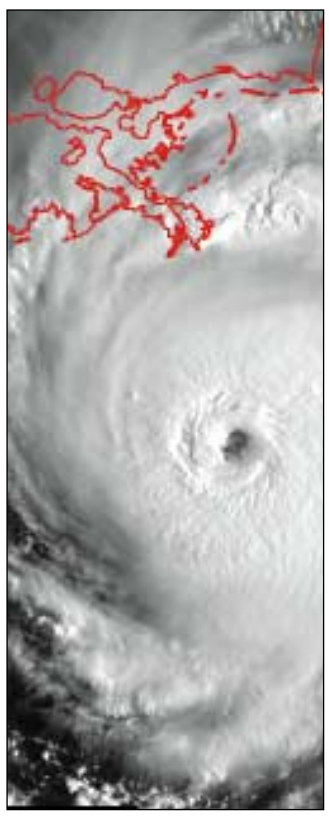

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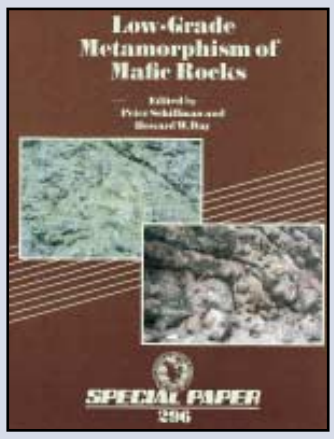

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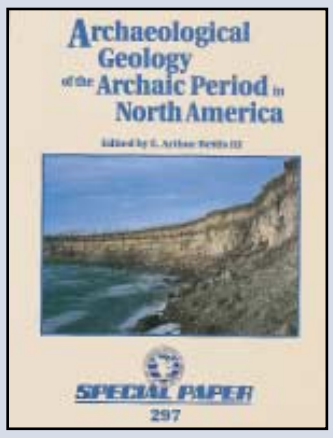

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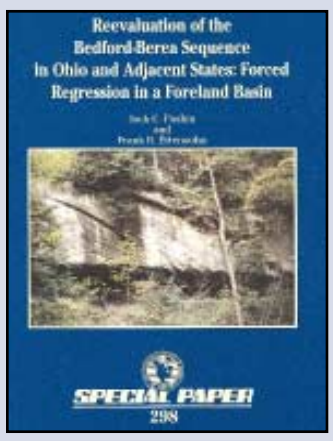

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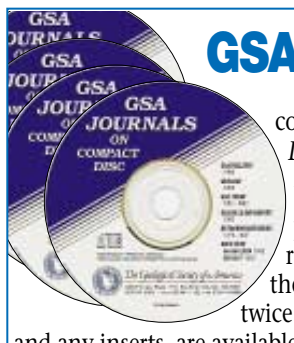

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