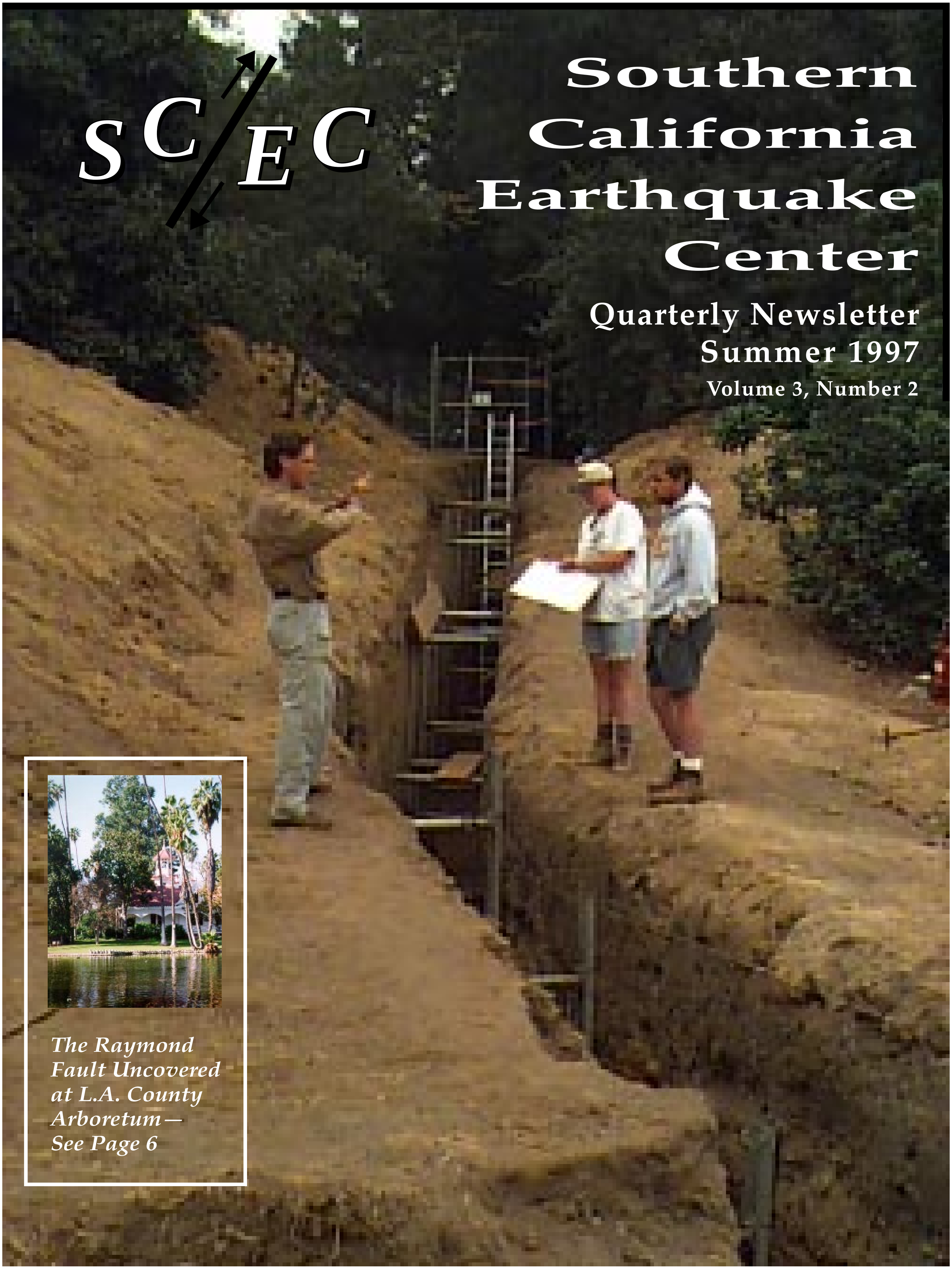


SCEC

Southern California Earthquake Center

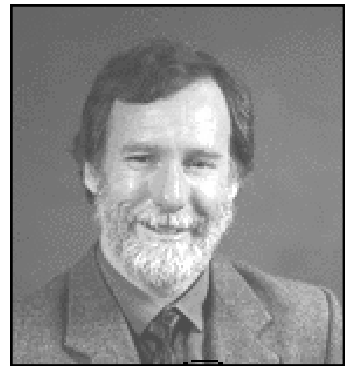
Quarterly Newsletter
Summer 1997
Volume 3, Number 2

The Raymond Fault Uncovered at L.A. County Arboretum— *See Page 6*

From the Center Directors . . .

SCEC Goes International?

Center Director



Science Director

Should we not consider investigating major continental strike-slip and thrust earthquakes elsewhere in the accessible part of the world?

A number of SCEC scientists have discussed the desirability of adding an international component to the Center. They have argued that it would expand our various databases and broaden our intellectual framework. It also might allow us to test some of our models more expeditiously. The downside would seem to be casting our resources more broadly and lessening our focus on southern California. In addition, the "interactive overhead" of the Center would surely increase.

However, there may be profitable ways in which we might expand internationally with only a modest additional expenditure of resources:

First, we could expand our Visitors Program to include, explicitly, the international exchange of scientists, whereby the Center would fund both foreign visitors and travel abroad by some of our own scientists.

Second, we might assess what it would take to develop a first-generation, first-order seismic hazard model for the world, or for some particularly important region of the world. A logical follow-on, perhaps under some form of international funding, would be to develop that model.

Third, and potentially most rewarding, might be to chase certain foreign earthquakes.

Because we may not have another major earthquake in southern California in the next five to ten years and because earthquakes provide quantum leaps in our understanding of fault rupture and seismic hazard, should we not consider investigating major continental strike-slip and thrust earthquakes elsewhere in the accessible part of the world if and when they occur?

If the answer is yes, then the Center should develop a post-earthquake scientific plan just as we should do for earthquakes in our own backyard.

These approaches to the international study of earthquakes, in addition to their scientific return, could significantly expand SCEC's visibility and be an important addition to our knowledge transfer program.

Editor's notes: See international articles in this issue on pages 24 and 27 (Iran and Panama).

We welcome comments from our readers in response to this message, especially scientists who chase foreign earthquakes or conduct studies in foreign countries.

What Is the Southern California Earthquake Center?

The Southern California Earthquake Center (SCEC) actively coordinates research on southern California earthquake hazards and focuses on applying earth sciences to earthquake hazard reduction. Founded in 1991, SCEC is a National Science Foundation (NSF) Science and Technology Center with administrative and program offices located at the University of Southern California. It is co-funded by the United States Geological Survey (USGS). The center also receives funds from the Federal Emergency Management Agency (FEMA) for its Education and Knowledge Transfer programs. The Center's primary objective is to develop a state of the art probabilitistic seismic hazard model for southern California by integrating earth science data. SCEC promotes earthquake hazard reduction by:

- Defining, through research, when and where future damaging earthquakes will occur in southern California
- Calculating the expected ground motions
- Communicating this information to the public

To date, SCEC scientists have focused on the region's earthquake potential. Representing several disciplines in the earth sciences, these scientists are conducting separate but related research projects with results that can be pieced together to provide some answers to questions such as *where* the active faults are, *how often* they slip, and *what size* earthquakes they can be expected to produce. Current work focuses on seismic wave path effects and local site conditions for developing a complete seismic hazard assessment of southern California.

Information: Call 213/740-1560 or e-mail *ScecInfo@usc.edu*

Looking Back and Marching Forward

SCEC's Contributions to Knowledge Transfer

by Jill Andrews

The Knowledge Transfer Program's staff (Mark Benthien, outreach specialist, and Ed Hensley, writer/editor, and I) tackle the task of converting scientific results into more broadly understandable form. We make research socially relevant. We turn information into products.

But that makes it sound more one-way than it really is. Stephen Gould, scientist and social commentator, once said,

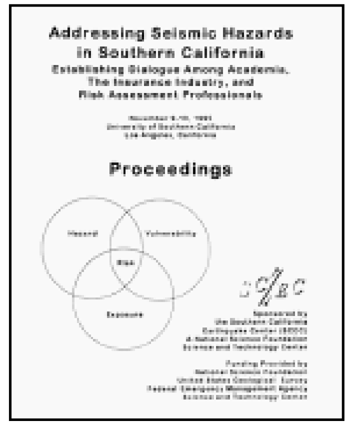
> It is not possible to act like an objective fact-gathering robot, and if we think we can, we're just deluding ourselves, and we're going to be more subject to the prejudices we don't even know we have because we're not scrutinizing them.

Gould was talking about the relationship between science and society. His overall point was that when things are working at their best, the exchange of insight, realization, and understanding flows freely both directions. In fact, in all directions. That, in a nutshell, is what the Knowledge Transfer Program is here for: to open channels and keep ideas flowing.

As Knowledge Transfer Director for the Earthquake Center, I'm often responsible for describing the research conducted by Center scientists and explaining its relevance and applicability. At times, just keeping up with what SCEC's own researchers are doing feels as though we are trying to move a mountain with teaspoons. Since each investigator submits an annual summary of studies in progress, I have access to a great deal of information. That's one of our "mountains." The sheer volume of archived data, technical reports, and research papers in itself requires constant management to keep it organized so that it's available and accessible when needed for any purpose—technical or nontechnical. As for our "spoons": you're reading one, and you're about to hear about others.

Jill Andrews and Mark Benthien

SCEC now enters the second half of its eleven-year life span as a National Science Foundation Science and Technology Center. That means it's time to assess our experience so far. It also means that it's time to plan for the next half of our life. I want to do that for the Knowledge Transfer portion of SCEC here in this article: share some of our accomplishments and our plans.



The SCEC Knowledge Transfer mission is to heighten public awareness and reduce earthquake losses by transferring research results and products to the community at large. To fulfill this mission, we aim to create a transportable program that organizes the ever-growing knowledge bases of academic scientists, engineers, and social scientists and makes sure that their work is applied to reducing earthquake-related risks. We essentially have two target audiences for our products: the community of scientists and technical professionals working in related fields and the general public. In both cases, we aim specifically at our region first, but eventually at the entire world of scientists and the national public.

In preparing for the future, our plan is to identify Knowledge Transfer's most successful and productive outreach efforts and then to make sure we concentrate on what works and make it better. We plan to base all our efforts on the strong foundation we've established, especially our extensive, growing network of partners, contributors, and collaborators. We work in a multidisciplinary, multi-institutional research environment, and we have gained expertise at translating scientific data and information into products and services for technical users and the general public.

How Did We Begin?

Early in the program's history, we convened a group of experts who aided us in identifying appropriate end-users for the Center—our clients. They also helped us establish objectives:

- Initiate and maintain personal contact with research scientists, engineers, social scientists, and end users through meetings, workshops, seminars, and field trips.
- Form mutually beneficial partnerships and alliances.
- Network: exchange ideas and information with other organizations.

Knowledge Transfer **continued.**

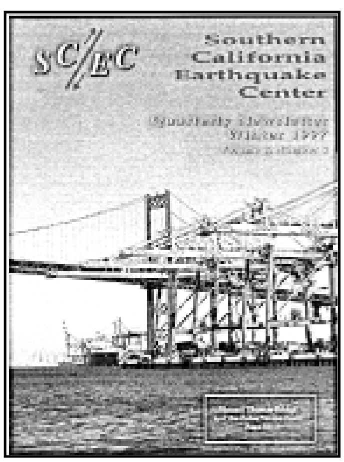
- Disseminate products using multimedia tools and techniques.
- Promote sustainability through development of funding sources.

SCEC's Knowledge Transfer Program has proven to be an effective information broker between the academic community and practitioners, between earth scientists and engineers, and between technical professionals and public officials. As a result, the Center is becoming known for its effective partnerships with local, state, and national government entities, academic institutions, industry, and the media.

What Have We Accomplished?

Before the Knowledge Transfer Program was formally established, Center scientists launched a seminar series in 1992. Building on that model and using the research results presented in the science seminars, the knowledge transfer staff designed workshops for targeted end-users. Since then the Knowledge Transfer Program has been involved in organizing workshops or symposia covering a variety of earth science and engineering topics and benefiting science faculty, post-doctorals, graduate students, and undergraduate students from member institutions and affiliated institutions.

Following the 1994 Northridge earthquake, we cosponsored a public workshop entitled "One Year after Northridge," in partnership with the Governor's Office of Emergency Services. More than 300 scientists, engineers, public officials, disaster preparedness and response officials attended. The workshop was an important focal point for both organizing the research and lessons learned from Northridge and for sharing information about preparing for future earthquakes.



We chose this venue to release the seminal *Phase II Report—Seismic Hazards in Southern California: Probable Earthquakes, 1994-2024* and to conduct a press conference with the principal authors, who explained the significance of the report. The Phase II report generated concern among city and county engineers, building officials, and planners, so we started a series of vulnerability and seismic zonation feasibility workshops. We presented information on the vulnerability of various building types, bridges, and lifelines to over 200 attendees at two major workshops in 1995 and 1996.

Those workshops led directly to a dialogue among structural engineers, civil engineers, geotechnical engineers, building officials, planners, and earth scientists that became the Ground Motion Joint Task Force, a 48-member task force jointly sponsored by the Structural Engineers Association of Southern California (SEAOSC), the California Division of Mines and Geology (CDMG), and SCEC. The task force is studying the types of vulnerable structures common to Los Angeles.

FEMA is funding the production of two booklets to be published in the coming year to make the public aware of the hazards posed by those structures during earthquakes. The task force has already tackled structures such as the ubiquitous tuck-under parking buildings (a well-known example is Northridge Meadows Apartments) and nonductile concrete buildings (e.g., concrete parking structures and some older office buildings). The task force plans to encourage city council members to take action to protect occupants of these types of structures.

We also cosponsored with CDMG the "Zones of Deformation" workshop. Participants represented a cross-section of the geological, engineering, and planning communities. The focus was to provide advice to CDMG about establishing guidelines for the delineation, evaluation, and mitigation of zones of deformation. Three issues were discussed: zoning—identifying and defining the hazard; site-specific hazard investigation; and mitigation.

The California Universities for Research in Earthquake Engineering (CUREe) recently submitted a proposal entitled "Earthquake Hazard Mitigation of Woodframe Construction" to FEMA's Hazard Mitigation Grant Program (Northridge Earthquake). The three-year project will include these components: testing and analysis, field investigations, building codes and standards, economic aspects, and education and outreach. As associate project manager for education and outreach, I will work with CUREe to develop education and training for home owners, apartment building owners, officials, and others.

We also addressed requests from the insurance industry by forming a steering committee that designed insurance vulnerability workshops, focusing on evaluation and upgrading of current methods used by the insurance industry in measuring exposure. The first two workshops, held in 1995 and 1996, were attended by more than 400 representatives from the insurance and reinsurance industries, as well as earth scientists and earthquake engineers. The workshops promote two-way communication and increased understanding of the earthquake threat in southern California. As a next step, we plan a series of small workshops focusing on specific areas of concern to both primary insurers and reinsurers.

New and Innovative Technologies

As with any other effort that involves a high degree of coordination and time-sensitivity, the emergency management community must incorporate new and emerging technologies in order to meet its ever-more-complex responsibilities. New technologies can gather, disseminate, and coordinate better and faster information. We have been involved with our partners in both the public and private sectors to design workshops that promote sharing information between the producers and the users of those technologies. Emergency managers can find out what's out there to make their work more effective, and technology providers can find out what is needed.

We conducted three workshops on geographical information system (GIS) use for scientists, engineers, and government representatives. Topics included comparisons of hardware and software, and data disclaimers. We also cosponsored "Making the Most of New Real-Time Information Technologies in Managing Earthquake Emergencies," a workshop jointly hosted by SCEC, USGS, CDMG, California Emergency Services Association (SCESA), OES, and Caltech. Attendees included 125 emergency management and response personnel and represented business resumption and contingency planners, business and finance communities, public information officers, and local governments.

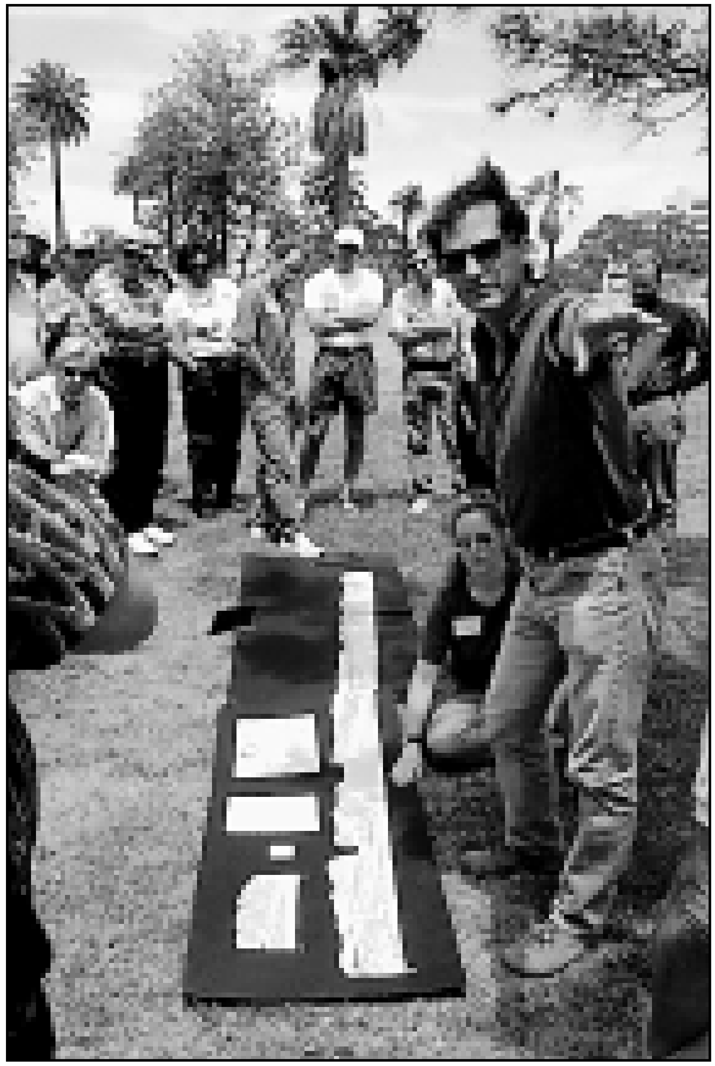
The Internet

The SCEC site on the World Wide Web represents the ongoing research and results from all seven core institutions. It provides links to related web sites, including nine SCEC-supported standard databases. You can learn about our featured products, educational products, and project data. You can link to the 50 institution members of the Earthquake Information Providers (EqIP) group and to many other interesting educational sites. The SCEC site receives about 1,000 hits per month; the SCEC Data Center receives about 100,000 hits per month. If you have access to the Web, visit us at WWW.SCEC.ORG.

Community Education

Our outreach to the general public includes hosting a series of town meetings sponsored by state senators. SCEC provides speakers and materials that address the earthquake hazard, risk assessment, and mitigation steps. Each meeting is tailored with information about protecting the homes and the neighborhood infrastructure of a sponsoring senator's district.

SCEC is also pilot testing a model program that provides information and guidance to entire urban neighborhoods to help residents and homeowners become uniformly prepared to protect their lives and property. The year-long pilot is being conducted by SCEC's education and knowledge transfer staff in cooperation with the USC Department of Psychology, which will be assessing



James Dolan leading a field trip to one of his research trenches

pre- and post-program attitudes in addition to the preparedness level of residents. The pilot is being conducted in a low-income, ethnically and culturally diverse neighborhood near South Central Los Angeles.

We believe in the importance of hands-on knowledge transfer. As part of our informal education effort, we conduct local field excursions, highlighting seismic hazards for practicing professionals (geotechnical, structural, and civil engineers); city, county, and state officials; other scientists; high school and community college instructors; utilities, transportation, and telecommunications industry representatives; and public and private emergency preparedness and response professionals. Accompanying field guides are published by SCEC's Knowledge Transfer Program for public distribution.

See "Knowledge Transfer" on Page 20

Fault of the Quarter

The Raymond Fault

Fault Stats

Length: 20 km

Slip Rate: unknown

Cumulative Offset: min. .42 km horizontal and .78 km vertical

Maximum Magnitude: 6.75 (preliminary estimate)

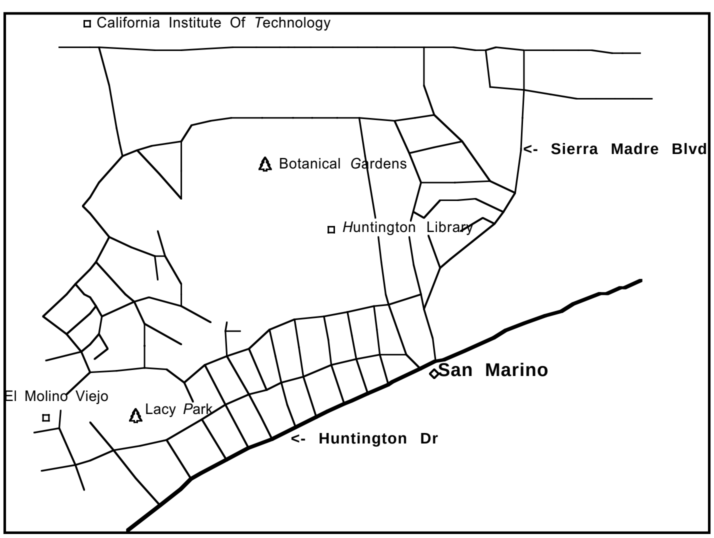
Recurrence Interval: max. 4,500 yr.

by Kristin Weaver
reviewed by James Dolan

The Raymond fault, which trends east-northeastward beneath the San Gabriel Valley, is one of the best-mapped faults in the Los Angeles metropolitan region. Unlike most other faults in the area, which were mapped during petroleum exploration, the Raymond fault was originally identified during the search for a liquid that is equally precious in arid southern California: water.

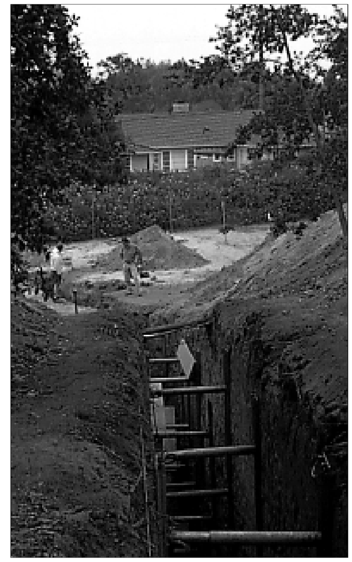
The fault forms a significant groundwater barrier and was originally thought to be a dike or ridge of impervious rock (Conkling, 1928; Crook and others, 1987). In 1940, Caltech geologist John Buwalda included the Raymond fault in his study of the Raymond basin for the Pasadena Water and Power. More recently, Richard Crook and his colleagues conducted a detailed trench and geomophological study of the Raymond fault. This work was published as a USGS Professional Paper in 1987.

The most recent work on this fault is going on as you read this article. I am currently conducting my own graduate research on the Raymond fault with Dr. James Dolan of the University of Southern California (see photos). The Raymond fault is of great interest to our research group and to the Southern California Earthquake Center because it lies beneath a densely urbanized region and is active, as was shown by the 1988 Pasadena Earthquake (M_L 4.9) (Jones and others, 1990).



The Raymond fault is a left-lateral strike-slip fault (Jones and others, 1990) that extends west from the Sierra Madre reverse fault system for 20 km. For most of its length the Raymond fault separates late Pleistocene alluvium on the north from early Holocene alluvium to the south. The only exceptions are on its ends, where it displaces older rocks. In the west these older rocks are Tertiary Topanga formation, which make up most of the hills in the Highland Park region. To the east, north of Monrovia, the fault juxtaposes much older rocks—the Cretaceous Wilson Diorite—against alluvium (Crook and others, 1987).

If you trace the Raymond fault through the cities of Monrovia, Arcadia, Pasadena, San Marino, South Pasadena, and the Highland Park region of Los Angeles, you notice the many geomorphic features that characterize it. On its eastern end, the fault runs along the base of a prominent crystalline ridge that forms the northern edge of Monrovia (Crook and others, 1987). Continuing to the west, the fault scarp is obscured by recent deposition in the Santa Anita Wash, but it can be picked up on the other side of the wash, where it forms the 15-m-tall hill along the northern edge of Santa Anita Racetrack. At that point, two splays of the fault bound a linear hill called a pressure ridge that has popped up between them (Crook and others, 1987).



This spectacular fault geomorphology continues into the grounds of the Los Angeles County Arboretum (see photos), where there is another pressure ridge caught between two fault splays. Baldwin Lake, which has been described as a sag pond (Buwalda, 1940; Crook and others 1987), sits between these ridges. West of the pressure ridges, the Raymond fault exhibits a low, diffuse scarp that has several prominent left-lateral stream channel offsets (Buwalda, 1940; Jones and others, 1990). Buwalda reported that one of these streams shows about 424 m of displacement; Jones' party found that other channels appear to have been similarly offset.

Crook and others mapped two anastomosing strands of the fault from east of Sierra Madre Boulevard through the southern part of Huntington Gardens. These meet again west of Sierra Madre Boulevard in San Marino and run along the northern side of Lacy Park. The hill along the northern edge of Lacy Park is the Raymond fault scarp. Just east of the park, at Huntington Gardens, the fault scarp exhibits upwards of 25 m of relief, providing Huntington Estate with its wonderful location, overlooking Los Angeles. My advisor refers to the Raymond fault as the most beautifully landscaped fault in the world. One look at Huntington Gardens in San Marino, and I think you will agree.

From Huntington Gardens to Highland Park, where the fault appears to splay into several west-trending strands, the Raymond fault appears to be a single strand. In this reach, the fault separates Tertiary Topanga formation from early Holocene alluvium (Crook and others, 1987). One of the most prominent hills along this stretch of the fault is Raymond Hill, for which the fault is named. Weber (1980) mapped the Raymond fault in this region, bringing it through the valley south of Occidental College.

During their study in the late 1970s and early 1980s Crook and others attempted to quantify slip on the Raymond fault. After examining well logs and excavating several trenches across the Raymond fault, they determined that the fault has had up to 775 m of total vertical displacement, as well as a significant, but unquantified amount of lateral displacement. In their trenches, Crook and others found evidence for at least five events, and perhaps as many as eight events on the Raymond fault that could have accommodated this displacement. The oldest event was dated at 35,800 ± 1,300 yr. B.P. and the youngest appeared to disturb the surface soil, from which a bulk-soil age of 1,630 ± 100 yr. B.P. was obtained.

Assuming that these eight events represent all the large earthquakes on the Raymond fault in the last 36,000 years, the average recurrence interval is ~4,500 years (Crook and others, 1987). If additional events have occurred, the recurrence interval would be shorter. Using a fault-plane area of ~325 km^2, Dolan and others (1995) suggested that rupture of the entire Raymond fault, by itself, could generate a M_W 6.7 earthquake. Such an event would be expected to produce ~1.7 m of slip. One of the main foci of our present study is to determine whether the Raymond fault typically breaks in such moderate events or whether it participates in even larger earthquakes that may involve other nearby faults, such as the Sierra Madre or Hollywood faults.

On the basis of the consistently south-facing fault scarps together with evidence for north-side-up displacements, Crook and others (1987) suggested that the Raymond fault is a high-angle reverse fault. However, the 1988 Pasadena earthquake focal mechanism shows nearly pure left-lateral motion on the Raymond fault (Jones and others, 1990). It is still unknown at this time how the Raymond fits in kinematically with the other faults in the region. The Raymond fault might act as a tear fault, transferring slip from the Sierra Madre fault to the Verdugo fault, with the help of the Eagle Rock fault. On the other hand, it may continue past the Eagle Rock fault and connect with the Hollywood fault along trend to the west of the Los Angeles River. However, a simple, thoroughgoing connection between the Raymond and Hollywood faults cannot be established by geomorphic mapping (Dolan and others, in press).

See "Raymond Fault," Page 23

Dolan Receives Zumberge Research Grant

James Dolan, assistant professor in the earth sciences department at USC and member of the SCEC Board of Directors, was named one of three recipients of natural sciences grants from the James H. Zumberge Research and Innovation Fund. Established as the Faculty Research and Innovation Fund by former USC president James H. Zumberge to enhance scholarship at the university, the fund was renamed in Zumberge's honor in 1991. It is the only university research money given to USC faculty.

The research seed grants are valued at up to $25,000 and are intended to help untenured junior faculty launch their research careers and provide a steppingstone to external funding agencies. The fund also assists tenured faculty in changing research emphasis or in resuming scholarship that has been disrupted. It occasionally helps faculty working in fields with inadequate funding sources.

MAP OPPOSITE PAGE:
A map of the San Marino area, showing landmarks near the Raymond fault.

PHOTO OPPOSITE PAGE:
The trench was located just south and west of the Hugo Reid adobe dwelling on the grounds of the Los Angeles County Arboretum. The photo shows a part of the trench near the arboretum's boundary (in middle distance) and shows part of the neighboring residential area in background.

BELOW:
Kristin Weaver and James Dolan inspect the trench wall.

photos by Jill Andrews

The Man Who Mapped California

by Michael R. Forrest

There probably isn't a single SCEC scientist trying to solve some problem of southwestern tectonics and fault structure who hasn't pored over one of the gorgeous and colorful geologic maps drawn by Tom Dibblee. Besides their aesthetics, the insight and precision behind the maps makes them one of the most useful reference tools available to researchers in the earthquake community.

Mention Dibblee's name to members of SCEC's Group C (Earthquake Geology), and you'll probably hear a rare outpouring of genuine enthusiasm for this man—words of gratitude and respect.

"Tom Dibblee's achievement is truly extraordinary," says James Dolan, University of Southern California/SCEC. "The scope of his 70-plus years of mapping is mind-boggling. The man has mapped half of California in great detail. His maps provide an extraordinary reference of the basic geology—in particular of southern California, which I use all the time in my mapping of fault zones. For example right now, we're using his maps extensively to understand exactly where the Oak Ridge fault is in the Ventura basin. It's one of the most rapidly moving faults in southern California and it's certainly capable of producing a large earthquake. His maps provide an amazingly easy reference for going into an area and understanding the basic geology very quickly."

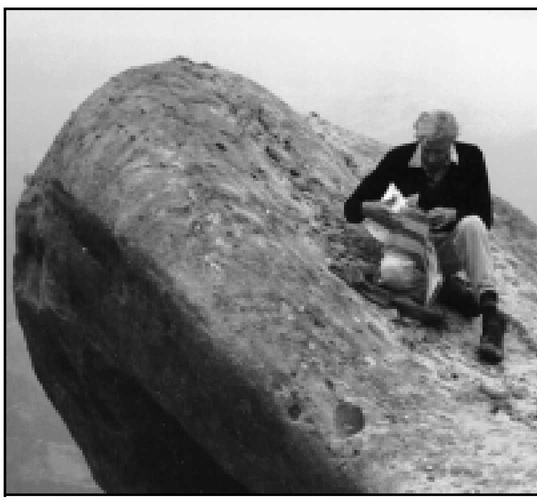
The San Andreas

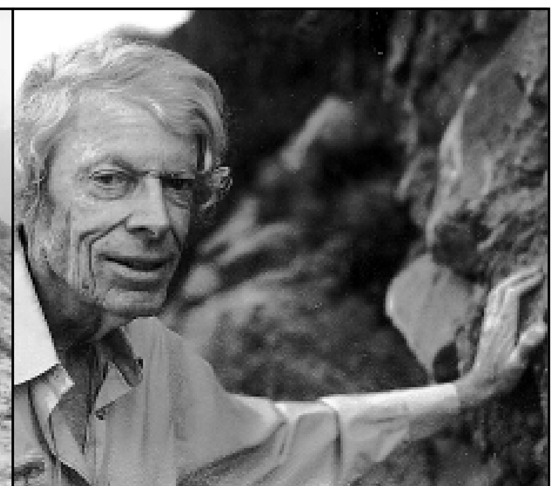
Dibblee's many monumental achievements include a paper that he coauthored with Mason Hill in 1953 (that was before full acceptance of plate tectonics, back in the dark ages of geology), in which he contended that the cumulative offset on the San Andreas fault was well over 100 miles—something not thought possible at the time. Geologists noisily debated the merits of this conclusion for years. Now, of course, they all know he was right.

Dibblee was also the first man to map the San Andreas fault in its entirety. In 1967, the USGS assigned Dibblee to map a 20-mile band on each side of the fault. He traveled the 600-mile-long fault by foot. The next time you drive up Highway 101 to San Francisco, look at the passing hills and valleys, and consider that virtually everything you see—hour after hour even traveling at 65 mph—was walked and mapped by Dibblee. In total, Dibblee has mapped over 40,000 square miles of California on foot—a record that is unlikely to be surpassed.

We've all heard something being described as being worth a million bucks. In the case of Dibblee's maps, it was more than true. Based on Dibblee's recommendations and maps, Atlantic Richfield (now ARCO) struck a 5,000-barrel-per-day

Tom Dibblee is perhaps the most amazing field geologist to have ever mapped in the western United States.





photos courtesy Helmut Ehrenspeck

At 86, Thomas Dibblee is still getting into areas he's mapping as he always did—any way he can. Here and opposite, Dibblee is shown on a recent field trip.

gusher with the first well they drilled in 1948 in the Cuyuma basin. In gratitude they named the main producing unit of sedimentary rock—the Dibblee sand—after the man who made it all possible.

A Born Geologist

Born in 1922, the oldest of four children, Thomas Wilson Dibblee grew up on his family's historic Spanish land grant, Rancho San Julian near Lompoc, California. Dibblee's lineage included Captain Jose Antonio de la Guerra y Noriega, who was commandante of the presidio at Santa Barbara in 1800. Dibblee's father was president of Central Bank and later managed a successful retail complex. Dibblee learned how to map when he was 13 from Harry R. Johnson, a geologist his family hired to look for oil on the ranch. He's been mapping ever since.

Dibblee graduated from Stanford University with a degree in geology in 1936. After working briefly for the California Division of Mines and Geology, he joined the Union Oil company in 1937. In 1949, at the age of 39, Dibblee married his boss' lively secretary Loretta Escabosa. The two have been happily married ever since. That boss, Harold Hoots, is himself an interesting figure in the history of California geology in that he appropriated some of Dibblee's maps, quit Union Oil, started drilling for oil as an independent, and became an extremely wealthy man.

Dibblee mapped sedimentary basins throughout California and western coastal Oregon and Washington for the Richfield Oil Corporation, producing dozens of quadrangles. Following that, he spent 25 (1952–1977) years with the U.S. Geological Survey, for whom he mapped the Mojave Desert, the San Gabriel and San Jacinto mountains, the eastern and central Transverse Ranges, the southern Coast Ranges, and the entire San Andreas fault zone.

Roughing It

Stories of Dibblee's years in the field have become the stuff of legend. A solitary and quiet man, Dibblee had no trouble spending time away from cities, towns, and people. When out mapping, Dibblee had no use for hotels and restaurants. He traveled light, unencumbered in all ways, over the mountains and across the deserts.

> *H*is maps provide an amazingly easy reference for going into an area and understanding the basic geology very quickly.

He traveled into the field in his 1946 Ford coupe. For provisions, he carried canned beans, bread, a couple of heads of lettuce, some raisins, and five gallons of water. For accommodations, he sawed off the bottom half of the steering wheel so he could stretch out beneath it, his feet extended out the car door on a wooden plank he carried for that purpose. No one would see him for a couple of weeks.

An expense claim Dibblee submitted from one of those trips horrified his bosses. He'd been gone for a month, mapping the Imperial Valley for Richfield. His request for reimbursement totaled $14.92. "They were concerned I wasn't getting enough to eat." His bosses drove him to a Mexicali restaurant and bought him the largest meal on the menu. "They wouldn't let me leave the restaurant until I finished eating the steak," said Dibblee.

After the USGS, Dibblee joined the faculty of U.C. Santa Barbara in 1977 and has been there ever since. From 1978 to 1983, Dibblee also worked with the U.S. Forest Service, eventually donating maps of the Los Padres National Forest (1.2 million acres) valued at a million dollars. For that gift, he received the Presidential Volunteer Action Award from Ronald Reagan.

"Tom Dibblee is perhaps the most amazing field geologist to have ever mapped in the western U.S.," says U.C. San Diego geologist Tom Rockwell. "Having spent some time with him in the field, I know that up until only a few years ago, he would have run many of my students into the ground just trying to keep up with him. I don't know anyone who hasn't used his maps as the basis for continued research. They are a tremendous resource."

Dibblee Foundation

In 1983 the Dibblee Geological Foundation was set up to preserve Dibblee's work (see HTTP://DIBBLEE.GEOL.UCSB.EDU/). The foundation publishes thousands of his maps of California in a standardized format. At present it has issued 66 of more than 80 maps (7.5-minute quadrangles) of southern California.

No one who knows Dibblee would be surprised that he is

still mapping at the age of 86. Typically, now he goes out one day a week with friend and Dibblee Foundation driving member Helmut Ehrenspeck. Ehrenspeck is a gregarious, energetic geologist, cartographer, and gourmet chef, who is as interested in the wild mushroom in the field as he is in the rocks. Dibblee limits his mapping expeditions in deference to his wife, who worries about him when he's out.

Dibblee and Ehrenspeck are making plans to map the Palos Verdes area. But neither is ready to pinpoint the dates. No doubt, admiring L.A. basin geologists would follow Dibblee from outcrop to outcrop, and he wouldn't get anything done.

Why him? Why is it that Dibblee was the one who mapped more of California than any other man or woman is likely ever to map? Rather than answer with background on education, experience, or skills, Dibblee's response is characteristically modest and focused on the practical: "I never met anyone else who liked to be alone in the country like I did and have nothing bother me. I loved the solitude."

Featured Interview with . . .

Ralph Archuleta

Interviewed by Jill Andrews

Ralph J. Archuleta was born in 1947 in Rock Springs, Wyoming. After taking his B.S. magna cum laude in physics from the University of Wyoming in 1969, he obtained his M.S. (1971) in physics and Ph.D. (1976) in Earth Sciences from the University of California, San Diego. He is a professor at the University of California, Santa Barbara, and has represented UCSB as a director on the board to the Southern California Earthquake Center since February 1991. After serving as associate director of the Institute for Crustal Studies at UCSB, he was recently appointed acting director.

He has served on the board of directors, as vice-president, and now president of the Seismological Society of America. He is a member of the American Geophysical Union, the Earthquake Engineering Research Institute, and the Committee on Seismology for the National Research Council, 1997–2000.

He is the author of numerous publications, a few of which are mentioned in this article. His research focuses on ground motion and site response; he and his group have recently produced some very compelling scenarios for the Los Angeles metropolitan area.

JA: Your academic career started out in physics. Why did you switch to earth sciences?

RA: While I was at UC San Diego, I began to question whether I was in the right field because my colleagues didn't seem to be working as hard as I was. In my chosen field of magnetospheric physics, there were only a handful of places where jobs were offered. So I left physics and worked at Systems Science and Software ("S-Cubed") with Jerry Frazier on finite element codes for wave propagation in elastic media. One of the consultants there was Charles Archambeau from Caltech. He asked me to become a graduate student in geophysics. But I'd just gotten married, and IGPP (San Diego) was closer. There I met Jim Brune, who asked me to work on the problem of simulating earthquakes using a dynamically propagating stress drop.

> I think the most difficult problem we face is how to correlate ground motion to damage. Damage is extremely nonlinear; it's very difficult to predict.

So I switched into strong motion seismology, looking at waves close to the source. Of course, this has a lot of social relevance. An interesting coincidence occurred: one year into my IGPP tenure, Jerry Frazier was hired as a faculty member in the applied mechanics and engineering science department at UC San Diego. He became my other adviser. I've never regretted getting into this field of study. It has been very exciting—and it's very easy to go to work.

JA: Let's fast-forward to your research focus today. As part of your SCEC involvement, you're beginning a borehole strong motion program in the Los Angeles basin. Could you explain the purpose of this experiment?

RA: We have a lot of instruments that are on the surface of the ground, but there is very little information about what the incoming wave field looks like. A lingering issue is site response—the effect of ground motion and its link to the local site geology. Local site geology could be how much alluvium you're on or what depth it is. Or it could be how close you are to the edge of a basing where the basin laps up onto mountains around it.

The Northridge earthquake produced the best data for what we had already identified—that local site geology greatly affects the ground motion. In fact, seismic waves traveling distances of 20,000–30,000 m can tremendously change their amplitude in the last 10–30 m. So we're looking at something that is about a tenth of a percent of the distance traveled, and it's making a big change in the amplitude of the waves. So the issue is how to quantify the site effects in Los Angeles, which we know is characterized by basins filled with sediments.

JA: So it's the type of soil?

RA: Yes. What we really need is a baseline to identify the incoming motion. We have to be able to say how much the incoming motion was really changed by the local site effect. To get the baseline, we need the boreholes. Right now, all instruments measure waves at the surface, and even surface rocks have an amplification all their own (see referenced publications below).

We have active tectonics in the area, and the rocks are "soft rocks," very weathered. So we need baseline measurements. With those, we'll have some idea of what input wave field we should be looking at—what is the amplitude of these incoming waves. We can then use those recordings at the borehole sites and the recordings simultaneously being made across the network to see how much of a difference there is between what we're recording in the boreholes and what's happening at the surface.

When we look at ground motion, we know we've got the source—that plays a major role. Then we look at the media through which the seismic waves travel. What we're finding is that the crust of California is fairly transparent—the waves travel almost undistorted. They decay with amplitude, just as light decays when you shine a flashlight, but they're not being distorted. As soon as the waves come into the shallow, sedimentary basins or other alluvial fans and the like, we're seeing tremendous changes in these waves.

JA: So are you siting the boreholes in areas where you're expecting to see great changes?

RA: Initially we're siting them only in the rock, because we'd like to identify 'true' input ground motion (our baseline). Then we have a lot of other stations with TriNet-type instruments now being installed that we can compare to. Again, TriNet doesn't have true baseline motion.

This is exciting—we are, in fact, developing one of the first 3-D regional arrays. By 3-D, we mean instruments at depth, coupled with instruments at the surface. Southern California has some borehole instrumentation sponsored by the

USGS and also my work for the US Nuclear Regulatory Commission and the French Commisariat l'Energie Atomique (CEA), but not on the order that we will have under the auspices of SCEC here in Los Angeles. We plan ten sites, plus perhaps five more due to cost-sharing with other organizations, over the life of the five-year project.

The primary investigators on this project are Jamieson Steidl and myself. Steidl is a research geophysicist here at UCSB's Institute for Crustal Studies (ICS). Having done his Ph.D. research using borehole data, he understands the requirements of instrumentation, the strategy of the deployment and the analysis of the data. I've been putting instruments into boreholes since 1984. We're collaborating with the ROSRINE project [Resolution of Site Response Issues from the Northridge Earthquake; see SQN 2.4:16], which is the NSF-sponsored project with Caltrans, PG&E, and other groups. The USGS has an interest in site effects as well, to characterize the site effects at all their strong ground motion sites. The whole point of this collaboration is to see whether we can get a uniform data set.

JA: In Los Angeles, how will your results be used to determine what kinds of buildings will be affected?

RA: Site effects will affect any given structure. The frequencies from the earthquake will have their own effect. As John Hall of Caltech once said at an SSA meeting, "The earthquake will select its own buildings." Local site conditions tend to play havoc with any sort of standard prediction.

I think the most difficult problem we face is how to correlate ground motion to damage. Damage is extremely nonlinear, and it's very difficult to predict—we leave that to the engineers to try to figure out. If you design for a specific threshold of damage but that building is subjected to earthquake damage, the same threshold may no longer apply, because now you have a completely different structure. It's a moving target once it's been damaged. The engineers know what they need to design for, as long as the building doesn't exceed its threshold—that's what we can help with. We can say there will be a certain range of ground motion, and they can design accordingly. That's the best we can do right now.

> We're finding that the crust of California is fairly transparent—waves decay with amplitude but are not being distorted. However, as soon as they come into the shallow, sedimentary basins or other alluvial fans, we're seeing tremendous changes in them.

JA: Your group has done some calculations to predict strong ground motions from a scenario earthquake on the San Andreas fault. Could you tell us about the result of those calculations?

RA: These are the results that Kim Olsen initiated as a SCEC post-doc. I had followed his career very early on. Our interests strongly overlap, and Olsen has an efficient code. We ran a simulation of a magnitude 7.75 earthquake on the San Andreas fault, and since that time, we've run others. We have run earthquakes for Santa Monica, Elysian Park, Palos Verdes, Northridge, and recently Landers. With Landers, we modeled the actual magnitude 7.3 earthquake of 1991. These are all model results, and we have ground motion at least for Los Angeles on these models.

We were trying to show the strong effect of the basins—the basin effect is tremendous. There are early papers from 1979 and 1980 by Rhett Butler,

Professional Highlights
RALPH ARCHULETA

Education
B.S., Physics—University of Wyoming
M.S., Physics—University of California, San Diego
Ph.D., Earth Sciences—University of California, San Diego

Professional
Geophysicist, USGS
Professor, UCSB
Director, SCEC
Acting Director, Institute for Crustal Studies

Honors & Positions
Phi Beta Kappa
Phi Kappa Phi
Woodrow Wilson Fellow
President, Seismological Society of America

Recent Publications

Olsen, K. B., R. J. Archuleta and J. R. Matarese (1995). Three-dimensional simulation of a Magnitude 7.75 earthquake on the San Andreas Fault, *Science*, **270**:1628–1632.

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Archuleta **continued . . .**

Hiroo Kanamori, Michel Bouchon, and Kei Aki, in which they modeled the 1857 San Andreas fault earthquake (the Big One for southern California). Both of those papers used a one-layer model— basin effects excluded. Both acknowledged that the basin could have a significant effect. We modeled one-half of the 1857 earthquake, a 170-km-long segment of the San Andreas that lies northeast of Los Angeles. This work shows amplification of the surface waves due only to the velocity structure and the basin effects.

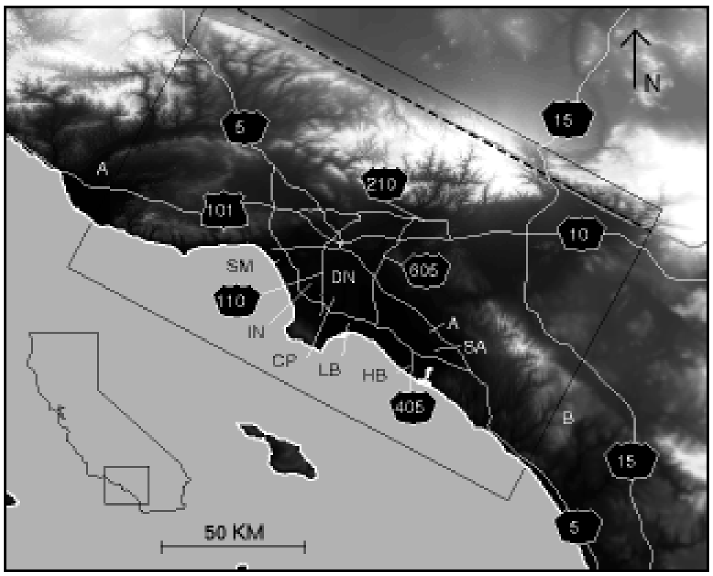
One variable is the stress drop we put into the model—nobody knows what it should be. Landers, for example, has a 200–230 bars stress drop. The numbers we used came from the SCEC Phase II report. We have a large stress drop; consequently we have large amplitudes. The ground motion can be scaled if better estimates of the slip on the fault can be determined from other means.

JA: And these results are accessible?

RA: Yes. Look at the site http://www.crustal.ucsb.edu/~kbolsen, Olsen's website. If you use a Macintosh computer, use Sparkle software to run the scenarios. Play the scenarios at half speed to get the full impact of the basin effect. Note that even after the scenario earthquake is over, the waves continue to bounce around in the basin, much like water sloshing in your bathtub. This is what will cause an increased duration in the ground motion.

JA: I understand that the Los Angeles basin would be subjected to fairly strong or high amplitude long-period waves. What sorts of structures might these waves impact?

RA: Imagine our structures as boats in a stormy ocean. A boat in a storm doesn't crack; rather it rides the waves, bobbing like a cork. These computer scenarios are instructive for us; we don't worry as much about the small buildings (the corks) such as single-family homes. The structures we really worry about are long structures, such as bridges and high-rise buildings, which are much more vulnerable to long-period waves.



An overview look at the area of Los Angeles modelled by Ralph Archuleta and Kim Olsen to show the basin effect during nearby earthquakes. An MPEG version of the model is available for viewing on the Web at http://www.crustal.ucsb.edu/~kbolsen.

And the ground motion is not controlled just by the alluvium. The geometry of the basin relative to the geometry of the fault that just moved is also going to play a major role. We're realizing that's why it's almost unpredictable. It's not enough to know the local site condition—you have to know the geometry of what fault will move relative to the fixed geometry of the basin.

People generally treat earthquakes as if they were a nuclear explosion—a single point from which all the energy comes. They point to the hypocenter or epicenter, which to me, are the most misleading pieces of information given to the public. It gives the impression that something happened "here"—in a single spot. In fact, nothing happened at the epicenter—it's often the place where there's not the most damage. The epicenter is simply a point on the surface of the earth. The energy is actually released over the entire area of the part of the fault that ruptured. What makes a San Andreas earthquake so potentially damaging is that because of the fault's great length, it can release energy over a huge area.

If we have a big earthquake on the Santa Monica fault or any one of the frontal fault systems, energy will be focused into Los Angeles. When you look at the geometry of those faults, they are dipping underneath the San Bernardino and San Gabriel Mountains. When that slip occurs, the energy will be focused into the basin, not away from it, as it was in the Northridge earthquake. Altadena, Pasadena, Azusa, Duarte could be in for some heavy hits.

JA: Are the amplitudes of these waves larger than have been considered by engineers in the past? Have they designed and built for these kinds of waves?

RA: Engineers based most of their information on past earthquakes. They collect all the data they can, and they plot the amplitude versus distance for given magnitude events. Then they say, "Here's what we should expect." The problem that Los Angeles presents is that we don't have data from large earthquakes in this setting, with this geometry. The only way to make predictions about what ground motions will be is, in fact, around these scenario earthquakes. We need to run the scenario earthquakes to see what the effect is of the basin and the waves and the particular characteristics of southern California.

JA: Is there anywhere else in the world where earthquakes occur in a basin setting?

RA: The other place is Tokyo. They are worried about a repeat of the 1923 earthquake, which was so devastating. They have very deep sediments, and they worry about the effect of ground motion. Their records from the 1923 earthquake indicate long-period waves, lasting several minutes.

JA: Are they interested in what you are doing?

RA: They are interested in it—they have Olsen's code and another one that was written by Rob Graves.

JA: Who's "they"?

RA: Private corporations—large engineering firms that have to design tall build–ings, who have research programs and strong motion instrument arrays. This is very different from the U.S., where most of our research is done by government or universities with minimal research support from private companies.

JA: Nonlinear effects: there has been considerable discussion in the SCEC community in the last couple of years regarding the significance of nonlinear effects in strong ground shaking. Can you tell us about the importance of these effects and how widespread these effects might be for different magnitude earthquakes?

RA: Original research on the nonlinear effect was done by Harry Seed (UC Berkeley) and Ed Idriss (now at UC Davis). They wrote a paper that said the soil, under very large strain, goes nonlinear and changes its properties. With the change in its properties, it dampens the amplitude of the waves. The soil actually becomes softer. When this happens, it can take up more of the energy, and thereby decrease the amplitude of the waves going to the surface. The implication of nonlinearity has always been that you could decrease the amplitude of the waves. Ultimately, it will basically put a finite value on acceleration—the acceleration can only reach a certain level. In effect, it caps the acceleration.

Over the years, they have found it is more complicated. For example, the clays in Mexico City definitely did not behave nonlinearly. They are soft and slow but have a high plasticity index, so they remained linear, even though the amplitudes of the Mexico City earthquake were very large.

The whole point was to show that nonlinearity decreases the amplitude in soils. But as it came out following Loma Prieta and Northridge, the material was linear to a much larger degree. The question is: at what level do soils go nonlinear? To measure this phenomenon, you need a very dense array, preferably a borehole array. This is one of the things we'll be looking at with our borehole instrumentation. A lot of questions remain open as to what a nonlinear effect actually is—and how important it is. We know it exists—a simple example of that is that you make footprints. If you can leave a footprint, then it's clearly nonlinear.

JA: If you can predict the amount of energy released from an earthquake, and predict nonlinearity's effect at the surface, i.e., less shaking, then would you be able to predict whether buildings would suffer less damage from the dampening effect?

RA: Yes. The whole argument has been that you could dampen or decrease the amplitudes or accelerations or forces that will be felt in a building or structure if they go through this nonlinear material. The issue is: does it? And if so, how prevalent is it?

Something to remember is that nonlinear effects almost always lead to less acceleration—but they don't necessarily lead to less deformation. If the soil goes nonlinear (such as landsliding, liquefaction, slumping), you can get a lot of damage from deformation. Also, if we look at the Rinaldi site after the Northridge earthquake, which has the largest velocity ever recorded—170 cm per second—with 0.7 g—once you get to that much, who cares? If the soil can still transmit such large particle velocity and acceleration, the expected benefit of nonlinearity (smaller amplitudes) is minimal.

> Ground motion is not controlled just by the alluvium. It's not enough to know the local site conditions—you have to know the geometry of the fault relative to the geometry of the basin.

JA: The strong motion data center at UCSB is also cataloging Empirical Greens functions. Can you tell us what EGFs are, and how you expect to use them in the future for predicting ground motions for future earthquakes?

RA: We're storing the records from the Southern California Seismic Network (SCSN) that are on-scale. Most data coming into the SCSN are off-scale—the instruments' primary purpose is locating earthquakes, so there are very high gains on most of the instruments. As a consequence, when a good-sized earthquake occurs, the amplitudes are clipped. They cannot reach full scale. However, for some of these stations, the amplitudes are faithfully recorded. We're trying to put together a library of where an earthquake has occurred, recorded on-scale, and then compile a complete time history. We then have a response of the earth between that point in the earth and the recording site. The idea behind the EGFs is that they have all the information about what the path and the local site condition look like. Thus, to estimate what a future large earthquake might produce for ground motion, we can combine the small earthquakes using some algorithm knowing that the path and site effects (linear) are already included in the original EGF.

That's the idea. If we can make a library of these, then we can look up all the earthquakes that occurred at a particular site and make a site-specific prediction for that site for a future earthquake somewhere in this region. Those small earthquakes have already provided recordings of the path and site effects. The only thing missing is the source.

Alexei Tumarkin, Peng-Cheng Liu (a SCEC post-doc), and I are using these EGFs for Northridge to invert for the source function of the main shock. We're using methods that are reliable. We have some good forward calculations, and we have some realistic seismograms for big earthquakes. This kind of information can be valuable to the insurance and reinsurance industries to assess risk in an area of study.

About our strong motion database: it is one of our most important outreach programs. A recent survey of strong motion data available showed the only one that is up to date and available on the Web is our SMDB. It's really only meant for southern California, but we've been expanding it to include more. We're trying to make it even more accessible. We think practicing engineers should be able to look at the data and download to their own PCs to do something with it. Other databases aren't as accessible. There is no national or worldwide database for strong motion. We're trying to put one together—the repositories exist, but accessibility is spotty. Our hope is that as we make our own database more accessible, others will follow suit.

JA: Tell us about the Portable Broadband Instrument Center (PBIC). Now that it is five years old, how well is it being used? What segment of the SCEC community uses the instruments, and what kinds of experiments are done with the instruments? Are they kept in a readily deployable mode?

Archuleta **continued . . .**

RA: The PBIC now has 18 instruments. We just got some new sensors that measure much more long-period response. The original plan called for us to be at 25 instruments after five years. But the board wanted us to campus. We try to accommodate everyone who needs them. We don't allow them to leave southern California, but they are constantly used.

Imagine our structures as boats in a stormy ocean. A boat in a storm doesn't crack, rather it rides the waves, bobbing like a cork. The structures we worry about are long structures—bridges and high-rise buildings.

improve communications to be able to broadcast into the SCSN so that the data would automatically go into the network. That's complicated, since the SCSN has fixed sites and ours are moveable.

The PBIC has been one of SCEC's success stories. The PBIC has been invaluable for specific studies. The SCSN can't simply readjust its instruments for this kind of purpose. We got tremendous data following Northridge, Landers, and Joshua Tree. We have also used the instruments for the Los Angeles Regional Seismic Experiment (LARSE)—and they are currently deployed by Monica Kohler at UCLA, where she's looking at LARSE Line 1, at teleseisms and local events. Also Yang Gang Li has used them extensively for his trapped waves experiments, which are such an important part of how to characterize fault zones. Jamieson Steidl and James Chin used them in one of the first characterizations of local site effects in the Los Angeles basin. They had them deployed during the Northridge earthquake and recorded the main shock on several SCEC recorders. We have used them here at UCSB to look at our own local site response on

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Olsen, K. B.. Web site containing scenarios showing the basin effect from an earthquake in Los Angeles area. HTTP://WWW.CRUSTAL.UCSB.EDU/~KBOLSEN

Hemispheric Conference of the Education Sector for Social-Natural Disaster

Dear Colleague:

We would like to take this opportunity to bring you up to date about the latest news regarding the organization of the Hemispheric Conference of the Education Sector for Social-Natural Disaster Vulnerability Reduction and the preparation of the Hemispheric Plan.The conference will be held in Caracas, Venezuela, on September 15–17, 1997.

We would like to know if we can count on your participation in the conference so we can better organize the event. There is no support available at this time to cover travel expenses of participants; therefore, we encourage you to complete the activity form for the Hemispheric Plan and send it to the area coordinator. By presenting the activity forms you can present the strategies and activities that you or your organization are carrying out. These will be considered in the preparation of the Plan.

We also want to inform you that, as part of the program at the Conference, we have reserved September 16 from 2:30 P.M. to 5:30 P.M. for technical discussions organized by participants related to issues regarding the proposed activities for the Plan (video presentation, research, presentation of case studies, software demonstration, etc.). If you wish to organize an activity as part of this program, we encourage you to communicate directly with Prof. Mercedes Marrero for room reservation, projection equipment, or any other need. It is important to do this in advance. Please specify the type of equipment you need, the estimated duration of the activity and the expected number of participants. You can contact Prof. Marrero at (58-2) 605-2011; Fax: (58-2) 285-1104; email: mmarrero@sagi1.ucv.edu.ve

Participants should plan the hotel reservations on their own.

To facilitate hotel reservations, here are two of the suggestions made by the coordinator in Caracas:

1. Caracas Cumberland Hotel—Tel (58-2) 761-3660; Fax (58-2) 761-6681; single or double occupancy room US$78/night
2. President Hotel—Tel (58-2) 708-8111; single or double occupancy room US$120/night

Please take note that these prices are valid until August 17.

We recommend that you maintain close contact with your coordinator listed below:

Academic Aspects: Jean Luc Poncelet

Tel (593-2) 464-629; Fax (593-2) 464-630; email poncelej@ecnet.ec

Citizen Education: Ricardo Mena

Tel &Fax (593-2) 469-810; e-mail rmena@ecnet.ec

Physical Infrastructure: Stephen O. Bender

Tel (202) 458-3005; Fax (202) 458-3560; email natural-hazards-project@oas.org

Please feel free to contact us if you have question or comments.

Stephen O. Bender, Project Chief, Unit for Sustainable Development and Environment Natural Hazards Project, OAS.

Barclay Jones, Author and Professor, Dies

Barclay G. Jones, Cornell University professor of city and regional planning and regional science, and a noted expert on protecting historic structures from earthquake damage and on the social and economic impact of natural disasters, died on May 26 in Ithaca, NY. He was 72. The cause of death was heart failure.

Jones was a native of New Jersey. He had taught at Cornell since 1961. A member of the Earthquake Engineering Research Institute, he had served on the editorial board of that organization's journal, *Earthquake Spectra.* Up until his death, he was a member of the executive and research committees of the National Center for Earthquake Engineering Research in Buffalo.

Jones wrote extensively about the social and economic aspects of earthquakes. His most recent work (see notice on this page) was the NCEER publication *Economic Consequences of Earthquakes: Preparing for the Unexpected.*

He was an authority on earthquake damage assessment and prevention. He was a key researcher in an NSF study of the earthquake hazard in the eastern U.S., especially the behavior of concrete and steel structures in earthquakes.

In 1992, The Barclay G. Jones Endowment for Planning Programs was established at Cornell. The fund supports graduate work in local planning to emphasize quantitative methods of analysis.

Position Available

Structural Geology & Seismology
Harvard University

The Department of Earth & Planetary Sciences of Harvard University invites applications for Postdoctoral or Research Associate positions in structural geology & seismology. We seek candidates interested in (1) the development of regional 3-D interval velocity models from seismic reflection and sonic log data for forward modeling of earthquake generated waves and seismic risk assesment, and (2) the characterization of active geologic structures, including blind thrusts, through integration of natural seismicity with industry seismic reflection profiles, well logs, and surface geology.

The application deadline is September 31; however, we will accept applications until the positions are filled. For further information contact Prof. John Shaw (shaw@eps.harvard.edu) or Prof. Jeroen Tromp (tromp@eps.harvard.edu). Applications should be mailed to Kathy Harrow, Department of Earth & Planetary Sciences, Harvard University, Cambridge, MA 02138, USA. Harvard is an equal opportunity/affirmative action employer.

Recent Barclay Jones Book Available

Economic Consequence of Earthquakes: Preparing for the Unexpected

E*conomic Consequences of Earthquakes: Preparing for the Unexpected,* edited by the late Barclay G. Jones, was recently published. Jones examines the ramifications of a large-scale earthquake in the U.S., while considering preparedness options to minimize losses. This publication contains a preface by Jones and 15 commissioned papers by experts in the fields of seismology, engineering, sociology, business, and insurance. The papers review and define:

- Earthquake problem in the U.S.
- Vulnerability of our built environment
- Impact of damaged and destroyed facilities on social and economic systems
- Precautionary measures to reduce exposure to risk

Economic Consequences of Earthquakes: Preparing for the Unexpected was published by the National Center for Earthquake Engineering Research in Buffalo, NY. For more information, call (716) 645-3391.

WSSPC XIX Annual Conference
November 4–7, 1997
Victoria, British Columbia

The conference policy sessions are structured around the development of seismic policy (government policy that relates to earthquake hazards and mitigation). Each policy session will have brief presentations by the speakers and extensive time for participants to discuss and develop policy alternatives for the issues presented.

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WSSPC web site HTTP://WWW.WSSPC.ORG

Risk/Insurance Journal Accepting Research Papers

Risk Management and Insurance Review is a new journal focusing on public policy, as it applies to risk management and insurance. Researchers interested in submitting papers to the new journal for review or anyone interested in additional information can check the web at HTTP://WWW.ARIA.ORG/RMIR or email the editor, Claude C. Lilly: clilly@cob.fsu.edu.

SCEC Scientists' Submissions and Research Abstracts

SCEC Quarterly Newsletter Now Highlights Recent Publications/Submissions

In each issue, the SQN highlights recent publications of SCEC scientists and also provides more in-depth information such as abstracts or interviews with authors. We also provide a complete bibliographical listing of SCEC research publications in the spring issue each year (see following pages).

All papers that are the result of SCEC-funded research must be included in the database, and should list the "SCEC Contribution Number" in the acknowledgements section. To be added to the database, and receive the contribution number in return, simply email or fax Mark Benthien, SCEC Outreach Specialist (contact information below), with the following: authors, title, publication name and any other bibliographic information that is known. If possible, also include the text of the paper's abstract or introduction. This will greatly improve the function of the SCEC database, allowing for key word searches in both the title and abstract of all papers. Please do this *before submitting a paper*, in order to facilitate assignment of the SCEC contribution number. This database will soon be available on the Internet at SCEC's home page:

www.scec.org

Please support both new projects by emailing or faxing both past (if readily available) and future abstracts of your SCEC-funded publications.

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SQN Seeks Contributions from Scientists

The SCEC Quarterly Newsletter seeks contributions from SCEC researchers. Short summaries of current work in progress by researchers in the eight SCEC working groups will be published each issue. Please follow these guidelines:

Your contribution must be a project which falls into one of the eight working groups:

Group A, Master Model: David Jackson, group leader

Group B, Ground Motion Modeling: Steve Day, group leader

Group C, Earthquake Geology: Kerry Sieh, group leader

Group D, Subsurface Imaging and Tectonics: Rob Clayton, group leader

Group E, Crustal Deformation: Ken Hudnut, group leader

Group F, Regional Seismicity and Source Processes: Egill Hauksson, group leader (will be combined with Group D)

Group G, Physics of the Earthquake Source: Leon Knopoff, group leader

Group H, Engineering Applications: Geoff Martin, group leader

The length of the article should be about 500-750 words of text, written at a 4-year (Bachelor's) college degree level. If you use technical phrases or jargon, please include brief definitions. (Although our readers are well-educated experts, they are likely not up to speed in your earth-science or engineering-related field; definitions help.) The text should cover a description of your research project and how it fits with the working group's goals; names of principal investigators, post-docs, graduate or undergraduate students; and the important findings. If you would like to include figures, graphs, or photos, we can incorporate them into the article. We can either scan in original figures or photos, or receive them from you via the Internet. For information on how to best transfer your figures or photos, contact Mark Benthien at *benthien@usc.edu*.

Abstracts of Recent Publications

Below are the abstracts that have been submitted for recently published SCEC publications. The numbers are the SCEC publication number. See the full publication list on the opposite page.

367. Kagan, Y. Y., "Are Earthquakes Predictable?" *Geophysical Journal International*, submitted, 1997.

The answer depends on the definition of earthquake prediction. We discuss several definitions and possible classifications of earthquake prediction methods. We also consider various measures of prediction efficiency, review several recent examples of earthquake prediction, and describe the methods that can be used to verify prediction schemes. We conclude that an empirical search for earthquake precursors that forecast the size of an impending earthquake has been fruitless. Reported cases of precursors can be explained by random noise or by a coincidence. We present evidence that earthquakes are nonlinear, chaotic, scale-invariant phenomena. The most probable consequence of earthquake similarity is lack of earthquake predictability as it is popularly defined—i.e., a forecast of a specific individual earthquake. Many small earthquakes occur throughout any seismic zone, demonstrating that the critical conditions for earthquake nucleation are satisfied almost everywhere; apparently, any small shock can grow into a large event. Thus, it is likely that an earthquake has no preparatory stage. This skeptical view of current earthquake prediction efforts should not be interpreted as a statement of the futility of any further attempts to mitigate the destructive effects of earthquakes. The seismic moment conservation principle, combined with geodetic deformation data, offers a new way to evaluate the seismic hazard, not only for tectonic plate boundaries, but for areas of low seismicity—e.g., the

See "Abstracts" *on Page 18*

SCEC Research Publications

365. Ben-Zion, Y., Dynamic simulations of slip on a smooth fault in an elastic solid, *Journal of Geophysical Research*, in press, 1997.

366. Souter, B. J., and B. H. Hager, Fault propagation fold growth during the 1994 Northridge, California, earthquake, *Journal of Geophysical Research*, in press, 1997.

367. Kagan, Y. Y., Are earthquakes predictable? *Geophysical Journal International*, submitted, 1997.

368. Kohler, M. D., J. E. Vidale and P. M. Davis, Lowermost mantle scattering from dense array waveforms, *AGU Geophysical Monograph on the Core-Mantle Boundary Region*, M. Gurnis, M. Wysession, E. Knittle and B. Buffett, eds., submitted, 1997.

369. Sornette, D., and L. Knopoff, The paradox of the expected time until the next earthquake, *Bulletin of the Seismological Society of America*, in press, 1997.

370. Hardebeck, J. L., J. J. Norris and E. Hauksson, Quantitative observations of static stress change triggering in two southern California aftershock sequences, *Journal of Geophysical Research*, submitted, 1997.

371. Eneva, M., and Y. Ben-Zion, Techniques and parameters to analyze seismicity patterns associated with large earthquakes, *Journal of Geophysical Research*, in press, 1997.

372. Eneva, M., and Y. Ben-Zion, Application of pattern recognition techniques to earthquake catalogs generated by models of segmented fault systems in three-dimensional elastic solids, *Journal of Geophysical Research*, in press, 1997.

373. Lyakhovsky, V., Y. Ben-Zion and A. Agnon, Distributed damage, faulting, and friction, *Journal of Geophysical Research*, submitted, 1997.

374. Day, S. M., G. Yu and D. J. Wald, Dynamic stress changes during earthquake rupture, *Bulletin of the Seismological Society of America*, submitted, 1997.

375. ten Brink, U. S., R. M. Drury, G. K. Miller, T. M. Brocher and D. A. Okaya, Los Angeles Region Seismic Experiment (LARSE), California off shore seismic refraction data, USGS Open File Report 96-27, 1996.

376. Fuis, G. S., J. M. Nurphy, W. J . Lutter, T. E. Moore, K. J. Bird and N. I. Christensen, Deep seismic structure and tectonics of northern Alaska: crustal-scale duplexing with deformation extending into the upper mantle, *Journal of Geophysical Research*, in press, 1996.

377. Ryberg, T., and G. S. Fuis, A master decollement beneath the San Gabriel Mountains and northern Los Angeles basin: evidence from LARSE of a bright reflective zone, *Tectonics*, submitted, 1996.

378. Ward, S., Dogtails and rainbows: synthetic earthquake rupture models as an aid in interpreting geological data, *Bulletin of the Seismological Society of America*, accepted, 1997.

379. Spotila, J. A., K. A. Farley and K. Sieh, The exhumation and uplift history of the San Bernardino Mountains along the San Andreas fault, California, constrained by radiogenic helium thermochronometry, *Tectonics*, submitted, 1997.

380. Dolan, J. F., and T. L. Pratt, High-resolution seismic reflection profiling of the Santa Monica Fault Zone, West Los Angeles, California, *Seismological Research Letters*, in press, 1997.

381. Wen, L. X., Helmberger and V. Donald, Propagational corrections for basin structure: Landers earthquake, *Bulletin of the Seismological Society of America*, 87, no. 4, pp. 782–787, 1997.

382. Bock, Y., M. Van Domselaar, S. Williams, P. Fang, and K. Hudnut, Southern California permanent GPS geodetic array: continuous measurements of crustal deformation in the Los Angeles basin between the 1992 Landers and 1994 Northridge earthquakes, *Northridge Earthquake Research Conference*, CUREe, submitted, 1997.

383. Olsen, K., R. Madariaga and R. Archuleta, Three-dimensional dynamic simulation of the 1992 Landers earthquake, *Science*, submitted, 1997.

384. Madariaga, R., K. Olsen and R. Archuleta, Modeling dynamic rupture in a 3-D earthquake fault model, *Bulletin of the Seismological Society of America*, submitted, 1997.

385. Stirling, M. W., and S. G. Wesnousky, Comparison of recent probabilistic seismic hazard maps for southern California, *Bulletin of the Seismological Society of America*, submitted, 1997.

386. Zhao, D., Y. Xu, D. Wiens, L. Dorman, J. Hildebrand, and S. Webb, Depth extent of the Lau back-arc spreading center and its relationship to subduction processes, *Science*, submitted, 1997.

387. Tsutsumi, H. and R. S. Yeats, Geologic setting of the 1971 San Fernando and 1994 Northridge earthquakes in the San Fernando Valley, California, *Journal of Geophysical Research*, submitted, 1997.

388. Geiser, P., and L. Seeber, Three-dimensional seismo-tectonic imaging in the central Transverse Ranges, *Journal of Structural Geology*, in preparation, 1997.

Alphabetical Cross-Reference

The recent publications are cited in full by SCEC publication number. The list below is an alphabetical list of main authors showing corresponding publication numbers to help you find a particular author's work in the numerical list.

Abstracts **continued from Page 16 . . .**

interior of continents. Earthquake clustering with the power-law temporal decay (Omori's law) can be used to estimate the rate of future earthquake occurrence. The real-time seismology can facilitate relief efforts after large earthquakes and eventually provide an immediate warning about strong earthquakes a few seconds or tens of seconds before the shaking starts.

374. **Day, S. M., G. Yu, and D. J. Wald, "Dynamic Stress Changes during Earthquake Rupture,"** *Bulletin of the Seismological Society of America*, submitted, 1997.

We assess two competing dynamic interpretations that have been proposed for the short slip durations characteristic of kinematic earthquake models derived by inversion of earthquake waveform and geodetic data. The first interpretation would require a fault constitutive relationship in which rapid dynamic restrengthening of the fault surface occurs after passage of the rupture front, a hypothesized mechanical behavior that has been referred to as "self-healing." The second interpretation would require sufficient spatial heterogeneity of stress drop to permit rapid equilibration of elastic stresses with the residual dynamic friction level, a condition we refer to as "geometrical constraint." These interpretations imply contrasting predictions for the time dependence of the fault-plane shear stresses. We compare these predictions with dynamic shear stress changes for the 1992 Landers (M□7.3), 1994 Northridge (M□6.7), and 1995 Kobe (M□6.9) earthquakes. Stress changes are computed from kinematic slip models of these earthquakes using a finite difference method. For each event, static stress drop is highly variable spatially, with high stress drop patches embedded in a background of low, and largely negative, stress drop. The time histories of stress change show predominantly monotonic stress change after passage of the rupture front, settling to a residual level, without significant evidence for dynamic restrengthening. The stress change at the rupture front is usually gradual rather than abrupt, probably reflecting the limited resolution inherent in the underlying kinematic inversions. On the basis of this analysis, as well as recent similar results obtained independently for the Kobe and Morgan Hill earthquakes, we conclude that, at the present time, the self-healing hypothesis is unnecessary to explain earthquake kinematics.

378. **Ward, S., "Dogtails and Rainbows: Synthetic Earthquake Rupture Models as an Aid in Interpreting Geological Data,"** *Bulletin of the Seismological Society of America*, accepted, 1997.

For decades geologists have been collecting information from historical and paleoearthquakes that could contribute to the formulation of a "big picture" of the earthquake engine. Observations of large earthquake ruptures, unfortunately, are always going to be spotty in space and time, so the extent to which geological information succeeds in contributing to a grander view of earthquakes is going to be borne not only by the quantity and quality of data collected, but also by the means by which it is interpreted. This paper addresses the need to more fully understand geological data through carefully tailored computer simulations of fault ruptures. Dogtails and rainbows are two types of fault rupture terminations that can be recognized in the field and can be interpreted through these models. Rainbows are concave down ruptures that indicate complete stress drop and characteristic slip. Rainbow terminations usually coincide with fault ends or strong segment boundaries. Dogtails are concave up ruptures that indicate incomplete stress drop or stress increase and noncharacteristic slip. Dogtail terminations can happen anywhere along a fault or fault segment. The surface slip pattern of the M□6.6, 1979 Imperial Valley CA earthquake shows both dogtail and rainbow terminations. The rainbow confirms the presence of a strong fault segment boundary 6 km north of the international border that had been suggested by Sieh (1996). The dogtail implies that the displacement observed in 1979 is not characteristic. By combining paleoseismic information with the surface slip patterns from this event and the M□7.1, 1940 Imperial Valley earthquake, a quantitative Imperial fault model was developed with northern, central, and southern segments possessing 50, 110, and 50 bar strength and 28, 13, and 22 km length respectively. Both the 1940 and 1979 events showed 1-m amplitude dogtailed ruptures of the northern segment; however, characteristic slip of the segment is more likely to be about 3 m. To illustrate the full spectrum of potential rupture modes, models were run forward in time to generate a 2000-year rupture "encyclopedia." Although the segmentation and strength of the Imperial fault are well constrained, modest changes in two friction law parameters produce several plausible histories. Further discrimination awaits analysis of the extensive paleoseismic record that geologists believe exists in the shore deposits of the intermittent lakes of the Salton Trough.

382. **Bock, Y., M. Van Domselaar, S. Williams, P. Fang, and K. Hudnut, "Southern California Permanent GPS Geodetic Array: Continuous Measurements of Crustal Deformation in the Los Angeles Basin between the 1992 Landers and 1994 Northridge Earthquakes,"** Northridge Earthquake Research Conference, CUREe, submitted, 1997.

We investigate the time series of daily positions estimated for two continuously global positioning system (GPS) sites in the Los Angeles region in the 19-month period between the 1992 Landers and 1994 Northridge earthquakes. The site at the Jet Propulsion Laboratory in Pasadena (JPLM) was active throughout the 19-month period; the site on the Palos Verdes Peninsula (PVEP) was activated only 9 months before the Northridge earthquake. A comparison of the post-Landers site velocities with those derived GPS and very long baseline interferometry measurements collected over 5–8 years prior to the earthquake indicate a significant change in the displacement rate at JPLM. The velocity difference after the Landers earthquake is manifested primarily as a decrease in magnitude of about 2 mm/yr in a direction nearly coincident with the direction of coseismic surface displacement. Since the same pattern of deformation is observed over a wide aperture in southern California, we infer that the entire Los Angeles basin experienced postseismic deformation in order of 1–2 mm/yr in the 19-month period preceding the Northridge earthquake. By analyzing the coseismic and postseismic displacements at the JPLM and PVEP sites, we infer (1) an increase in the contraction rate of the Los Angeles basin after the Landers earthquake, which is relieved by the Northridge earthquake; and (2) a possible role for the Landers earthquake in triggering the Northridge earthquake.

385. **Stirling, M. W., and S. G. Wesnousky, "Comparison of Recent Probabilistic Seismic Hazard Maps for Southern California,"** *Bulletin of the Seismological Society of America*, submitted, 1997.

Probabilistic seismic hazard (PSH) maps for southern California produced from the models of Ward (1994), the Working Group on California Earthquake Probabilities (1995), and the U.S. Geological Survey and California Division of Mines and Geology (Petersen and others, 1996) show the peak ground accelerations predicted with each model to occur at 10% probability in 50 years and the probability that 0.2g will occur in 30 years for "rock" site conditions. Differences between the maps range up to 0.5g and 50%, respectively. We examine the locations and magnitudes of the differences as a basis to define the issues and avenues of research that may lead to more confident estimates of PSH in the future. Our analysis shows that contrasting assumptions bearing on the proportion of predicted earthquakes that are distributed off the major mapped faults, the size of the maximum magnitude assigned to a given fault, the use (or not) of geodetic strain data to calculate earthquake rates, and the choice of ground motion attenuation relation each contribute to the observed differences between the maps.

386. **Zhao, D., Y. Xu, D. Wiens, L. Dorman, J. Hildebrand, and S. Webb, "Depth Extent of the Lau Back-Arc Spreading Center and Its Relationship to Subduction Processes,"** *Science*, submitted, 1997.

Seismic tomography and waveform inversion reveal that very slow velocity anomalies (5–7%) beneath the active Lau spreading center extend to 100 km depth and are connected to slow anomalies (2–4%) in the mantle wedge to 400 km depth. This indicates that geodynamic systems associated with back-arc spreading are related to deep processes, such as the convective circulation in the mantle wedge and deep dehydration reactions in the subducting slab. The slowest anomalies exist just west of the Lau spreading center, consistent with the observation that current ridge propagation processes are moving the spreading center away from the Tonga arc.

SCEC-Sponsored Science Seminar & Workshop on Sediment Nonlinearity

When:
Seminar: Jan. 29, 1998 (afternoon)
Workshop: Jan. 30, 1998

Where: USC

Organized by: Ned Field (field@usc.edu)

Description:
It has been understood for more than 100 years that sediments can increase the level of earthquake ground motion relative to bedrock. However, there has been a long-standing and often contentious debate between seismologists and engineers on whether the response of sediments to strong ground motion is similar to that of relatively well-studied weak motion. The prevailing view in the engineering community, based almost exclusively on laboratory studies, is that sediments respond nonlinearly. That is, amplification factors are generally reduced for stronger ground motion because the finite strength of sediments causes a breakdown of Hooke's law. This perspective has been applied in engineering practice. Seismologists, on the other hand, have traditionally been skeptical because of a lack of evidence and a skepticism that laboratory studies represent in situ behavior. They've generally concluded that either sediment nonlinearity is insignificant or that it is buried among the myriad of other complicating factors (i.e., uncertainties) in the data. Recent progress in several disciplines makes the time ripe for a seminar and workshop on this problem.

At the seminar (afternoon of Jan. 29, 1998), representatives from each discipline will give overview talks on the following topics:

- Lab-based studies of sediment response conducted by the engineering community
- How engineers use these results to theoretically model sediment response
- Seismological evidence for and against sediment nonlinearity
- The view from the rock-mechanics/physics community
- What's applied in the building codes

The purpose of this seminar is to educate the general SCEC community and to bring the members from the various disciplines up to speed about the other disciplines.

With this introduction, the workshop on the next day will focus on specific technical issues that remain unresolved. Participants will be invited to present and discuss results that pertain to these issues. Given the unprecedented diversity of disciplines that will be in attendance, it is hoped that this workshop will establish points of agreement and disagreement, stimulate crossbreeding, and identify priorities for future research.

If you are interested in participating in the workshop, please contact Ned Field (213-740-7088; field@usc.edu) to let him know. Please also include your thoughts on what issues should be addressed at the workshop.

Knowledge Transfer **continued from Page 5 . . .**

Southern California museums are also targeted by SCEC, which has developed a series of prototype mechanical exhibits that inform the public about natural hazards and earthquake engineering concepts and practices.

State Mitigation Plan

Our involvement in the earthquake safety community and the effects of our work go beyond our southern California borders. Representing SCEC and the knowledge transfer community in general, I served during 1996-1997 as a member of the writing team in the area of education and information dissemination for the state's earthquake hazard mitigation plan. A Seismic Safety Commission publication, the *California Earthquake Loss Reduction Plan*, should be off the presses this fall. Besides being required by FEMA before the release of any mitigation money, FEMA plans to use this plan as a model for other states. We developed initiatives for legislation to set licensing and competency requirements for practicing professionals; short courses and other means to increase the level of understanding among the media and the public; workshops for state, city, and county officials on vulnerability assessment and loss reduction measures; and the establishment of a statewide K-12 earthquake education program.

Our work with the Seismic Safety Commission, the California Division of Mines and Geology, and the City of Los Angeles has helped strengthen the resolve of public officials to improve mitigation strategies. Earthquake scenarios now under development (for the Phase III report) will provide much more realistic estimates of expected ground shaking in the metropolitan areas of southern California. The probabilistic hazard assessment methods and earthquake scenarios being developed for southern California can be transferred nationwide. Already they are beginning to be emulated in northern California and in the Pacific Northwest.

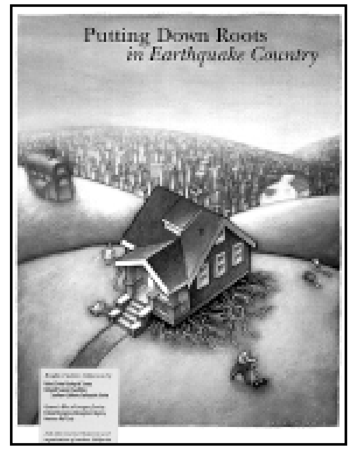
Key Publications

Finally, a couple of other publications deserve mention. Our most successful endeavor to date has been a public awareness booklet.

USC Seeking Student Researchers

The geophysics group at the University of Southern California is looking for outstanding graduate students and postdoctoral fellows to participate in a variety of vigorous research programs on earthquake physics, crustal dynamics, and waveform seismology. For more information on the geophysics program, visit the USC web site at HTTP://WWW.USC.EDU/DEPT/EARTH. For information on available opportunities and application procedure, contact Prof. Sammis (sammis@earth.usc.edu).

In 1994-95, we developed and produced two million copies of *Putting Down Roots in Earthquake Country*, a 32-page, full-color nontechnical version of the *Phase II* report. The booklet was directed to a diverse audience of disaster preparedness and response personnel, city and county officials, engineers and planners, the general public, and the media. Two-thirds of the booklets were distributed through all 12 of southern California's county public library systems; the rest, through the SCEC office. We are now negotiating a reprint of the booklet, adding a Spanish language version, in partnership with a local television station.



And if you're reading this article, you know about our *SCEC Quarterly Newsletter*. We feature ongoing research and activities sponsored by the Center, and include in each issue a list of the latest Center publications. We publish scientific and technical articles written by SCEC scientists, researchers, and staff and glean interesting information and articles from other organizations emphasizing research on earthquake phenomena. Readers include representatives of the U.S. government; California state, county, and city government agencies; business and industry leaders interested in earthquake hazard mitigation; academic institutions, including pre-college teachers and students; the media; and the general public.

Where Do We Go from Here?

Plans for the next five years include media-related activities that promote awareness and loss reduction, such as the "L.A. Underground" radio spot series with KFWB Radio Anchor Jack Popejoy. As part of the second printing of *Putting Down Roots*, KTLA Television will be launching its own television spots or vignettes that encourage earthquake preparedness.

Partnerships with the media will be fundamental to getting out our message. One of our baseline efforts will be a guide for the media themselves, providing them with basic information, contacts, and guidelines related to earthquake preparation and response. In the coming months, we will plan a workshop to produce a media information guidebook, special Web site, and field training series.

The *Phase III* version for practicing professionals, authored by Edward Field, a SCEC research scientist at USC, will be available soon. We also plan to feature the newest research on ground motion scenarios in future versions of *Putting Down Roots*. Of course, Web surfers will see us continue to promote product usage and data dissemination via the SCEC Web pages and links, the SCEC infrastructure facilities, and the online databases.

Highlights of Knowledge Transfer Projects

Partner	Project	Description
	PUBLICATIONS	
	Putting Down Roots in Earthquake Country	32-page, full-color nontechnical overview of earthquake probabilities, risks, and preparation.
	SCEC Quarterly Newsletter	Ongoing Center research and activities, lists of Center, scientific and technical articles by SCEC scientists, researchers, and staff, and interesting information from related organizations.
	Phase I Report : Future Seismic Hazards in Southern California, Phase I: Implications of the 1992 Landers Earthquake Sequence	First stage of a comprehensive assessment of the earthquake risk in southern California; discusses the recent increase in the frequency of earthquakes in southern California, makes several recommendations for further study.
	Phase II Report: Seismic Hazards in Southern California: Probable Earthquakes, 1994-2024	Second stage of our overall assessment of the earthquake risk, giving the probability of earthquake shaking strong enough to cause moderate damage, specifically predicting 80- 90% probability of an earthquake M 7+ before 2024.
	Phase III Report: [in preparation]	Builds on Phase II; includes source effect, site conditions, propagation path effect on strong ground motion. Two-part report will contain sample probabilistic seismic hazard maps and consensus time histories for selected earthquake scenarios and sites in southern California.
KFWB Radio Anchor Jack Popejoy	"L.A. Underground" radio spots	One of several media-related activities to promote awareness and loss reduction.
	WWW.SCEC.ORG	World Wide Web site containing access to organizational information, data, and links to related topics and organizations.
	WORKSHOPS	
USGS, CDMG, SCESA, OES, Caltech	Making the Most of New Real-Time Information Technologies in Managing Earthquake Emergencies	Comparisons of hardware, software, and data disclaimers.
OES	One Year after Northridge	Overall reassessment and update by all involved disciplines.
IASPEI	Educating the Public about Earthquake Hazards and Risks	One-day workshop we led at the general assembly of IASPEI in Greece; future workshops planned.
Insurance industry	Insurance vulnerability workshops	Evaluation and upgrading of current methods used by the insurance industry in measuring exposure.
CDMG	Zones of Deformation	To provide advice to CDMG about establishing guidelines for the delineation, evaluation, and mitigation of zones of deformation.
	ONGOING PROJECTS	
CUREe	PEER	New alliance to support the outreach efforts of the proposed Pacific earthquake engineering research center.
CUREe	Earthquake Hazard Mitigation of Woodframe Construction	3-year project covering all aspects of woodframe construction, including education and training.
SEAOSC, City of L.A.	Ground Motion Joint Task Force	To study vulnerable structures in southern California.
EERI, OES	Post-Earthquake Technical Clearinghouse	Actively involved with the Hardware and Archiving and Distribution working groups.
EERI, NCEER, SSC, NISEE /EERC (UCB), NISEE/Caltech, NHRAIC	Earthquake Information Providers Network	To keep the emergency planning and response communities informed.
NISEE/Caltech	Library loan agreement	For exchange of materials and library assistance to end users.
AEG	AEG Fault & Fold Database	To aid the Association of Engineering Geologists in creating a fault and fold database.
SSC	*California Earthquake Loss Reduction Plan*	Participation on the writing team in the area of education and information dissemination for the state's earthquake hazard mitigation plan.
	PLANNED	
KTLA TV	Second printing of *Putting Down Roots*	Television spots or vignettes that encourage earthquake preparedness & newest research on ground motion scenarios.
OES; USGS; all media	Media information guidebook	To provide media with basic information, contacts, and guidelines related to earthquake preparation and response.
Edward Field	Phase III report, "nontechnical" version	Version for practicing professionals who may use portions of the report to aid in the design of new structures in seismically active areas.
FEMA; Ground Motion Joint Task Force	Two booklets	To increase public awareness of the hazards of vulnerable structure types.
WSSPC	1998 Conference on Hazard Insurance Policy	To help formulate and act on a national all-hazard approach to address this critical issue.

IASPEI = International Association of Seismology and Physics of the Earth's Interior
NHRAIC= Natural Hazards Research & Applications Information Center

SCESA= Southern California Emergency Services Association
WSSPC = Western States Seismic Policy Council

Southern California Earthquake Center Knowledge Transfer Program

The SCEC administration actively encourages collaboration among scientists, government officials, and industry. Users of SCEC scientific products (reports, newsletters, education curricula, databases, maps, etc.) include disaster preparedness officials, practicing design professionals, policy makers, business communities and industries, local, state and federal government agencies, the media, and the general public.

Knowledge transfer activities consist of end user forums and workshops, discussions among groups of end users and center scientists, written documentation and publication of such interactions, and coordination of the development of end user-compatible products.

Planned and in-progress products and projects include:

- Insurance industry workshops; proceedings; audio tapes
- Engineering geologists' workshops; proceedings; geotechnical catalog.
- Vulnerability workshops, city and county officials
- Media workshops
- Field trips
- Quarterly newsletter
- *Putting Down Roots in Earthquake Country* handbook
- SCEC WWW pages (WWW.SCEC.ORG)
- SCEC-sponsored publications; scientific reports

For more information on
the SCEC Knowledge Transfer Program, contact
Jill Andrews, Director, Knowledge Transfer
phone 213/740-3459 or email *jandrews@usc.edu*
or
Mark Benthien, Outreach Specialist
phone 213/740-0323 or e-mail *benthien@usc.edu*.

OFF-SCALE

READINGS FROM AUTHORS WHO ARE NOT EARTH SCIENTISTS BUT WISH THEY WERE

"There is something fascinating about science. One gets such wholesale returns of conjecture out of such a trifling investment of fact."

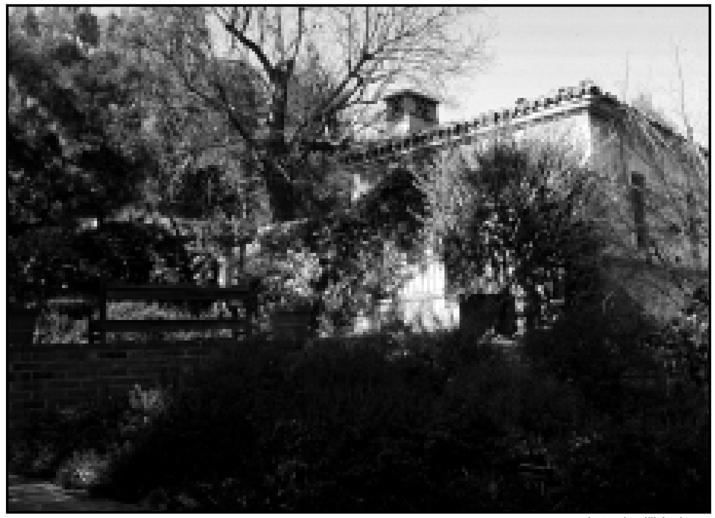
Now, if I wanted to be one of those ponderous scientific people, and 'let on' to prove what had occurred in the remote past by what had occurred in a given time in the recent past, or what will occur in the far future by what has occurred in late years, what an opportunity is here [the Mississippi River]!

In the space of 176 years the Lower Mississippi has shortened itself 242 miles. That is an average of a trifle over one mile and a third per year. Therefore, any calm person, who is not blind or idiotic, can see that in the Old Oolitic Silurian Period, just a million years ago next November, the Lower Mississippi River was upwards of 1,300,000 miles long, and stuck out over the Gulf of Mexico like a fishing-rod. And by the same token any person can see that 742 years from now the Lower Mississippi will be only a mile and three-quarters long, and Cairo and New Orleans will have joined their streets together, and be plodding comfortably along under a single mayor and a mutual board of aldermen. There is something fascinating about science. One gets such wholesale returns of conjecture out of such a trifling investment of fact.

Mark Twain
Life on the Mississippi

Raymond Fault continued from Page 7 . . .

El Molino Viejo (the Old Mill), an adobe structure built right at the base of the Raymond fault scarp around 1808, is evidence that the Raymond fault has not had any surface rupture in almost 200 years. This view is to the NNW; the vegetated fault scarp is to the left and behind the Old Mill.



photos by Jill Andrews

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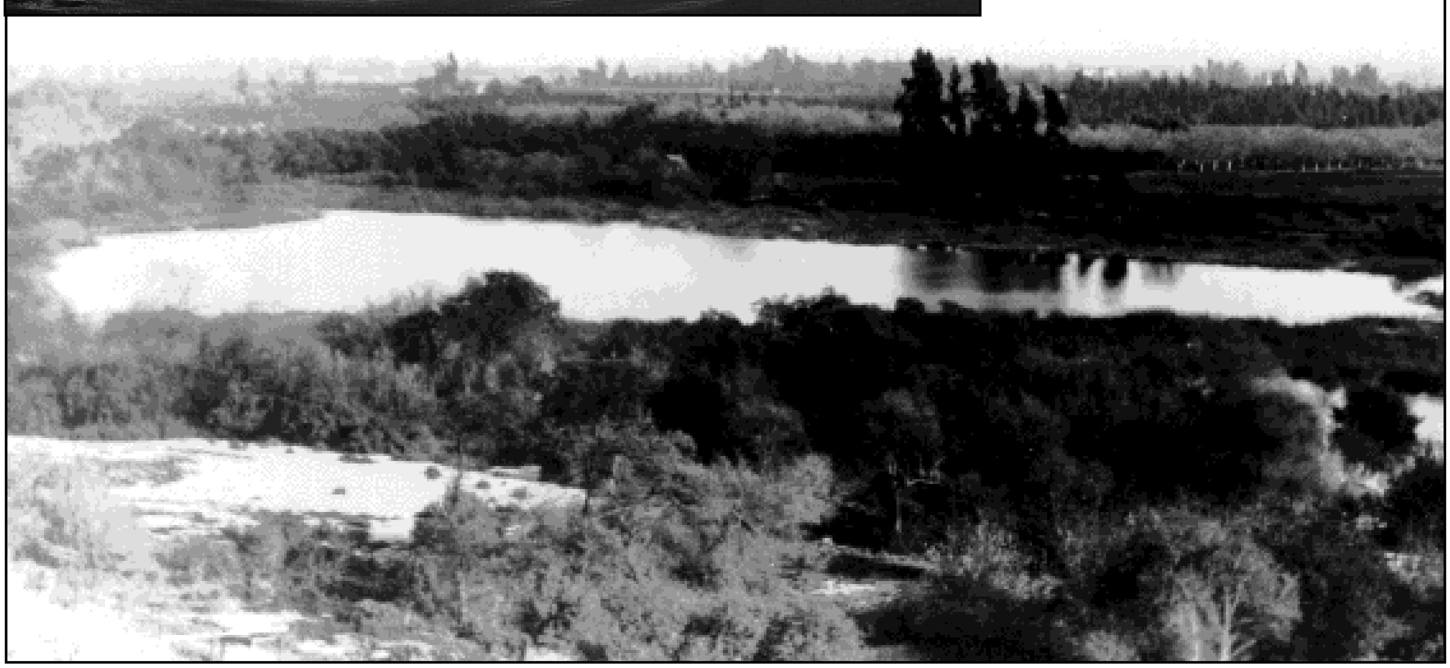
"Before and After" shots of Lacy Park. The larger photo, circa 1900, is a view to the south overlooking Wilson Lake, a sag pond on the Raymond fault (courtesy of the San Marino Historic Society). The view in the inset is the same area today. View is to the south and west. Most of the park is located on the fault zone, at the base of the scarp. It is no longer possible to take exactly the same shot as the turn of the century photo: trees now block that vista.

photo courtesy San Marino Historic Society



The Global View . . .

Three Views of the 10 May

The People

It Roared "Like a Dragon"

As aftershocks shook the region, tens of thousands of survivors slept shivering in near-freezing temperatures in the streets outside their homes, many without blankets. Most of the severe damage occurred in poor villages in a 60-mile region roughly parallelling the Afghan border in the far eastern side of central Iran. Relief workers and researchers said that the air in these villages was rank with the smell of death.

More than 2,500 people died—most of them buried alive in mud huts. Approximately 5,000 people were injured, and 100,000 left homeless. In Ardakul more than 100 children were killed at once when a schoolhouse collapsed. One despondent patriarch had lost all six of his grandchildren to the school's collapse. Altogether, almost a third of that village's 1,600 residents perished.

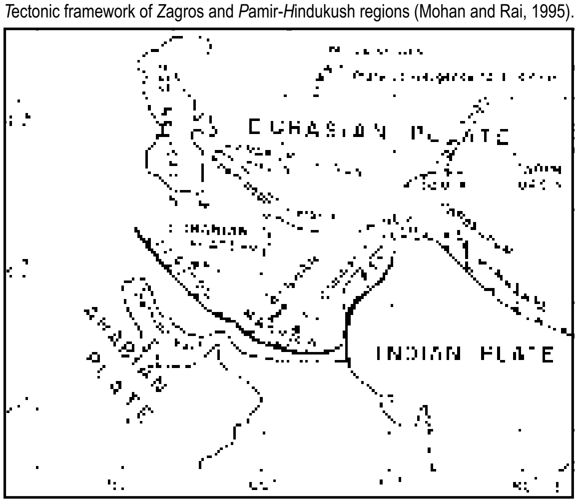
The land "roared like a dragon," say survivors of the 10 May 1997 M 7.1 earthquake that struck at 12:28 PM on the Abiz fault in eastern Iran., They also say that day turned to night as thick clouds of dust blotted out the sun in Khorassan province.

The government put a cost of $100 million on damage caused by the earthquake, which was the most devastating event to strike Iran since two earthquakes shook the provinces of Gilan and Zanjan on June 21, 1990. Approximately 50,000 people were killed and 60,000 inured in those quakes, which had magnitudes of 7.3 and 7.7, respectively.

Following the May 10 Abiz earthquake, the Iranian government promised to pay $167 to every person who lost a relative.

Michael R. Forrest

Tectonic framework of Zagros and Pamir-Hindukush regions (Mohan and Rai, 1995).



The Earthquake

M 7.1—80 Km of New Rupture

A field team including Manuel Berberian (Najarian and Associates) and Manushehr Ghorashi (Geological Survey of Iran) was able to visit the site of the 1997 earthquake on the Abiz fault in Khorassan province in eastern Iran, near the Afghan border. The earthquake produced more than 80 km of new surface rupture (right-lateral, strike-slip) on the fault, which strikes about N-S. Up to 195 cm of right-lateral offset was measured.

The Abiz fault previously ruptured during an M_S 6.6 earthquake on November 14, 1979, with 17 to 35 km of surface rupture and right lateral displacement of up to 100 cm. It has not yet been determined whether the 1979 and 1997 earthquakes ruptured the same source, although at least some parts of the fault were ruptured in both events.

The 33-km depth widely reported for the earthquake is a teleseismic default depth. In actuality, it was a crustal earthquake with focal depth probably between 10 and 20 km. The Abiz fault can be visualized on Fig. 10-27, p. 323 of the *Geology of Earthquakes* (the Kerry Sieh text), located at about 34N, 60E. It is part of a complex array of faults with historical surface rupture starting with the Dasht-e-Bayaz left lateral fault in 1968. The 1997 earthquake appears to be part of a sequence starting with Dasht-e-Bayaz in 1968.

L. A. and Tehran: Sister Cities?

Because of similar local tectonic styles, an interesting—if at first glance unlikely—comparison can be made between greater Los Angeles and Tehran. Tehran is like the Los Angeles basin: a huge population living in a plain that features range-front active reverse faults to the north and some active reverse faults in the basin itself. Khorassan has a thick-skinned reverse fault province southeast of the Dasht-e-Bayaz region, which produced a M 7.7 reverse-fault earthquake at Tabas in 1978. Los Angeles has the thick-skinned Transverse Ranges. Iran, however, has 4,000 years of recorded history, with numerous nearby examples of earthquakes of M 7 to M 7.5 in settings similar to those in southern California.

This suggests that the two M 6.7s the Los Angeles area has had in the last 200 years do not represent the size of earthquake we need to be worried about—and planning for.

Bob Yeats, Manuel Berberian, and Manushehr Ghorashi.

1997 Earthquake at Abiz, Iran

The Geology

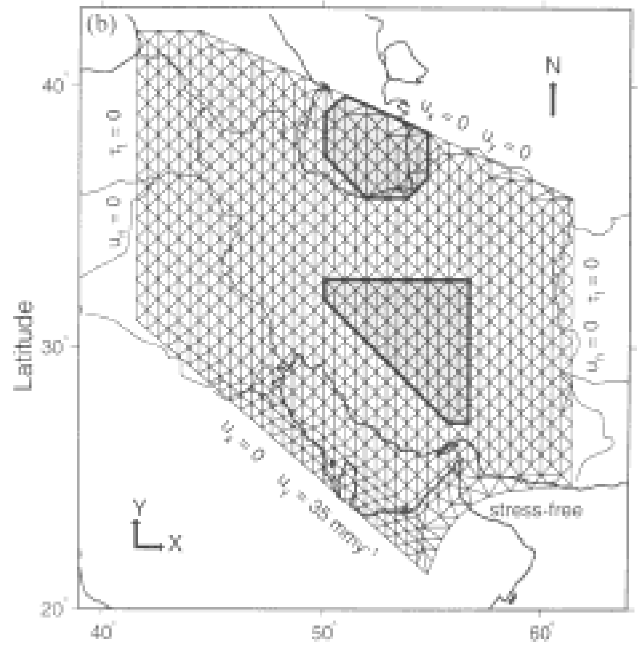
Tectonic Framework of Eastern Iran

The Afro-Arabian plate is subducting beneath much of Iran and Afghanistan along the Zagros thrust and the Makran arc-trench system. Continental convergence between these two plates is taken up by distributed deformation in Iran, including folding, complex block rotations, and the associated slip on faults such as the Abiz fault.

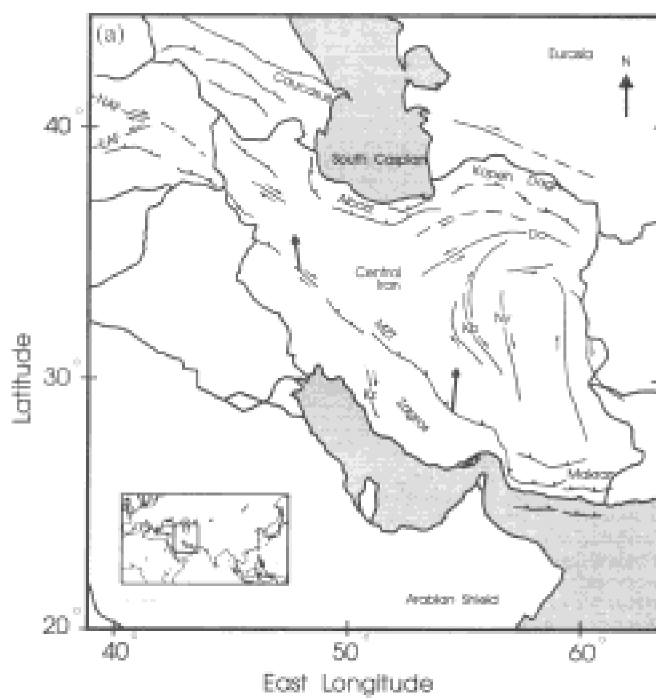
Along the central and eastern part of the Iranian Plateau, the tectonics are dominated to the north by E-W left-lateral and thrust faults. South of these faults, subordinate N-S right-lateral strike-slip faults can be found that do not cross the northerly faults, as well as thrust faults trending NW-SE. Movement on all these faults facilitates the squeezing of the eastern Iranian plateau against the stable blocks of western Afghanistan.

Iran was originally part of the great Arabian shield during the Paleozoic and was separated from Asia by a proto-Tethys sea. The proto-Tethys closed, and the Iranian microplate was formed when rifting occurred along the Zagros thrust zone at the end of the Paleozoic or in the early Mesozoic. A Neo-Tethys sea opened to the south at that time and eventually closed again in the late Cretaceous as a result of northward drift of the Afro-Arabian plate. Continued convergence initiated a Himalayan-type collision and consequent crustal thickening along the Zagros thrust in the Late Miocene, a process that continues now.

Michael R. Forrest



Tectonic maps of Iran, The abbreviations stand for the following faults: NAF—North Anatolian, EAF—East Anatolian, MZT—Main Zagros, Na—Naiin, Kb—Kuh-Banan, Ny—Nayband, Do—Doruneh and Kz—Kazerun. The two arrows show the Arabia-Eurasia convergence velocity. The arrow in the southern Zagros corresponds to 35 mm/yr. (Sobouti and Arkani-Hamed, 1996)



References

Mohan, G., and Rai, S. S. 1995. Large-scale three-dimensional seismic tomography of the Zagros and Pamir-Hindukush regions. *Tectonophysics* 242, 255–265.

Sobouti, F., and Arkani-Hamed, J. 1996. Numerical modeling of the deformation of the Iranian plateau, *Geophys. Journ. Int*, 126:805–812.

Paleoseismology in the Cocos-Nazca-Caribbean Triple Junction

Hugh Cowan, Coordinator of Neotectonic Studies CEPREDENAC Program Central America

Since the late 1980s, six countries have participated in a regional program to reduce the impact of natural disasters in Central America. The goal of the program is to avert future suffering and economic losses such as those caused by earthquakes in El Salvador (1986), Guatemala (1976), and Nicaragua (1972).

The program was funded by Sweden under the auspices of the IDNDR (International Decade for Disaster Reduction). In the early 1990s the program was expanded with contributions from Norway (Seismic Instrumentation and Seismic Hazard Assessment) and Denmark (Flood Hazard Modeling). The first phase of the program concluded in 1994, and a second four-year phase (1996-99) began last year. The program is coordinated by Centro de Coodinacion para la Prevencion de los Desastres Naturales en America Central (CEPREDENAC) on behalf of Guatemala, El Salvador, Honduras, Nicaragua, Costa Rica, and Panama.

A modest but important new component of the program is the application of paleoseismology for hazard assessment of major active faults in Central America. The paleoseismology project is presently linked to microzonation studies in selected urban centers. The first field session was conducted in southern Costa Rica, adjacent to the Panama border during April 1–15, 1997, as a precursor to the seismic microzonation of David, the third city of Panama (pop. 100,000).

Western Panama and Southern Costa Rica

Costa Rica and Panama form a tectonically active junction between four major lithospheric plates—Caribbean, Cocos, Nazca, and South America at the southern end of the Middle American volcanic arc-trench system. Three of these plates—Cocos, Nazca, and Caribbean—interact beneath the Pacific margin of southern Costa Rica and western Panama, producing frequent earthquakes, including four events of M 7.5 or greater during this century.

Major structural elements of the triple-junction include the Cocos Ridge—a buoyant trace of the Galapagos hot-spot that forms part of the Cocos plate, presently being subducted beneath southern Costa Rica at a rate of 7–9 cm/yr. The eastern margin of the Cocos Ridge is truncated by the Panama Fracture Zone (PFZ), a highly active oceanic transform fault that accommodates 5–6 cm/yr. of right-lateral strike-slip. The PFZ divides the Cocos and Nazca plates north-south and intersects the Costa Rica-Panama arc at Burica Peninsula, the Pacific land border between Costa Rica and Panama.

Previous studies, notably by researchers from the University of Texas, have identified elements of the PFZ extending onshore along the axis of Burica Peninsula, then curving westward into the strike of a fold-and-thrust belt, developed in Cretaceous-Quaternary forearc sediments above the subducted Cocos plate and its antecedents. The present location of the Cocos-Nazca-Caribbean triple junction has traditionally been depicted as the intersection of the PFZ, at the supposed subduction interface offshore, or beneath, Burica Peninsula.

However, discoveries in a study conducted in 1996 indicate that the PFZ extends farther north into the Costa Rica-Panama volcanic arc than previously supposed (Cowan and others, in prep.). A spectacular surface trace has been mapped extending unbroken for 15 km—from the swampy lowlands north of Burica Peninsula to the foothills of the Cordillera Talamanca. A right-lateral offset of 1.3 km has been measured where the fault trace bisects the distal margin of a large alluvial fan of probable late Pleistocene age. Smaller dextral offsets (4–65 m) are preserved at several streams and shutter ridges along the surface trace. At its northern end the surface trace curves westward into a major east-west regional fault—the Longitudinal Fault Zone (LFZ) or Ballena-Celmira Fault Zone. The proposed name for the newly identified structure is Canoas fault, after the adjacent border town of that name.

Context for the Study

Paleoseismic investigation of these large faults is important for determining the size and frequency of surface ruptures at the edge of the subducted Cocos plate and in the overlying forearc crustal wedge. These shallow seismic sources are of concern for the city of David, located 50 km east of the international border, but within a few kilometers of the LFZ.

The LFZ has been recognized as a major geological structure since the 1960s, but no data have been available to constrain its sense of movement or late Quaternary slip rate. A better knowledge of the relationship between the LFZ and PFZ in the border region may clarify whether the LFZ is presently active farther east in Panama, or whether it's less active because of the siphoning of strain southward along the Canoas fault. In the 1996 study, no evidence of Holocene displacement was documented along the LFZ in Panama, but abundant circumstantial evidence of Holocene activity is evident on the LFZ west of its intersection with the Canoas fault—for example, unweathered fault gouge zones and anomalous drainage patterns.

Better knowledge of the slip rates on the respective faults would also improve existing seismological models of interplate coupling in this area and help clarify the cross-cutting relationships between the triple-junction elements.

Fieldwork

Fieldwork spanned 15 consecutive days from April 1–15. The national team included Walter Montero and Guillermo Salazar from the Central American School of Geology, University of Costa Rica, and Guillermo Alvarado and Fransisco Arias of Instituto Costarricense de Electricidad.

Several of the potential trenching sites had been identified from reconnaisance study last year. Locating an available backhoe was more difficult. With the onset of the rainy season imminent, most contractors were working frantically to complete their summer drainage tasks. Paleoseismology seemed too fiddly....

We eventually located excellent machines and operators and subsequently opened six trenches: four on the Canoas fault and two across the LFZ. We were lucky with the weather—no rain fell during the two weeks. Conditions in the trenches were tough, however, with 100% humidity and a grinding heat. We managed to dig at least one trench adjacent to a deep river pool—replete with waterfall and ripe mangos—but not every site was so blessed.

The evenings never failed to please. Toucans flew in to roost overhead as we logged trench walls by half-light. Comet Hale-Bopp put on a good show following a flaming sunset, and that was followed by thousands of fireflies in the grass fields after dark. Inevitably, we encountered characters in the countryside with always a spare moment to recount the folklorico of snakes, Indian relics, stony ground, artesian springs, and harder times past. One old timer described precisely the location and extent of the (Canoas) fault—known to him for 20 years or more.

Preliminary Results—Canoas Fault

At its southern tip, the Canoas fault passes beneath late Holocene fluvial overbank deposits. We trenched the youngest expression of the fault, where sand and silt deposits are displaced across a small sag pond. Two buried soils and associated colluvial wedges should help constrain the ultimate and penultimate rupture events. An unexpected bonus was the discovery of pumice and ash horizons in this trench and two others farther north. These sediments probably correspond to eruptions from Volcan Baru, a 3,470-m strato-volcano located in the Cordillera, 40 km north of David, Panama.

In two other trenches on the PFZ, stratigraphic control appears strong for constraining the last event. Pre-Colombian artifacts (probably 500-1,500 yr B.P.) were recovered from four of the six trenches. In all cases, the horizons of human occupation were faulted, and one site was possibly abandoned after the last event diverted an active stream channel.

Preliminary Results—LFZ

At Rio Abrojo, 4 km east of Ciudad Neilly, Costa Rica, the LFZ truncates fluvial terraces 6-15 m above the modern floodplain. Terraces less than 6 m above the floodplain are not offset. We excavated one trench at the mid-slope of the highest section of the fault scarp (beneath the oldest terrace) and another on the flat 10 m south of the scarp at an anomalous, left-lateral offset in two channels whose source is a spring at the base of the fault scarp.

Regrettably, we had only one day in which to excavate this important site because of local political difficulties. Furthermore, 30 minutes into the excavation, the backhoe had a punctured tire; simultaneously its alternator burned out. Despite the constraints imposed by this additional delay, we recovered important information. A reverse fault was exposed beneath the main scarp and offsets in a thick sequence of silty colluvium were documented, extending almost to the ground surface. Pre-Colombian artifacts and charcoal were recovered in the hanging-wall at -1.70 m, implying that the sedimentation rate has been high.

In the second trench south of the main scarp, a fault extended up into a deformed silt layer 0.4 m below ground surface. The surface of the silt layer was associated with wood and large palm seeds, indicating a former ground surface. This surface was covered by cobbles and small boulders, consistent with rapid burial by landsliding (there is no active stream channel). The debris was overlain by sandy organic sediment. Projection of the fault to the surface coincided with the offset wall of the stream channels. There was no evidence of more than one rupture event. Precise dating of the buried channel surface will, we hope, constrain the timing of the last rupture. The offsets? Three measurements on three channel margins: 7 m, 6.5 m, 5.5 m, all left-lateral.

Conclusion

The preliminary results of this work are encouraging. The LFZ is now confirmed as an active structure and a major seismic source in Costa Rica. With direct evidence of the last event, we can hope to constrain magnitude limits and clarify the kinematic models previously based on ambiguous seismological (focal mechanism) data. The timing of two events on the Canoas fault seems feasible, and it is also possible that we can learn more about the timing of late Holocene eruptions from Volcan Baru, Panama.

Each of the sites trenched in this study is situated adjacent to a larger volume of undisturbed terrain, so future studies may yield additional information about the rupture histories of these large faults. Data from this field campaign will be presented shortly, together with related unpublished data gathered during the past two years in this region.

The best initial source of information about the tectonics, regional structure, and unsolved problems of this fascinating region is the excellent compilation of work in Geological Society of America Special Paper 295, 1995 (P. Mann, Ed.).

Future Paleoseismology under CEPREDENAC

Tentative planning has begun for a trenching study of normal faults in the Managua Graben, Nicaragua, the site of the devastating 1972, M 6.2 earthquake. If confirmed, the work will be conducted during the dry season (Jan.–April) of 1998 as a small part of a microzonation project presently underway in Managua. Naturally, there are more potential projects than either time or resources permit. I am keen to hear from people interested in the concept of "joint-ventures" that would broaden the technical input and experience in paleoseismology studies under the CEPREDENAC program. A parallel goal within this program is the transfer of experience to participating institutions throughout the region.

Because the paleoseismology component of the total program is modest, it is not possible to offer financial support for salary or travel to people outside the local participating institutions. However, the institutional relationships and local logistical support provided by the CEPREDENAC program represent a tangible benefit for any group or individual interested in this type of work in Central America.

Addresses for Hugh Cowan: Instituto de Geociencias Universidad de Panama, Panama; hcowan@ancon.up.ac.pa

Also available on the paleoseismology website (HTTP://GLDAGE.CR.USGS.GOV/PALEOSEI/PPFORUM.HTM):

"Paleoseismology along the Caribbean-North American Plate Boundary"

"Preliminary Geological Report on the Cariaco July 9, 1997, Earthquake, Sucre State, Northeastern Venezuela"

Calendar

September

24-27—Field Workshop on Paleoseismology of the San Andreas Fault, Los Angeles Host: Kerry Sieh. Contact: mcraney@usc.edu

30-Oct 3—AEG Annual Convention, Portland, OR; 520/204-1553

October

2-3—3-D Modeling Workshop L.A. area. Host: Norm Abrahmson: nabraham@holonet.net

5-7—SCEC Annual Meeting & Field Trip,Costa Mesa, CA (See agenda on page 31.)

5-8—Annual meeting, Eastern Section of the Seismological Society of America. Ottawa. Contact: G. Atkinson, esssa@ccs.carleton.ca

15—SCEC San Andreas Fault Field Trip for Media Representatives, led by Thomas Henyey, et al. Los Angeles, CA. Info: 213/740-1560.

20-23—Geological Society of America annual meeting, Salt Lake City. Contact: 800-472-1988; email meetings@geosociety.org; http://www.geosociety.org/meetings/97/index.htm.

22-24—Using GIS for Disaster Management: Domestic and International Applications, Madison, WI. Disaster Management Center, Univ. of Wisconsin-Madison. 800-462-0876; dmc@engr.wisc.ed

23-25—General Earthquake Modeling (GEM) Workshop. Los Alamos National Laboratory and others, Santa Fe. gem@acl.lanl.gov

24-25—SCEC Workshop: Computational Methodologies for Simulating Earthquakes. Santa Fe, NM. Hosts: John Rundle (UofCO, Boulder); Bernard Minster (Scripps, UCSD). 303/492-5642

November

TBD—City of Los Angeles Vulnerability Workshop III

1-4—International Workshop on the Vrancea Earthquake, Bucharest, Romania. fwenzel@gpiwap1.physik.uni-karlsruhe.de or lungud@hidro.utcb.ro.

3-5—International Conference and Sino-American Symposium on the Tectonics of East Asia, Chungli, Taiwan. Contact: C.H. Lo, lo@suno3.gl.ntu.edu.tw

4-7—WSSPC Annual Conference, Victoria, British Columbia, Canada. Email wsspc@wsspc.org

6–8—Symposium on New Images of the Earth's Interior Through Long-Term Ocean-Floor Observations, Chiba Prefecture, Japan. ohp_sympo@oyoyo.eri.u-tokyo.ac.jp (or hitosi@eri.u-tokyo.ac.jp)

10-14—Second Pan-American Symposium on Landslides. Rio de Janeiro. willy@pec.coppe.ufrj.br.

17-19—12th International Conference and Workshops on Applied Geologic Remote Sensing. Environmental Research Inst. of Mich.. Denver. wallman@erim.org

12, 3-6 pm—CLA/SEAOSC/SCEC JTF full committee meeting, Davidson Hall.

December

8-12—AGU Fall Meeting, San Francisco, CA. Contact: ward@andreas.wr.usgs.gov

January 1998

6—NSF preproposal for new round of STCs due.

16—San Cayetano Fault Field Trip. Ventura County, CA. Led by Dr. Thomas Rockwell, SDSU

27-28—Workshop with Los Alamos National Lab, "Earthquakes and Urban Infrastructure"; Los Angeles. Contact: Grant Heiken (LANL), Jill Andrews

29-30—SCEC Science Seminar & Workshop on Sediment Nonlinearity. L.A. Ned Field: field@usc.edu

January—Shalheveht Freier International Workshop on Advanced Methods in Seismic Analysis, Dead Sea, Israel. Dr. Nitzan Rabinowitz, workshop@ndc.soreq.gov.il

February

4-8—Earthquake Engineering Research Institute annual meeting, San Francisco, CA. eeri@eeri.org

March

8-15—Fourth International Conference on Case Histories in Geotechnical Engineering. St. Louis, MO. Abstracts due 12/15/97. buddyp@shuttle.cc.umr.edu.

16-18—Seismological Society of America annual meeting. Boulder, CO. snewman@seismosoc.org.

May

TBD: Insurance Summit with WSSPC

26-29—American Geophysical Union Spring Meeting, Boston, MA. meetinginfo@kosmos.agu.org; http://www.agu.org.

31-June 4—U.S. National Conference on Earthquake Engineering, Seattle, Washington. eeri@eeri.org

November

11-15 or 18-20—US/Japan conference. Tokyo, Japan; Jill Andrews is on steering committee.

SCEC Notes

New Writer & Editor

This month a new writer and editor begins work at SCEC. You've been looking at his first assignment.

Though we had originally planned to add a staff position, we were lucky enough to find and talk Ed Hensley into a contract to take on the main part of our writing and editing load for the coming year. Ed comes with an impressively appropriate background. He has previously worked in the area of earthquake safety for the state Seismic Safety Commission.

He also worked as a writer and editor for the state Department of Education. In addition, he has taught English, reported for a newspaper, worked as a freelance writer and editor, and been a staff technical writer and editor for several organizations. Currently, he works as an independent writer and editor based in Sacramento.

He will be working with the Knowledge Transfer Program staff at SCEC. Even though he will not have an office at SCEC, he will be integrated into the team via electronic links since one of his specialties is long-distance desktop publishing.

If you have comments or questions about the newsletter or ideas about any SCEC publication, feel free to email Ed at edhensley@earthlink.net.

Kei + Valerie = Uka

Congratulations from the SCEC community to Professor Kei Aki and Valerie Ferrazzini, who announced the birth of their daughter Uka, born July 28, 1997. "Uka" is a combination of "U" for "Universe" and the Japanese word "Ka," which means "volcanic island." Professor Aki and Valerie live on La Reunion Island, where he is conducting research and spending time with his family.

Earthquake Information Resources On Line

SCEC on the Web

www.scec.org

Earth Sciences

SCEC Data Center

HTTP://WWW.SCECDC.SCEC.ORG/RECENTEQS
Recent earthquake activity in northern and southern Calif. Maps and earthquake lists are interactive and updated at the time of an event

HTTP://WWW.SCECDC.SCEC.ORG/EARTHQUAKES/CURRENT.TXT (TEXT)
HTTP://WWW.SCECDC.SCEC.ORG/EARTHQUAKES/CURRENT.GIF (MAP)
Southern California Seismic Network weekly earthquake reports

HTTP://SCEC.GPS.CALTECH.EDU/FTP/CA.EARTHQUAKES
SCSN weekly earthquake reports archives to January 1993

HTTP://SCECDC.SCEC.ORG/SEISMOCAM/
Caltech/USGS Seismocam: waveform displays of data 30-seconds-old earthquakes in southern California: includes aftershock maps, animations of aftershock sequences and rupture models, and a clickable map of historic southern California earthquakes.

HTTP://WWW.SCECDC.SCEC.ORG/EQSOCAL.HTML
Main page

HTTP://WWW.SCECDC.SCEC.ORG/CLICKMAP.HTML
Southern California clickable earthquake map

HTTP://WWW.SCECDC.SCEC.ORG/EASOCAL.HTML
Los Angeles basin clickable earthquake map

HTTP://WWW.SCECDC.SCEC.ORG/EQSOCAL.HTML
Earthquakes in southern California

HTTP://SCEC.GPS.CALTECH.EDU/CGI-BIN/FINGER?QUAKE
"Finger Quake" ftp (updated frequently)

HTTP://WWW.SCECDC.SCEC.ORG/FAULTMAP.HTML
Southern California fault map

HTTP://WWW.SCECDC.SCEC.ORG/LAFAULT.HTML
Faults of Los Angeles

HTTP://WWW.SCECDC.SCEC.ORG/LARSE.HTML
LARSE home page

Seismo-Surfing the Internet

HTTP://WWW.GEOPHYS.WASHINGTON.EDU/SEISMOSURFING.HTML
Clearinghouse of research data & informmation

USGS Web Sites

HTTP://WWW.USGS.GOV
General USGS site

HTTP://GLDSS7.CR.USGS.GOV/
National Earthquake Information Center

HTTP://GEOLOGY.USGS.GOV/QUAKE.HTML
Earthquake Information

HTTP://QUAKE.WR.USGS.GOV/
USGS Menlo Park

HTTP://WWW-SOCAL.WR.USGS.GOV
USGS Pasadena

HTTP://GEOHAZARDS.CR.USGS.GOV/NORTHRIDGE/
USGS Response to an Urban Earthquake — Northridge '94

HTTP://WWW-SOCAL.WR.USGS.GOV/LISA/NETBULLS/NETBULL_LIST.HTML
Southern California Seismic Network

HTTP://WWW.SEISMO.UNR.EDU
Nevada Seismological Laboratory

Features work by two SCEC-funded researchers, John Anderson and Steve Wesnousky. Contains lists, maps, and seismogram data from recent earthquakes. Also: background geologic and seismicity maps; searchable earthquake catalogs; contact lists, brochures, geophysics degree program information; courses in earthquake fundamentals and scientific visualization.

USGS email addresses

NEIC@USGS.GOV
National Earthquake Information Center

NGIC@USGS.GOV
National Geomagnetic Information Center

NLIC@USGS.GOV
National Landslide Information Center

Paleoseismology

HTTP://INQUA.NLH.NO/COMMPL/PALSEISM.HTML
The INQUA Subcommission on Paleoseismicity: content list and authors for the special issue of journal of geodynamics arising from the INQUA Berlin 1995 symposium on paleoseismicity.

Active Tectonics

HTTP://WWW-GEOLOGY.UCDAVIS.EDU/~GEL214/
University of California, Davis—Active Tectonics
- Lecture notes ("Contents")
- Problem sets ("Problems") for this course
- WWW links ("Links") of interest to students and researchers
- References

GIS Web Sites

HTTP://WAREHOUSE.GEOPLACE.COM/
Bibliography of GIS & environmental applications:

HTTP://PASTURE.ECN.PURDUE.EDU/~ENGELB/
Bernie Engel, professor of agricultural engineering: soil and water conservation, environmental issues, systems engineeering

HTTP://WWW.LIB.BERKELEY.EDU/CGI-BIN/PRINT_HIT_BOLD.PL/UCBGIS/
UCB GIS Task Force integrates GIS activities with other resources at UCB campus, recommends GIS services for library

HTTP://WWW.NWI.FWS.GOV/THINKTANK.HTML
GIS Think Tank on problems of digital mapping for users of NWI data

HTTP://FGDC.ER.USGS.GOV/LINKPUB.HTML
List of FTP directories for federal Geographic Data Committee

HTTP://MIS.UCD.IE/STAFF/PKEENAN/GIS_AS_A_DSS.HTML
Paper on how to use a GIS as a DSS generator

See "On Line Resources" on Page 30

***On Line Resources* continued**

HTTP://SPSOSUN.GSFC.NASA.GOV/EOSDIS_SERVICES.HTML
A spectrum of services, some for casual users, some for research scientists, some inbetween

HTTP://WWW.GGRWEB.COM/
Services of information technologies, earth sciences, GIS, GPS, & remote sensing industries

Geodetic Information

HTTP://LOX.UCSD.EDU
This site is the IGPP & Scripps Orbit and Permanent Array Center (SOPAC) and features global (IGS) and regional (SCIGN) continuous GPS archive, SCIGN maps, time series, and site velocities.

GMT

HTTP://QUAKE.UCSB.EDU
Helps make shaded relief maps with GMT. Has catalog of maps produced by Geoffrey Ely at the ICS/UCSB. Downloadable digital elevation model for southern California in GMT-readable (netCDF) format. The grid covers the region 121W 115W 32.5N 35.5N at a resolution of 3 arc sec. You can get to the web page from the ICS home page, then click on Mapping, and then Geoff's Map Catalog.

Preparedness, Disaster Management

HTTP://WWW.BEST.COM/~TRBU/OES/
California Governor's Office of Emergency Services: information on Earthquake Preparedness Month campaign

HTTP://KFWB.COM/EQPAGE.HTML
KFWB Quake Page (by Jack Popejoy)

HTTP://KFWB.COM/CUCAMONG.HTML
KFWB Webservice exclusive: trenching the Cucamonga fault:

HTTP://WWW.HIGHWAYS.COM/LASD-EOB/
The Los Angeles Sheriff's Department Emergency Operations Bureau

HTTP://WWW.JOHNMARTIN.COM/EQPREP.HTM
John A. Martin & Associates

HTTP://WWW.EERC.BERKELEY.EDU/
Earthquake Engineering Research Center offers extensive, searchable database of abstracts, reports, and other resources. New: "Lessons from Loma Prieta,"with papers, images, and data.

Earthquake Information Sites

HTTP://WWW.EQNET.ORG/
EQNET

HTTP://WWW.CIVENG.CARLETON.CA/CGI-BIN/QUAKES
Recent quakes (with a great map viewer)

HTTP://WWW.CRUSTAL.UCSB.EDU/SCEC/WEBQUAKES/
Up-to-the-minute southern California earthquake map—latest 500 earthquake locations. Java-enabled browsers only.

HTTP://WWW.CONSRV.CA.GOV/DMG/SHEZP/PSHA0.HTML
Probabilistic Seismic Hazard Map, California

HTTP://WWW.ABAG.CA.GOV/BAYAREA/EQMAPS/LIQUEFAC/BAYALIQS.GIF
Bay Area hazard map

HTTP://WWW.WSSPC.ORG
Western States Seismic Safety Policy Council site, an overall earthquake safety information source.

HTTP://WWW.SCECDC.SCEC.ORG/GLOSSARY.HTML# BLIN
Glossary of terms (in progress)

HTTP://WWW.GEOPHYS.WASHINGTON.EDU/SEISMOSURFING.HTML
Seismic Info Sources

HTTP://WWW.SEISMIC.CA.GOV/SSCCATR.HTM
Seismic Safety Commission—state earthquake hazard mitigation plan

HTTP://WWW.SEISMIC.CA.GOV/SSCLEG.HTM
Seismic Safety Commission legislation page (current state and federal bills being tracked and analyzed by the Commission)

HTTP://WWW.SEISMIC.CA.GOV/SSCSIGEQ.HTM
Seismic Safety Commission—significant damaging California earthquakes

Internet Discussion Groups

WSSPC-L@NISEE.CE.BERKELEY.EDU
Western States Seismic Policy Council discussion group

EQ-GEO-NET@GSJTMWS8.GSJ.GO.JP
Paleoseismic ListServe

GVN@VOLCANO.SI.EDU
Global Volcanism Network

QUATERNARY@MORGAN.UCS.MUN.CA
Research in quaternary science

SEISMD-L@BINGVMB.BITNET
Seismological discussion list (SEISMD-L)

QUAKE-L@LISTSERV.NODAK.EDU
Earthquake discussion list

Conferences, Events

HTTP://WWW.SCEC.ORG/CALENDAR/ANNUAL97/ANNUALMEETING.HTML
SCEC annual meeting information and registration

HTTP://WWW.SEISMO.NRCAN.GC.CA/ESSSA97
October 5-8—Annual meeting, Eastern Section, Seismological Society of America, Ottawa.

HTTP://WWW.GEOSOCIETY.ORG/MEETINGS/97/INDEX.HTM
October 20-23—Geological Society of America annual meeting, Salt Lake City.

HTTP://EPDWWW.ENGR.WISC.EDU/DMC/
October 22-24—Using GIS for Disaster Management, Madison.

HTTP://ACL.LANL.GOV/GEM
October 23-25—General Earthquake Modeling Workshop, Santa Fe, NM.

HTTP://FERMAT.GEOL.UCONN.EDU/INFO/TAIWAN
November 3-5—International Conference and Sino-American Symposium on the Tectonics of East Asia, Chungli, Taiwan.

HTTP://WWW.ERIM.ORG/CONF/CONF.HTML
November 17-19—12th International Conference & Workshops on Applied Geologic Remote Sensing, Denver.

WWW.AGU.ORG/MEETINGS/FM97TOP.HTML
December 8-12—Fall Meeting of the American Geophysical Union, San Francisco.

HTTP://WWW.EERI.ORG
February 4-8, 1998—Earthquake Engineering Research Institute annual meeting, San Francisco.

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SCEC ANNUAL MEETING

WHEN: October 5–7, 1997

WHERE: Doubletree Hotel, Costa Mesa, CA

Sunday, October 5

10:00am	Field Trip—San Joaquin Hills
6:00pm	Icebreaker and Dinner
7:15	Poster Session
8:00	Advisory Council meeting
8:30	Meeting of SCIGN Coordinating Board

Monday, October 6

	Session I: Plenary Session
8:00am	Welcome and Introduction (20)
	SCEC Science Program (30)
	The SCIGN Project Bock (20)
	Report of Knowledge Transfer and Education (30)
9:40	Break
10:00	Short Research Reports from Group Leaders
11:15	Phase III Presentation
12:45	Lunch
	Session II: Working Group Meetings
1:45	Group A: Jackson
3:15	Group B: Day
4:45	Groups C & G: Sieh, Knopoff
6:15	Dinner— Speaker: Arch Johnston: "New Madrid"
7:45	Groups D and F: Clayton, Hauksson
9:15	Group E: Hudnut

Tuesday, October 7

8:00	SCEC II: The Future Proposal—Henyey
Noon	End of SCEC meeting
Noon	Lunch for Advisory Council &Steering Committee
1:00pm	ROSRINE meeting—Schneider

FOR DETAILS & REGISTRATION:

http://www.scec.org/calendar/annual97/annualmeeting.html

SCEC Quarterly Newsletter

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SCEC Knowledge Transfer and Education Programs are reachable via electronic mail. Ask general questions, make requests, send us information for use in our resource center or for consideration for publishing in the next newsletter.

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SCEC Quarterly Newsletter

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