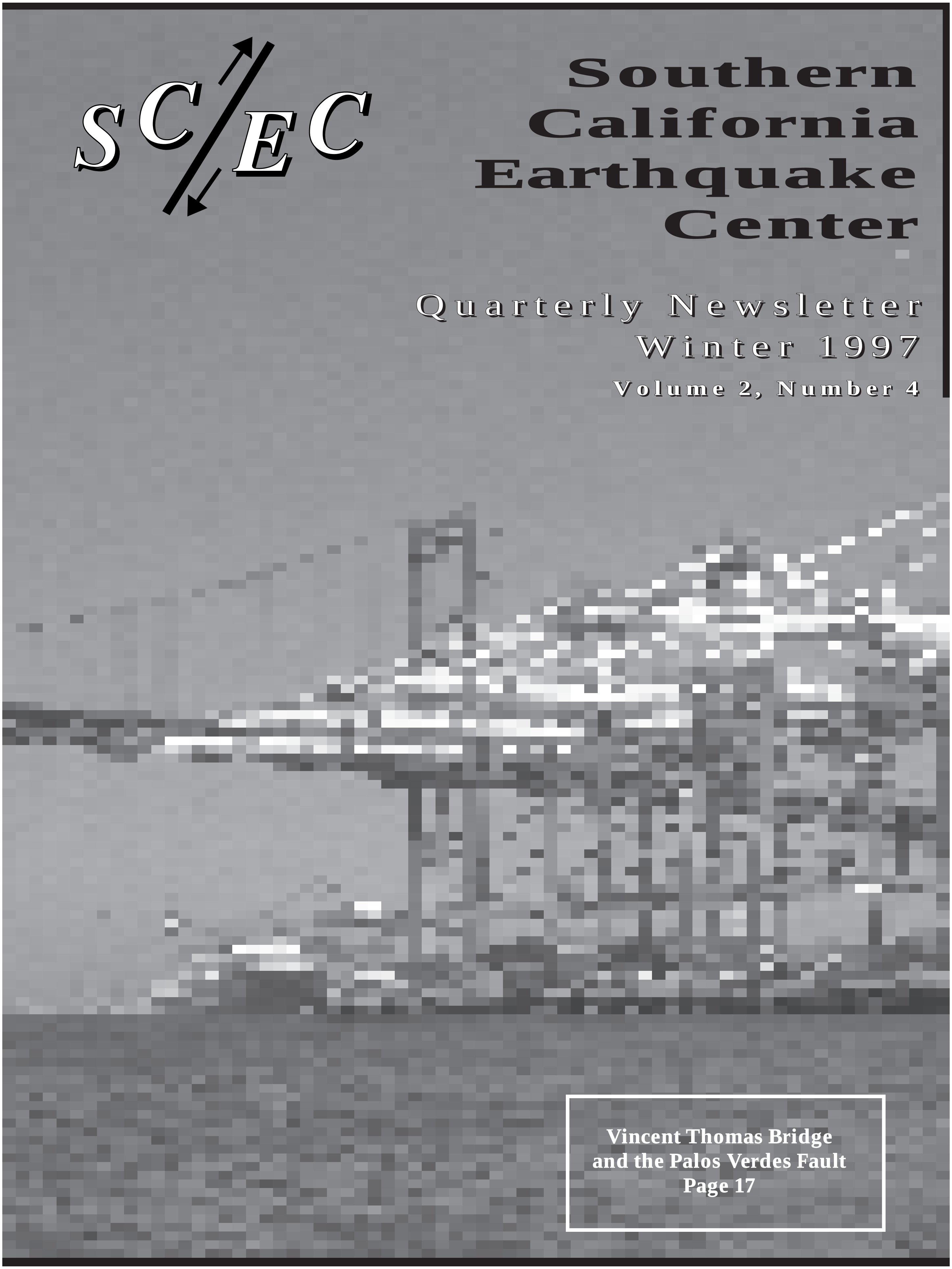
SCEC

Southern California Earthquake Center

Quarterly Newsletter
Winter 1997
Volume 2, Number 4



Vincent Thomas Bridge
and the Palos Verdes Fault
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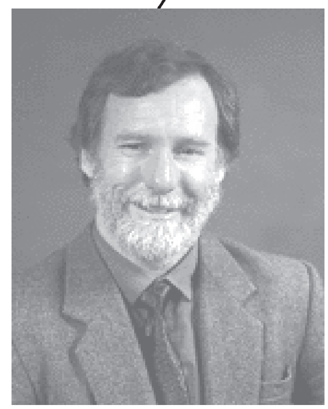
From the Center Directors...

Center Director

Science Director



Competitive New Programs

With six years under our collective belts, and a successful renewal of the Center for the next five years, it is worth reflecting on one of the things we do best — namely, spearheading major new initiatives in earthquake research. Major initiatives require several elements that have become an intrinsic part of the Center: 1) participation by a broad segment of the scientific community, 2) consensus building within that community, 3) a well-developed and well-articulated scientific plan, and 4) a good organizational and management structure. The Southern California Integrated GPS Network (SCIGN), initially sponsored by NASA, and with new funding recently announced by NSF ($2M) and the W.M. Keck Foundation ($5.6M), is perhaps our best example to date. But in a sense, the Phase II and Phase III reports are also major initiatives that would not have occurred without the Center.

The ability of SCEC to initiate major projects is a strength that we should seek to exploit for the benefit of the earth sciences community both locally and nationally. In particular, we are in competition with astronomers, physicists, chemists, and biologists for an ever-dwindling supply of basic scientific resources from traditional funding agencies, foundations, and the private sector. This was clearly the case with SCIGN. Consensus-building goes a long way in convincing funding entities, including Congress, of the efficacy of a new scientific program, and the need to push back certain frontiers.

As most of you probably know, we now have a newly-appointed head of the Earth Sciences Division at NSF — Dr. Ian Mc Gregor. At the recent American Geophysical Union meeting in San Francisco, Ian reinforced some of these points by commenting that as the new Division head, he would welcome dialogue (and presumably some action) on exciting new directions in the earth sciences — i.e., major programs or initiatives that would be competitive with those being proposed by the other sciences, and might even grab the attention of Congress.

It is our feeling that rising to this challenge represents both an opportunity and a duty of the Center. Not only might we have an chance to further the scientific scope and impact of the Center, but also, because the Center has many of the right ingredients as noted above, we are a logical group to help lead the charge on behalf of the entire earth sciences community. As your Directors, we hope to open dialogue on this issue in the not-too-distant future, and will welcome the input and / or participation from any or all.

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; and,
- 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*

SCEC Annual Meeting Report

Palm Springs the Site of the Sixth Annual Meeting

The 1996 SCEC Annual Meeting, held October 20-22, 1996, attracted the largest number of participants in five years. Over the course of the three-day meeting, priorities were established by the working groups and administration, in preparation for fiscal year 1997 (February 1, 1997 - January 30, 1998). The SCEC Annual Report, due to be published this month, will include progress reports from principal investigators funded in 1996. Proposal categories include Infrastructure, Science, Education and Outreach, and Workshops.

A general paper on the 1997 Scientific Mission for SCEC was circulated to all researchers interested in submitting proposals. Excerpts of the Center's Scientific Mission, Working Group goals, and Knowledge Transfer and Education Programs are featured here.

As in previous years, all proposals are evaluated by disciplinary working group leaders and the science director. Following the evaluation period, group leader recommendations will be reviewed by the SCEC Board of Directors (in late January). Final selection of research projects are made by the SCEC science director, in consultation with the SCEC Board of Directors.

1997 Scientific Mission

The Center's mission is to promote earthquake hazard reduction by defining when and where future damaging earthquakes are likely to occur in southern California, calculating expected ground motion, and communicating this information to the community at large. The scientific objectives can be described as an attempt to answer the following four questions:

Question 1: What are the sources of future earthquakes in southern California? Research tasks include estimating the location and focal mechanisms of earthquakes, estimating the geometry and slip rates of active faults, determining the size and extent of past ruptures on these faults, geophysical measurements of fault properties, and measuring the strain-rate field.

Question 2: What are the probabilities, as a function of magnitude, location, and time, of earthquakes in southern California. Research tasks include formulating and testing stationary or time-dependent seismicity models, formulating and testing hypotheses of fault segmentation, modeling stress interactions among faults and earthquakes, and simulation of long-term earthquake recurrence. Proposals that infer characteristic earthquake magnitudes from fault geometry using existing models address Question 1, while projects to test these models or to develop new ones respond to Question 2.

Question 3: What are the characteristics of earthquake rupture? Research tasks include geological and geodetic investigations of the detailed slip distributions of recent earthquakes; inversion of seismic waveform data to determine rupture progression in recorded earthquakes; examining seismic waveform data for effects of segmentation; postseismic investigations to detect seismic velocity, stress, or heat flow variations caused by recent earthquakes, and theoretical rupture calculations.

Question 4: How do source, path and site effects influence seismic ground motion? Research tasks include construction of velocity models for use in waveform modeling; collection of shear-wave velocity, surface geology, and other data relevant to site effects; statistical studies of the effectiveness of techniques for modeling linear and nonlinear site effects; numerical modeling of waveforms; investigations of the non-uniqueness in interpreting

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Annual Meeting *continued from Page 3 ...*

observed waveforms; testing of complete seismogram calculations using available full-waveform data; and calculation of theoretical seismograms for scenario earthquakes.

SCEC Scientific Working Group Leaders

A: Master Model: David D. Jackson, UC Los Angeles
B: Strong Motion Prediction: Steve Day, San Diego State Univ.
C: Earthquake Geology: Kerry Sieh, Caltech
D: Subsurface Imaging and Tectonics: Robert Clayton, Caltech
E: Crustal Deformation: Kenneth Hudnut, USGS Pasadena
F: Seismicity and Source Parameters: Egill Hauksson, Caltech
G: Earthquake Source Physics: Leon Knopoff, UCLA
H: Engineering Applications: Geoffrey Martin, USC

*This year, Groups D and F will be merged.

Working Group Goals

Group A: Master Model Construction and Seismic Hazard Analysis

The general goals of Group A are (1) to complete the preparation and publication of the “Phase III” report on Seismic Hazards in Southern California, (2) to develop the “online Phase III report,” that is the capability to revise input data and models used in the report, and to allow selected users limited interactive capability to apply the methodology for user-defined cases, and (3) to develop and test realistic models of stress interactions from past earthquakes on active faults.

Many topics covered in the Phase III report overlap those covered by other working groups. The distinction between Working Group A efforts and those others is that Working Group A activities carry a higher commitment to integration with related studies and to producing data in standard format with strict deadlines. For example, geologic studies to determine the geometry and slip history of certain sites is covered by Working Group C; identifying coordinates and slip rates of all fault segments to be used in seismic hazard calculations, providing these data in standard tables, obtaining consensus from the larger community on the values to be used, and assuring valid use of the data is a task for Working Group A.

Scientists in Group A may address these major questions:

- Sources of future earthquakes
- Earthquake probabilities
- Characteristics of rupture
- Seismic ground motion

Annual Meeting Poster Session...

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Group B: Ground Motion Modeling

The focus of Group B is on the prediction of ground motion time histories from earthquakes, and all aspects of Question 4 ("How do source, path, and site influence seismic ground) may be addressed.

Areas of special emphasis include the following:

Annual Meeting *continued from Page 4 ...*

- Synthetic time history computations for scenario earthquakes.
- 3D modeling of basin effects on ground motion, with particular reference to Los Angeles Basin.
- Site effects. A priority will be research to establish which observables (e.g., surface geology, borehole logs, coda spectra, etc.) are the best predictors of site amplification of strong ground motion.

Group C: Earthquake Geology

Group C is beginning a major change in focus. In 1997, the Group's efforts will be focused in three areas.

- Paleoseismic research along the southern half of the San Andreas fault. We intend to expand and improve significantly the observational basis for physical models of the fault's behavior over several earthquake cycles.
- Paleoseismic research within the metropolitan region. We intend to determine whether large-magnitude (M 7+) events have been produced by metropolitan faults in the past few tens of thousands of years.
- Investigations of various neotectonic and paleoseismic problems in southern California. Projects that do not fall under the umbrella of the above two projects, but address fundamental problems of seismic hazard evaluation and fault behavior.

Group D: Subsurface Imaging, Seismicity, and Tectonics

At the Annual Meeting in Palm Springs it was decided to combine Groups D and F under the single title Subsurface Imaging, Seismicity, and Tectonics. The goals and specific areas of interest are now combined from both groups.

Group D will continue its 5 year plan of investigations in the following areas:

- Integrated velocity models and seismicity parameters.
- Subsurface structure of the L.A. Basin
- Relationship of seismicity patterns to structure.
- Dynamic and kinematic tectonic studies
- Measurements of fault zone properties
- Stress measurements
- High-resolution studies of shallow fault zones

These objectives contribute to all questions raised in the overall SCEC plan.

At the 1996 Annual Meeting at Palm Springs, the following

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Annual Meeting *continued from Page 5 ...*

specific areas of research were identified:

- Final analysis of existing LARSE data
- Integration of Basin velocity models with regional models.
- Relocation of seismicity catalogue in the new model, and the integration of source parameters (i.e. mechanisms) in the catalogue.
- Use of trapped waves to measure fault-zone properties
- Development of dynamic tectonic models
- Evaluation of high-resolution techniques
- Acquisition and archiving of industry seismic and borehole data.
- Pre-proposal for a new active source LARSE survey on the Northridge line (LARSE Line 2), possibly including a survey across the Santa Monica Fault to determine strong-motion focusing effects.
- Rapid determination of source parameters from near real-time ground motion measurements.
- High Resolution Imaging of barrier and fault segmentation.

Group E: Crustal Deformation

Group E aspires to apply the SCEC Velocity Map release 1.0 results, as well as other high precision geodetic measurements, to all tasks outlined in the RFP, and in particular to identifying earthquake sources (Question 1) and assessing earthquake probabilities (Question 2).

Group E goals are divided into infrastructure and science - the former is defined somewhat more broadly than is done by other groups, and is meant to include the provision of data for crustal deformation and master-model studies. The “science” goals are more focused on the interpretation of such data. The order is (very roughly) from higher to lower priority in each category.

I. Infrastructure:

- Continued SCEC contribution towards operation of the SCIGN PGGA network, to provide a regional framework for other GPS studies and to begin to elucidate more details of deformation in the Los Angeles region. (responds to Question 1).
- Continuing work towards production of second release of the SCEC velocity map. This includes continuing data processing and analysis (and some software support) by 3-4 institutions working together (responds to Question 1).
- Operation of an archiving facility to get field GPS data onto the Caltech archive, in support of continuing work on the Velocity Map (responds to Question 1).
- Continued operation of PFO to provide a detailed time history of strain (Responds to Question 2).

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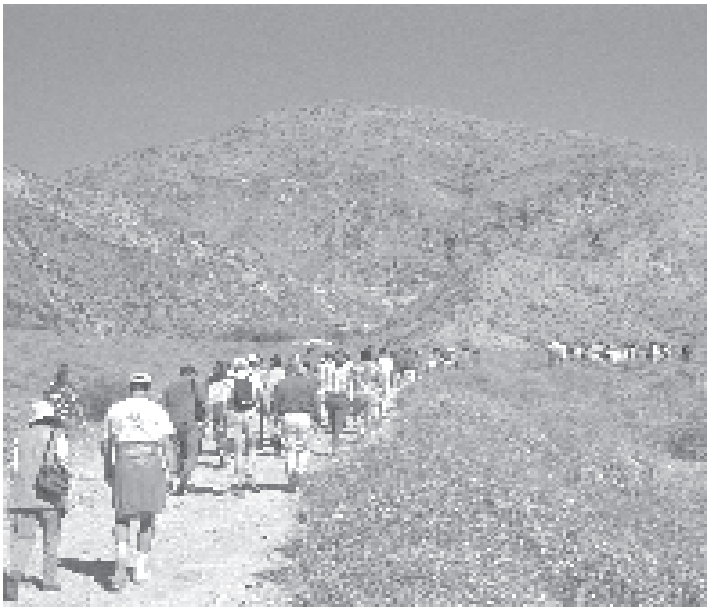
Annual Meeting



Annual Meeting *continued from Page 6 ...*

Field Trip...

- Additional GPS fieldwork, in support of the Velocity Map and to address specific SCEC tasks and the issue of fault segmentation.

II. Science

- Interpretation of velocity maps: How to convert from velocity to strain to hazardous strain? (Shared with Groups C and A; responds to Question 2).
- What geodetic signals are expected from geophysical models, especially in the Los Angeles region? (responds to Question 1).
- How can we infer stress change, especially at seismogenic depths, from surface displacements? (responds to Question 2).
- What is an accurate error model for continuous GPS data? (responds to Question 2).
- Postseismic phenomena: Are there regional, long period signals? If so, how may they be explained? Are there changes in aseismic slip rate on neighboring faults following moderate to large earthquakes in the region (e.g., Landers and Northridge)?
- What can be learned about co-seismic slip heterogeneity? (responds to Question 2).

Group F: Source Processes and Seismicity

Group F has now been combined with Group D.

Group G: The Physics of Earthquake Sources

Proposals to this group will be evaluated in terms their application to the list below, as well as their presentation of evidence for interaction with the other working groups, and especially Working group C.

- Regional seismicity
- Friction during individual earthquake events
- Stress transfer at long-range
- Source-time slip functions

Workshops

Workshops on unresolved issues in the Phase-II and Phase III reports are particularly encouraged for 1997. These issues include: (1) long-term changes in seismicity, including the effects of stress increments from earthquakes (2) aseismic release of accumulating strain, (3) maximum magnitude for each source zone (4) fault segmentation, (5) modeling of observed full-waveform seismograms. Workshops that involve participation of earthquake engineers and other groups addressing earthquake hazards are also encouraged.

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SCEC Research Report

SCEC Releases Deformation Map Based on GPS, Trilateration Measurements

The Crustal Deformation Group of the Southern California Earthquake Center released its first version of the Horizontal Deformation Velocity Map at the 1996 SCEC Annual Meeting in Palm Springs. This work represents a benchmark of the group's ongoing effort to synthesize all the Global Positioning System (GPS) and Electronic Distance Meter (EDM) data collected in southernCalifornia t SCEC Releases Deformation Map Based on GPS, Trilateration Measurements

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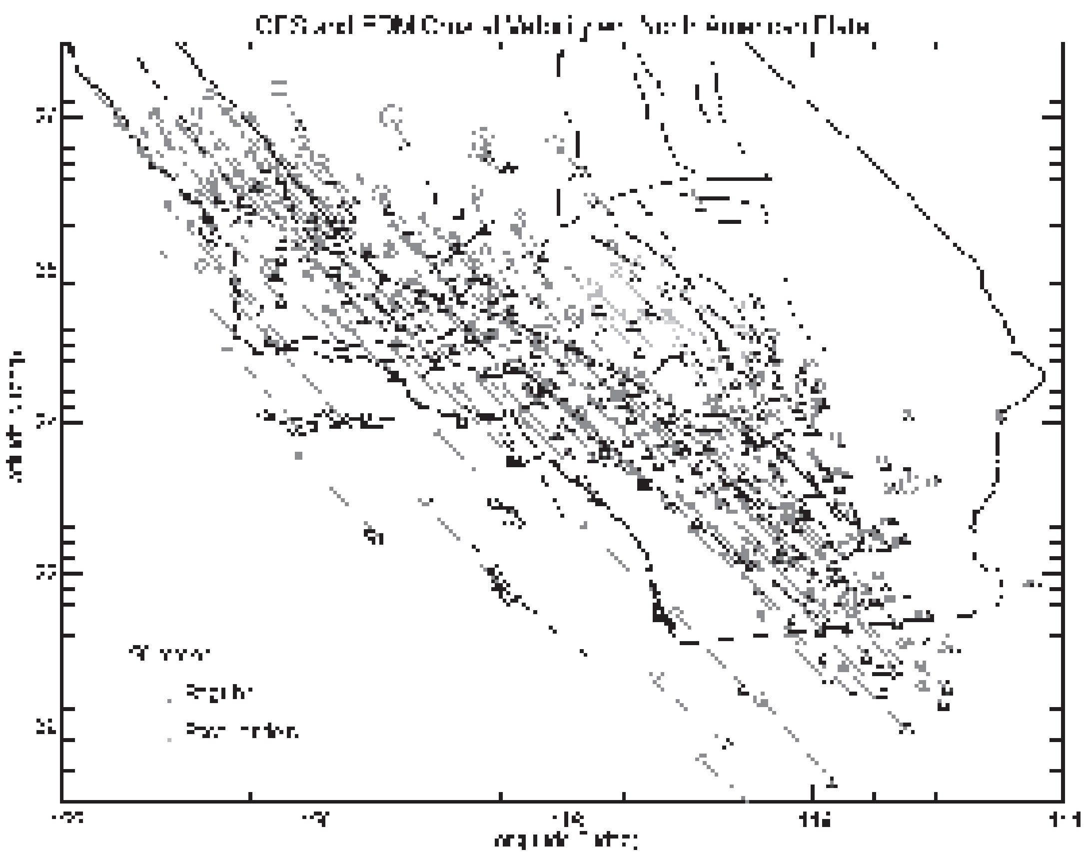

Estimated GPS and EDM velocities with respect to North America Plate. Error ellipses represent one standard deviation.

community, evidenced by frequent visits to the velocity map web site. The number of such visits has reached 270 as of December 4, 1996. One of the enthusiastic users of the velocity map result is Richard Snay of the National Geodetic Survey (NGS). After some analysis, he found "these vectors to be of such quality that they made the horizontal velocity field that the NGS had derived from triangulation and other geodetic data essentially obsolete for this part of California."

Realization of such a velocity map has been near the top of the list of SCEC tasks ever since the founding of the Earthquake Center. Such a map charts the interseismic crustal deformation anywhere in southern California, and is a powerful tool for detecting contemporary fault activities and potential seismic risks. This version of the velocity map is beginning to show its importance in seismic hazard estimation. In the SCEC Phase III model, this first release of the SCEC velocity map will provide the geodetic information crucial to estimating the seismic moment distribution in southern California.

The GPS data used in the velocity map were collected between 1986 and 1995 by people from many universities and government agencies, such as UCLA, UCSD, Caltech, MIT, USGS, NGS, JPL, Caltrans, LA City, LA County, Riverside County, Orange County, and San Bernardino County. The data include observations from a state-wide experiment: Caltrans High Precision GPS Network (HPGN) from 1991 to 1994, and many regional campaigns. The regional surveys include the Transverse Ranges Experiment (TREX), 1986-1991; the Salton Trough and Riverside County (STRC) surveys, 1988-1995; the Los Angles Basin experiments (LABS), 1987-1993; the Inter-county survey, 1993, the Ventura Basin experiments, 1992-1993; the Santa Maria Basin experiments, 1990-1994; the Santa Barbara Channel experiment, 1991; the Landers Post-seismic Joint Survey, 1992; the Gorman survey, 1992; and the Mojave Desert experiments, 1994-1995. Each site had several years of occupation, with at least a couple of days of measurements at the site each year. The EDM data were collected by California Division of Mines and Geology and USGS consecutively during a time period from 1969 to 1992.

To model the velocity field, we assume that the crust moves at a constant rate except at the time of an earthquake. A sudden displacement is allowed for a site at the time of the earthquake if the site is located close enough to the earthquake hypocenter to cause more than a millimeter of coseismic displacement. We first adjusted the GPS and EDM data separately to obtain their velocity and coseismic displacement solutions. The Joshua Tree, Landers, and Northridge earthquakes were modeled for their coseismic displacements in the GPS solution. The GPS solution was also constrained using fiducial velocities derived from Very Long Baseline Interferometry (VLBI) at global sites. Then we combined the GPS and EDM velocity solutions together through a least squares procedure, forcing the GPS and EDM horizontal velocities of about 2-dozen mutually observed sites to be equal. A total of 287 site velocities were obtained.

A quick look of the velocity map has already revealed some important features of tectonic deformation in southern California:

- The relative plate motion across the plate boundary in southern California is about 52 mm/yr. This number is close to the prediction of 50 mm/yr from the global plate motion model NUVEL-1A.
- Significant postseismic deformation (>10 mm/yr) is found in the Landers epicentral area during a 3-year time period after the earthquake.
- In addition to strain concentration along the San Andreas, geodetic strain rates are large in the vicinities of the Coalinga Anticline, the White Wolf fault, the Imperial Valley-Brawley seismic zone, and the Mojave Shear Zone. These were the sites of the 1983 Coalinga, 1952 Kern County, 1940 and 1979 Imperial Valley, and 1992 Landers earthquakes, respectively. Thus the geodetic strain rates seem to mimic the historical seismic strain pattern in southern California. More detailed analyses of the velocity map result will be presented by the SCEC researchers at the Fall AGU Meeting.

The Crustal Deformation Group intends to update the velocity map periodically. More data will be processed and included as they become available, so the spatial and temporal coverage will be more complete. One particularly important data set will come from the Southern California Integrated GPS Network (SCIGN), a group of permanent stations whose number has been growing steadily since the foundation of the network a few years ago. Inclusion of this data set to the velocity map will allow more detailed analysis of the crustal deformation, including possible changes in the velocity field as a result of the earthquakes.

More information, including numerical values of the site velocities and their uncertainties, can of course be found on the World-wide Web:

http://scec.ess.ucla.edu/velmap/welcome.shtml

For information on SCIGN, try:

http://www.scecdc.org/scign/

Zheng-kang Shen

Acknowledgements:
This version of the horizontal deformation velocity map has been prepared by Zheng-kang Shen, Li-yu Sung, Danan Dong, Bob King, and Simon McClusky. Major contributors include Duncan Agnew, Rick Bennett, Yehuda Bock, Michael Cline, Andrea Donnellan, Peng Fang, Brad Hager, Tom Herring, Ken Hudnut, David D. Jackson, David Potter, Rob Reilinger, and Steve Salyards. The Crustal Deformation Working Group consists of Duncan Agnew, Andrea Donnellan, Yehuda Bock, Brad Hager, David D. Jackson, Ken Hudnut (Chair), Ross Stein, Bob King, Tom Herring, Steve Ward, and Zheng-kang Shen. The author thanks Ken Hudnut and David D. Jackson for their suggestions and contributions to the writing of this newsletter article. ♦

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Knowledge Transfer

The five-year goal for SCEC's Knowledge Transfer program is to develop and promote meaningful, mutually beneficial partnerships among funding agencies, government entities and public and private sector end user groups, while producing usable, marketable earthquake hazard and risk mitigation products.

We plan to accomplish our goal by developing and maintaining, through a combination of personal contact and use of multimedia tools, meaningful and productive interactions with all entities concerned with earthquake hazards and risks.

Projects and Products

- Workshops\Conferences
- Field trips and guidebooks
- Scientific Reports
- Publications - both scientific and non-technical
- Quarterly Newsletter
- Speakers' bureau
- Development of Internet capabilities (i.e., Web Site)
- Link to Earthquake Information Network
- Established, formal partnerships with key organizations
- Participation in all appropriate associations, information clearinghouses, and organizations concerned with earthquake hazards and mitigation.

Education

The mission of SCEC's education program, Global Science Classroom, is to highlight SCEC science through the development and dissemination of educational experiences, materials and exhibits, and through creative approaches to teacher enhancement and student activities.

Three goals have been established: (1) To influence and impact earth science education at the national level; (2) to develop educational support tools for earthquake science education; and (3) to provide leadership services in earthquake and earth science education for secondary and undergraduate schools**.** The following list describes some of the projects in progress:

Activities that promote attention to National Science Education Standards and the National Mitigation Strategy: Influencing seismic safety in schools through the development of a handbook that describes the post earthquake support system for school districts is a new area of educator training in which SCEC can make a contribution. The handbook will be one of the products of the study completed jointly by SCEC and the California State Governor's Office of Emergency Services. A series of school district workshops will be developed and implemented.

Activities that promote systemic reform/restructuring of science education K-12 in selected local school districts: Continuation of the SCEC / Palos Verdes School District Partnership and the development of new partnerships with La Canada and Rialto on an accelerated schedule will help with these districts' restructuring plans. SCEC scientists will mentor semester-or year-long student research projects, a student-conducted community preparedness survey, staff development (teacher training) workshops, support for teacher summer research projects and development and upgrading of science courses. Additionally, FEMA's *Tremor Troop* and *Seismic Sleuths* workshop funding will be directed at staff development activities in these districts**.**

Activities that promote Center visibility and sustainability through the development and distribution of original educational products that highlight SCEC scientific research: The development of a Teacher's Activity Guide to *Putting Down Roots in Earthquake Country* is just one of the ways that SCEC is efficiently "repurposing" previously-developed earthquake education materials. A teacher's guide will be developed and distributed as a special supplement for K-12 teachers. The work will be carried out by a FEMA Education Intern assigned to USGS seismologist Lucile M. Jones. SCEC Science Modules are the basic building blocks for the long term development of a California Student Seismic System. "Virtual Ancient Earthquakes" on paleoseismology and "Focus, Snap!" on earthquake physics are scheduled for development in 1997.

From the successful outcome of the first CUBE (Caltech / / USGS Broadcast of Earthquakes) Educational Users workshop held in December, 1996, CUBE will be offered to museums, libraries and other schools and supported by one one-day training workshops. Ten new educational users will be trained and outfitted with CUBE software, curriculum and training.

Activities that promote career development of earth science students, with special attention to minorities and women: SCEC will continue to support at least 10 earth science undergraduate student research projects this year through its SCEC Summer Intern Initiative. In addition, it will support three Academic Year Science Education Internships with departments / schools of education through funding from FEMA. SCEC plans to support 20 students who will present papers at the Undergraduate Symposium on Earth Sciences at the Annual Meeting of the Southern California Academy of Sciences in May.

Activities that prepare educators in the earth sciences: SCEC has cultivated a community of faculty from state universities, community colleges and private institutions. As part of an ongoing series of workshops, we propose to conduct, "A Big One on the San Andreas or the Other Big Ones on Los Angeles' Urban Faults: A New Consensus?" which will feature dialogue, discussion and debate with SCEC scientists. ♦

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. The most recent publications by SCEC researchers are listed below.

All papers which 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.usc.edu/go/scec.*

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

Mark Benthien, Outreach Specialist
Southern California Earthquake Center
USC, University Park Campus
Los Angeles, CA 90089-0742

email: scecinfo@usc.edu
tel (213)-740-0323
fax (213)-740-0011

Recent Submissions

354. Bevis, M., Y. Bock, P. Fang, R. Reilinger, T. Herring, J. Stowell, and R. Smalley, MOST: A New Strategy for Regional GPS Geodesy, EOS, Transactions of the American Geophysical Union, in press, 1996. (No abstract.)

355. Li, Y. G., F. L. Vernon, and K. Aki, Observations and Implications of Fault-Zone Guided Waves at the San Jacinto Fault Near Anza, California, Journal of Geophysical Research, submitted, 1996.

We deployed three 350 meter-long 8-element linear seismic arrays at the San Jacinto Fault Zone (SJFZ) near Anza, California, to record microearthquakes during August to December of 1995. Two arrays were deployed 18 km northwest of Anza, across the Casa Loma fault (CLF) and the Hot Springs fault (HSF) strands of the SJFZ. The third array was deployed across the San Jacinto fault (SJF) in the Anza slip gap. We observed fault-zone guided waves characterized by low frequency, large amplitudes following S-waves only at the CLF array and the SJF array for earthquakes occurring within the fault zone, but not at the HSF array for any events. The amplitude spectra of these guided waves showed a peak at 4 Hz at the CLF, and 6 Hz at the SJF, which decreased

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Selected Research Abstracts

Analysis of Aseismic Deformation in the Upper Crust of Southern California

Introduction

The purpose of this research is to assess the contribution of aseismic deformation to regional shortening in southern California during the last 5 Ma. Recent SCEC studies (e.g., Dolan et al., 1995) suggest that deformation rates determined by geologic and geodesic studies are far in excess of that which can be accounted for by historical seismicity and thus a deficit of moderate and / or large earthquakes exists in southern California. These authors, however, did not consider the contribution of aseismic deformation to regional strain. Studies have shown that earthquakes account for only 10-70% of the geodetic and geologic deformation rates in orogenic belts (North, 1974; Molnar and Chen, 1982; Ekstrom and England, 1989) and thus aseismic deformation mechanisms must be considered when forecasting earthquakes from deficits in the seismic budget. Our preliminary findings from the Ventura basin suggest that aseismic deformation mechanisms contributed to regional shortening strain in southern California.

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Exploring Options for Seismic Zonation in the City of Los Angeles: SCEC Delivers Preliminary Report

On Friday, January 17, 1997, the third anniversary of the Northridge Earthquake, SCEC produced a preliminary report on the October 30-31 workshop. The report, issued to the Los Angeles City Council and Mayor Richard Riordan, briefly summarizes the highlights of the workshop and outlines possible next steps. The following is an excerpt from the report by Tom Henyey.

Recent earthquakes in the Los Angeles metropolitan area, including the 1987 Whittier Narrows and 1994 Northridge events have re-focused our attention on the region's earthquake hazard. It is now clear that the City of Los Angeles and surrounding municipalities are located over a complex web of active earthquake faults capable of producing potentially damaging earthquakes every few decades. While these recent earthquakes have resulted in significant damage and even death, they have also added substantially to our understanding of where earthquakes are likely to happen in the future, and most importantly, what kinds of ground motions we can expect.

At the request of Councilman Hal Bernson, the Southern California Earthquake Center in conjunction with the City of Los Angeles and the California Division of Mines and Geology held a workshop on October 30-31, 1996 to take stock of our current level of understanding of the earthquake hazard, and whether new strategies might be implemented to reduce earthquake risk in the future. In addition, the workshop provided a forum for renewing the dialogue among engineers, earth scientists and planners. Although engineers and earth scientists have different responsibilities vis-a-vis the earthquake problem, an effective earthquake mitigation program demands that good communication exist between the two groups. Earth scientists must understand what seismic information engineers require for earthquake resistant design, while engineers must be cognizant of the extent of earth scientist's knowledge of earthquake ground motions, liquefaction, and landsliding. Planners must understand the current state of knowledge and its uncertainties.

The primary purpose of the workshop was to examine to what extent variable seismic zonation (microzonation) makes sense given our current level of knowledge regarding the earthquake hazard in the metropolitan region, and the extent to which uncertainties in our understanding may make such zonation, or variations in the building codes, impractical. Of specific concern are the siting of critical public facilities such as hospitals, schools, and emergency response centers, and the evaluation and retrofitting of unreinforced masonry and non-ductile concrete structures.

The workshop first explored the nature of earthquake risk in Los Angeles on existing buildings and what measures are being taken to mitigate earthquake damage. Next, the implications of microzonation needs to satisfy future code requirements for new buildings were examined. This was followed by a discussion of the earthquakes likely to cause damage in the city, and what the patterns of strong ground motions were likely to be. And lastly opportunities for secondary earthquake hazard (liquefaction and landsliding) loss reduction was discussed in the context of California's seismic hazard mapping act.

The workshop proved to be a great success in bringing together the relevant constituencies in earthquake risk mitigation in Los Angeles, reviewing the current state of knowledge, and formulating the next steps which include:

- Establishing a vehicle for continuing dialogue among the relevant groups,
- Continuing education of public officials about the new information and how it can be used,
- Identifying products and projects that would benefit the City over both short and long terms,
- Holding workshops for other concerned end users (e.g., the financial community), and
- Opening lines of communication on hazard mitigation planning among neighboring communities and jurisdictions.

Note: The final report will be released in March, 1997. —DQN Ed.

USGS News

U.S.-Japan Natural Resources Panel Report

This UJNR panel is the primary government-to-government connection between researchers in the U.S. and their counterparts in the science and technology agencies in Japan for a broad spectrum of earthquake-related activities. This issue of SQN highlights the proceedings of the meeting and provides more information on the Earthquake Disaster Mitigation Partnership.

The first meeting of the US-Japan National Resources (UJNR) Panel on Earthquake Research under the new Earthquake Disaster Mitigation Partnership took place at the Doubletree hotel in Pasadena on Nov. 12 and 13. This meeting is a continuation of the UJNR panel on Earthquake Prediction Research which has previously had 9 biennial meetings. U.S. and Japanese scientists presented 31 technical papers on a variety of earthquake research topics. The first day there were talks on large-scale crustal deformation monitoring projects (GPS, SAR, VLBI) in the U.S. and Japan along with presentations on seismicity and strong ground motion in the two countries. The second day focused on studies of active faults, especially those that have produced significant earthquakes near cities (Kobe, Los Angeles). The final session explored areas where the two countries can establish cooperative projects in earthquake research under the Common Agenda agreement that was signed by the 2 countries. Possible projects include space technologies for monitoring of crustal deformation, realtime seismology, fault-zone studies (including drilling and paleoseismology), and hazard estimation.

On Nov. 14, there was a field trip led by Jim Dolan of USC to see faults in the Los Angeles Basin and features on the San Andreas fault. The meeting was hosted by SCEC and the USGS with John McRaney providing much of the organizational preparations.

Following is the resolution that was adopted at the end of the meeting.

Resolution of the First Joint Meeting of the U.S.-Japan Panel on Earthquake Research following the Ninth Joint Meeting of the U.S.-Japan Panel on Earthquake Prediction Technology

New Panel

The renaming of the UJNR panel on Earthquake Prediction Technology marks the beginning of a new phase of cooperation between the earthquake programs in the U.S. and Japan. The newly named panel on Earthquake Research continues the work of the previous panel, which has provided much of the basis for the current earthquake research programs in the two countries. Recently the focus of much earthquake research has shifted from earthquake prediction toward a more fundamental understanding of the earthquake process and hazard estimation. So, it is appropriate that a new panel be formed to address the challenges of the new set of problems.

Common Agenda

The new UJNR panel recognizes the potential benefits of working together to achieve the goals set forth in the Common Agenda. This agreement seeks cooperative work between our two countries that will accelerate the efforts in earthquake hazard reduction. Among the stated priorities of this agreement, the Earthquake Research Panel will take a lead role in implementing bilateral programs to

- Quantify the potential for future earthquakes
- Test basic theories about the sources of earthquakes
- Understand the near-source ground motions
- Develop and improve real-time seismic systems
- Improve the modeling of ground motions

Areas of Cooperation

Some specific areas of earthquake research where cooperative research between the U.S. and Japan may lead to significant advancements include, but are not limited to

- Space technologies for measuring crustal deformations
- Realtime seismic systems
- Fault-zone physics
- Paleoseismology
- Seismic hazard estimation

The panel strongly urges that the appropriate agencies in the U.S. and Japan, that are represented on this panel, work together to support and coordinate the scientific work in these areas of cooperation.

The new panel recognizes the success of the previous panel in promoting exchange of scientific personnel, exchange of data, and fundamental studies that may lead to earthquake prediction. The panel endorses continuation of these activities.

Next Meeting

The next meeting will be held in Japan in the autumn of 1998.

James Mori
US Geological Survey
Pasadena, CA

Recent Submissions *continued from Page 11 ...*

sharply with the distance from the fault trace. In contrast, no spectral peaks at the frequency lower than 6 Hz were registered at the HSF array. We used the finite-difference method to simulate these guided modes as S waves trapped in a low-velocity waveguide sandwiched between high-velocity wall rocks. While the results are non-unique, the guided mode data are adequately fit by a waveguide 120 m wide on the CLF where the S-velocity is 2.7 km / s, and 50 m wide on the SJF in the Anza slip gap where the S-velocity is 2.9 km / s; the S-velocity within the waveguide is reduced about 20 to 25 percent from that of the surrounding rock. But, there is no low-velocity waveguide on the HSF at depth. We tentatively interpret that the distinct low-velocity waveguide on the CLF was a result of the rupture of the 1899 M7.0 earthquake occurring near the towns of San Jacinto and Hemet while the HSF was not ruptured in this event. Locations of the events with guided modes further infer that the fault-plane waveguide along the CLF, to a depth of at least 18 km, dips northeastward at 75-800. The waveguide becomes nearly vertical along the SJF in the gap.

356. D. Dong, T. A. Herring, and R. W. King, Estimating regional deformation from a combination of space and terrestrial geodetic data, Journal of Geodesy, 1997.

An approach of efficiently combining various types of geodetic data to estimate a crustal deformation field is discussed. Three-step analysis procedures, quasi-observations and general constraints (“soft” constraints) are employed to ensure both rigor and efficiency of the combination solution. The corresponding statistical tests for checking the compatibility between different data sets and for calculating normalized root-mean-square (nrms) are developed and addressed. An empirical non-integer degree of freedom is defined to handle the case of general constraint and stochastic perturbation in parameter space, and the increment of “weighted sum of squared residuals” is defined in the form of Kalman filtering. With these developments, we show an example of combining space and terrestrial geodetic data to obtain the deformation field in southern California.

SCEC Researcher Yan Kagan

To access an extended abstract of Dr. Yan Kagan’s November 7, 1996 presentation at the Royal Astronomical Society and the Joint Association for Geophysics “A DISCUSSION MEETING ON: ASSESSMENT OF SCHEMES FOR EARTHQUAKE PREDICTION,” go to his Web site at:

http://scec.ess.ucla.edu/ykagan.html
or
ftp://minotaur.ess.ucla.edu/pub/kagan/ras.txt

Piñon Flat Observatory Web Site

This facility’s activities are partially supported by SCEC under the infrastructure budget of the geodesy group. The address is

http://ramsden.ucsd.edu

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, southern California 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
- WWW SCEC Home Page (*http://www.usc.edu/go/scec*)
- SCEC-Sponsored Publications; Scientific Reports

For more information on the Knowledge Transfer Program, contact Jill Andrews, phone 213/740-3459 or email *jandrews@coda.usc.edu*, or Mark Benthien, 213/740-1560; e-mail *ScecInfo@usc.edu*.

Independent Data Validates LARSE Discovery of San Gabriel Mountains Bright Spot

http://www.seismo.unr.edu/ftp/pub/louie/nr/smmig.html

The following short article should be of interest to SCEC participants who worked on the LARSE project, according to Dr. John Louie. The figure that the article refers to is available through the on-line version of the article. ÑSQN Ed.

Fuis et al. (1996) stacked explosion data from Los Angeles Region Seismic Experiment (LARSE) line 1, revealing a reflective bright spot at 15-19 km depth below the San Gabriel Mountains between Azusa in San Gabriel Valley and the San Andreas fault near Wrightwood. We undertook the imaging of a section below the San Gabriel Mountains near LARSE line 1 from seismic network recordings of the June 28, 1991 M5.8 Sierra Madre event and its aftershocks in an attempt to reproduce the bright spot seen by Fuis et al. (1996).

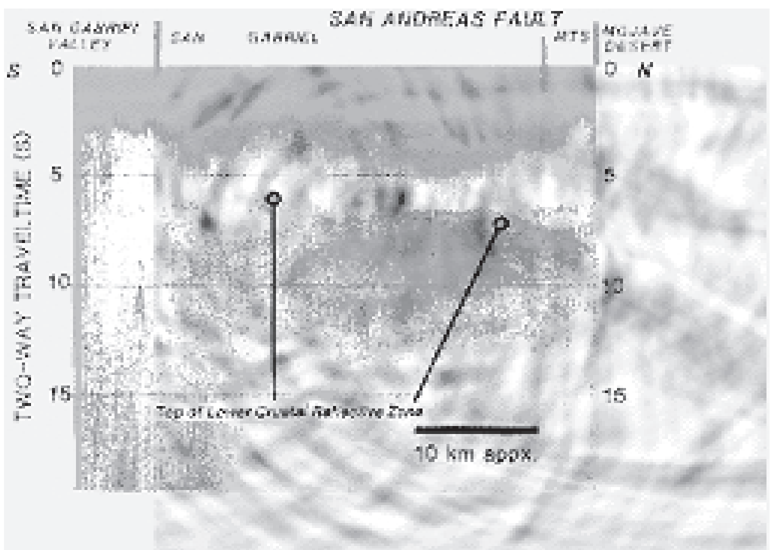
We imaged a 50 km long by 40 km deep section of crustal structure along a section striking straight north from Azusa, through the 1991 Sierra Madre sequence. Our section is thus several kilometers west of LARSE line 1 at its northern end, near the San Andreas fault. We used pre-stack Kirchhoff-sum 3-d migration, without accounting for lateral variations in seismic velocity, of records from 18 events including the Sierra Madre mainshock.

The image above overlays our migration (with relative reflectivities in grayscale) on the LARSE line 1 stack of Fuis et al. (1996; with relative reflectivities in color) assuming the stack is plotted with approximately no vertical exaggeration, and at corresponding locations. The locations on the two sections of the bright spot reflector correspond well, and there are hints that both sections also are imaging a diffractor at about 10 km depth below the southern side of the San Gabriel Mountains.

It is remarkable that the narrow-angle LARSE line 1 explosion data and the very wide-angle aftershock network records can show exactly the same reflective structure. Further, this fact suggests not only the veracity of the mid-crustal reflective zone, but also the accuracy of both data sets and imaging methods.

Further details are accessible at the WWW location above.

See WWW site (above) for a color and black-and-white depiction of the adjacent figure.



References: Fuis, G.S., D.A. Okaya, R.W. Clayton, W.J. Lutter, T. Ryberg, T.M. Brocher, T.M. Henyey, M.L. Benthien, P.M. Davis, J. Mori, R.D. Catchings, U.S. ten Brink, M.D. Kohler, K.D. Klitgord, and R.G. Bohannon (1996). Images of crust beneath southern California will aid study of earthquakes and their effects, EOS Trans. Am. Geophys. Union 77, 173-176.

J. Louie and S. ChaÔez-PeÔz
Seismological Laboratory
Mackay School of Mines/174
University of Nevada
Reno, NV 89557-0141
(702) 784-4219 fax (702) 784-1833
louie@seismo.unr.edu

Resolution of Site Response Issues From the Northridge Earthquake: "ROSRINE"

The ROSRINE project brings together a strongly coordinated group of geologists, geotechnical engineers and seismologists from a number of organizations to address geotechnical site characterization and ground motion response issues resulting from the Northridge earthquake. The work is co-funded by the National Science Foundation and the California Department of Transportation (Caltrans), and is leveraged by cost-sharing from the Electric Power Research Institute (EPRI), the Southern California Earthquake Center (SCEC), and the U.S. Geological Survey (USGS), and with cooperation from the State of California's Department of Conservation, Division of Mines and Geology (CDMG). SCEC serves as administrative coordinator for the various co-investigators.

The objectives of this project are:
1) Collection, compilation, and rapid dissemination of high-quality site geotechnical and geophysical data to the research community; and
2) Focused analyses limited to the following:

- Determining the extent to which local site and regional wave propagation effects control strong ground motion, including nonlinear site response;
- Evaluating the adequacy of the conventional approach to estimating site effects using measured shear-wave velocities, results of laboratory tests, and one-dimensional equivalent-linear and nonlinear analyses;
- Assessing the degree of model complexity (2- and 3- D analyses) required to adequately explain site effects; and
- Determining the uncertainties in measure properties and how these uncertainties affect ground motion predictions

The research objectives will be addressed in three phases by an integrated group of geologists, seismologists and geotechnical engineers. In Phase 1 a series of geotechnical investigations will be conducted at significant site of strong motion recording and/or structural failures.

Investigations will be performed at approximately 10 sites (eight strong motion site and two Caltrans design sites). Sites include Pacoima Downstream, Kagel Canyon, Newhall Fire Station, Arleta Fire Station, La Cienega & I-10, and Sepulveda Veteran's Administration. Investigations will include geologic logging, borehole logging (velocity and electric), and laboratory testing of soil/rock samples.

In Phase 2, data collected in Phase 1 will be evaluated and combined with results of other data collection efforts to establish standard 1-D geotechnical models that include material strain dependencies as well as 2- and 3-D structural models. A workshop will be held to facilitate the coordination of researchers (within and outside this project) and dissemination of data.

In Phase 3, investigators will perform site response analyses of the data collected in Phase 2. Comparisons will be made of ground motion response calculations to Northridge earthquake observations.

Dr. Robert Nigbor, Agbabian Associates

November 27, 1996 Coso Earthquake – Largest 1996 California Event

There was a moderate earthquake in the Coso area of southern California on November 27, 1996 at 20:17:23 GMT (12:17:23 PST). The hypocenter was located at 36.075N 117.650W with a depth of 1 to 3 km. The epicenter is 17 miles ENE of the town of Little Lake. The preliminary local magnitude (ML) was 5.0. The preliminary moment magnitude (Mw) from UC Berkeley was 5.1 . Focal mechanisms from both the first motions and the long-period surface waves showed a strike-slip solution with NE and NW nodal planes. The distribution of aftershocks tends to be elongated in a northeast-southwest direction suggesting left-lateral slip on a northeast trending fault plane, but the fault plane is still unclear.

In the 18 hours after the mainshock, we recorded over 225 aftershocks with 6 M3 events. In hindsight, we identified a small "foreshock" sequence that occurred 27 hours before the mainshock and had 3 M2 earthquakes with several smaller events. The closest telemetered strong-motion instrument recorded 2% g at Ridgecrest, about 40 km to the south. The region surrounding the earthquake is sparsely populated and there were no reports of damage.

This earthquake occurred in the area of the Coso geothermal fields which has frequent small earthquakes. This region has had vigorous swarms of many small earthquakes with several M4's in 1981, 1982-83, 1985 and 1992. The 1995-96 Ridgecrest sequence that included 3 M5 events occurred in an area 25 to 30 km to the south.

A list of current seismicity in southern California can be obtained by:
finger quake@scec.gps.caltech.edu

Maps of ground motion and seismicity for the current sequence can be seen on the USGS homepage at:
http://www-socal.wr.usgs.gov

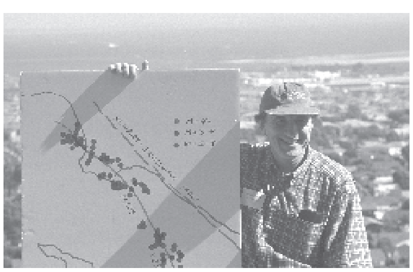
James Mori
Southern California Seismic Network
USGS Pasadena Office

The Palos Verdes Fault, a "Little San Andreas"

The following is an excerpt from the soon-to-be-published Palos Verdes Fault Field Trip Guide. Two field trips, one in October 1996 and one in February 1997, were led by SCEC scientists Tom Henyey and Tom Rockwell.

The October, 1996 field trip included a tour of the L.A. Harbor aboard the *Seawatch*, a Marine Institute yacht. Participants learned of results from Harbor studies and the hazard mitigation measures taken for future Harbor development.

The Palos Verdes Fault is a scaled down version of the granddaddy of all faults — the San Andreas. While the dextral San Andreas is slipping at roughly 30 mm per year in southern California, the Palos Verdes fault is slipping dextrally at about 3 mm per year. And while the San Andreas is 1,000 km long, the length of the Palos Verdes is approximately 100 km. And what's more interesting, the San Andreas has a "big restraining bend," along which the Transverse Ranges are being squeezed up, while the Palos Verdes fault has a "little restraining bend," along which the Palos Verdes peninsula is being squeezed up to the tune of about 0.4 mm / yr.



Tom Henyey displays a poster showing the Palos Verdes fault while co-leading the October, 1996 field trip.

The Pelona Schist, a subduction-related metamorphic rock that originally formed at depths of 15 to 20 km, is exposed in outcrops along the big bend in the San Andreas, while the Catalina Schist, its southwestern equivalent, is exposed along the little bend in the Palos Verdes fault. Both San Francisco and San Pedro overlook large bays (with strikingly similar suspension bridges at their mouths). But San Francisco is in for a M8 every century or two from slip on the San Andreas, while San Pedro should see no more than a M7 every millennium from slip on the Palos Verdes.

Though curious, many of the similarities between the faults such as their shapes, trend, and sense of movement aren't accidental. The two sub-parallel faults are the product of the same broad crustal stresses, which result from the relative motion between the Pacific and North American plates. The crust through which the faults cut is the product of both Jurassic and Cretaceous subduction, followed by Miocene extension, and most recently transpression along the largely transform plate boundary.

The Palos Verdes fault is one of several major northwest trending dextral faults in the Los Angeles region. Others include the offshore San Pedro Basin fault, and the onshore Newport-Inglewood and Whittier-Elsinore faults. These faults are spaced 10 to 15 km apart.

The Palos Verdes Fault has its beginnings in the sediments of Santa Monica Bay south of the Santa Monica and Malibu Coast faults. It comes onshore near the boundary between Torrance and Redondo beaches as a single strand, which then strikes along the northeastern base of the Palos Verdes hills. Southeast of Crenshaw Boulevard, the fault splits into at least three major strands as it makes a right hand bend into the Los Angeles harbor. Here the multiple strands rejoin into a single fault, passing under the Vincent Thomas Bridge (cover photo, this SQN), through the outer harbor, across the San Pedro Shelf, continuing southward to Lasuen Knoll. South of Lasuen Knoll the fault may feed into the Coronado Bank fault which can be traced as far south as Ensenada, Mexico. ♦

Michael Forrest

Excerpts from the LARSE I Progress Report

Compiled by Robert W. Clayton and edited by Mark Benthien

The Los Angeles Region Seismic Experiment (LARSE) was conceived in 1993. The first part of LARSE, now called LARSE I, was executed in the Fall of 1993 and 1994. The original project consisted of a NW-SE line from San Clemente Island to Barstow (Line 1), a N-S line from near Santa Catalina Island to just south of the Garlock Fault near Lancaster (Line 2), and an E-W line from San Bernardino to north of San Nicholas.

The primary emphasis of LARSE I was on Line 1, where five related seismic surveys were run: 1) a passive survey from Azusa to Barstow, 2) a marine MCS survey from Seal Beach to San Clemente Isl., 3) an onshore-offshore survey across the inner borderland 4) an active source survey across the San Gabriel Mtns., and 5) an OBS survey along the MCS profile. In addition, onshore-offshore and OBS surveys were run on Line 2, and an onshore-offshore survey on Line 3.

For further information regarding the planning, implementation and early results of LARSE I, please consult the Fall 1995 issue of the SCEC Quarterly Newsletter, or EOS, vol 77, no. 18, pp. 173-176, 1996. For the complete progress report, including additional figures and maps, access the LARSE web site at *www.scecdc.scec.org/larse.html.*

Scientific Results For LARSE I.

The scientific goals for LARSE I were to image the crust and upper mantle from the Inner Borderland to the Mojave Desert. The particular targets of interest were: the Los Angeles and San Gabriel sedimentary basins, the San Gabriel Mountains, thrust faults such as the Whittier and Sierra Madre Faults, the San Andreas Fault, and the horizontal detachment surface. The results to date have produced structural images, models, and tectonic models that are relevant to all these targets. The following are some of the results of research completed or nearly completed over the past two years:

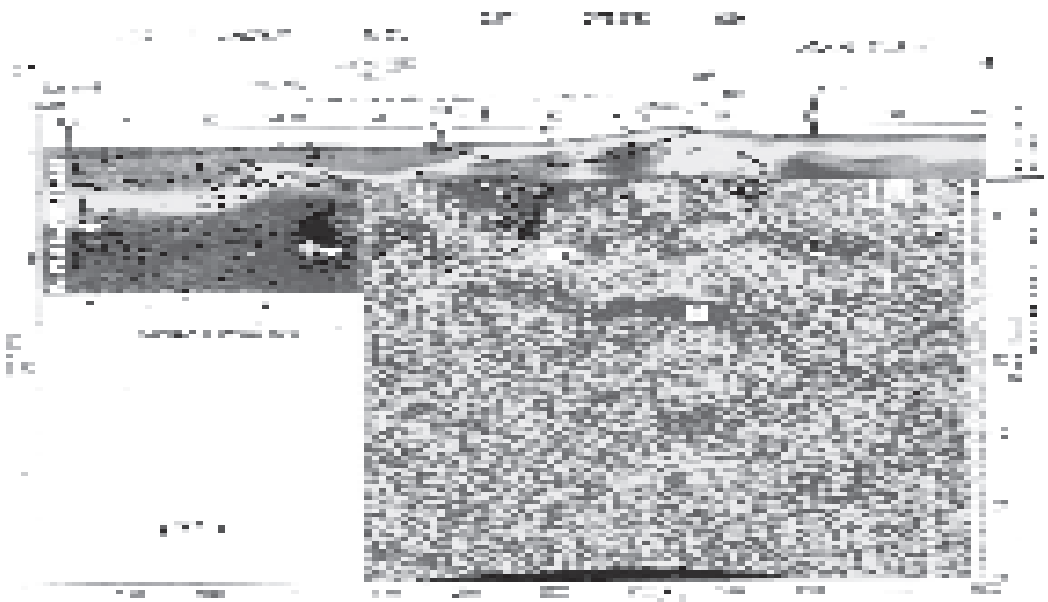


Figure 1.

1) Crustal Model, Los Angeles Basin to the San Gabriel Mtns. The results of imaging the explosion data for Line 1 are shown in Figure 1. The reflective portion of the image shows a set of bright reflections at ~20 km depth that can be interpreted as the horizontal detachment zone. The image also shows a slight change in character of the detachment at the location of the San Andreas Fault. Also shown are velocity images of the Los Angeles and San Gabriel Basins.

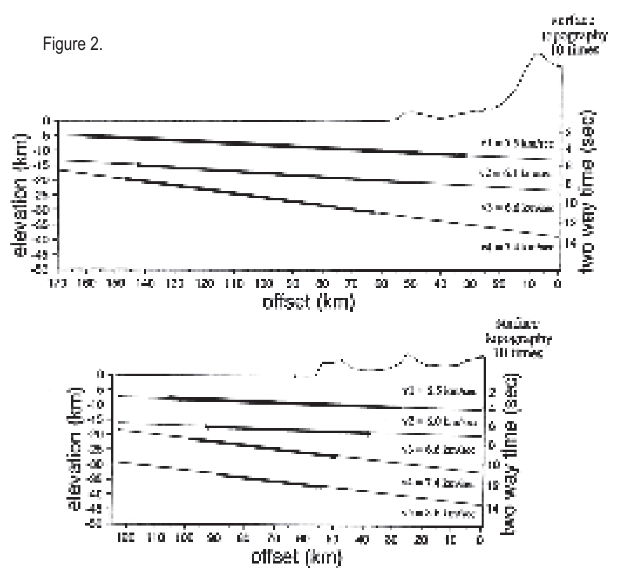


Figure 2.

2) Inner Borderland Model for Lines 1 and 2. The onshore-offshore data recorded during the LARSE experiment allows the imaging of the crust and sub-crustal structure in the Inner Borderland region. Both Line 1 and Line 2 reveal laterally coherent refractors beneath the inner borderland. Figure 2 shows the results for Line 1 and Line 2 respectively. The dips and layer velocities are constrained by being able to logically reverse the refraction profile. The important conclusion of this study is that there is a laterally coherent oceanic slab beneath the borderland. On Line 2, a deeper refractor is evident which we are interpreting as oceanic Moho. We are interpreting the presence of this arrival on Line

2 and not Line 1 as due to the better quality of the Line 2 data.

3) Lower Crust Model (Crustal Root) For the San Gabriel Mtns. The explosion data from LARSE Line 1 has been used to determine the depth and orientation of the Moho beneath the San Gabriel Mountains. Figure 3 shows a model for the Moho depth that include PmP picks made from several shot gathers distributed from the Mojave to Seal Beach. The question marks indicate the lack of an observable PmP reflection to use for locating the Moho depth. The 15 km of relief on the Moho agrees with the result of Kohler and Davis from teleseismic arrivals seen on the LARSE-93 array, which show a systematic variation with Mojave arrivals coming later than those on the south side of the San Gabriel Mtns by about 1/2-1 sec. These residuals can be modeled as a relative change in Moho depth of 15 km.

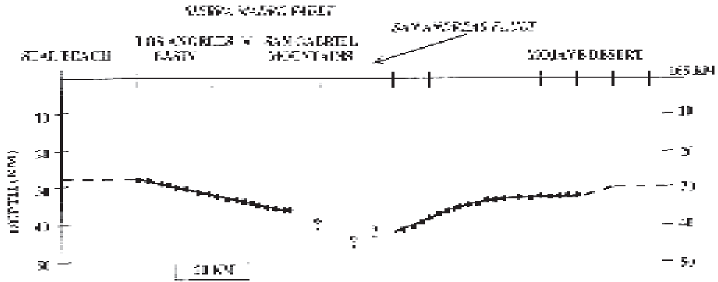
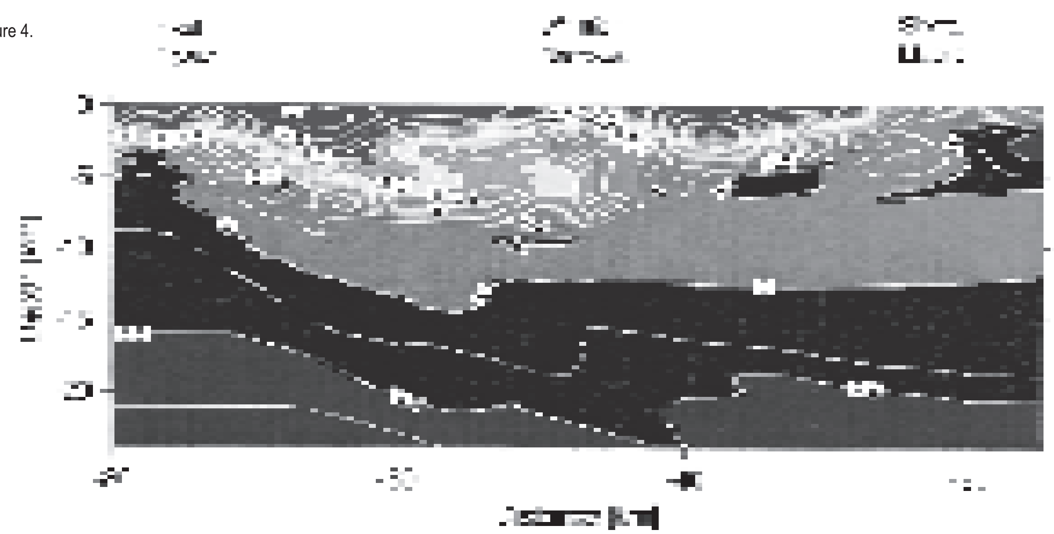


Figure 3.

4) Integrated Lower Crust/Upper Mantle Model - Line 1. The crustal model from the onshore-offshore data (figure 2) and the lower crustal model obtained from the explosion data have been combined with the upper mantle model of Humphreys and Clayton (1984). to obtain a revised tectonic model. The main feature of this model is the direct coupling of the mantle “drip” beneath the Transverse Ranges with the crust through the underlying oceanic slab. The dynamic flow implied by this model would translate directly into horizontal compression across the Los Angeles and San Gabriel Basins with the strain increasing northward towards the mountains. This effect is observed in the GPS data. The model also raises the question whether compression across the basin preceded or is a result of the drip. A joint tomographic inversion of LARSE passive and SCSN teleseismic residuals including LARSE-determined Moho variations, has provided a better resolved image of the “drip” and has found that it lies directly beneath the Transverse Ranges.

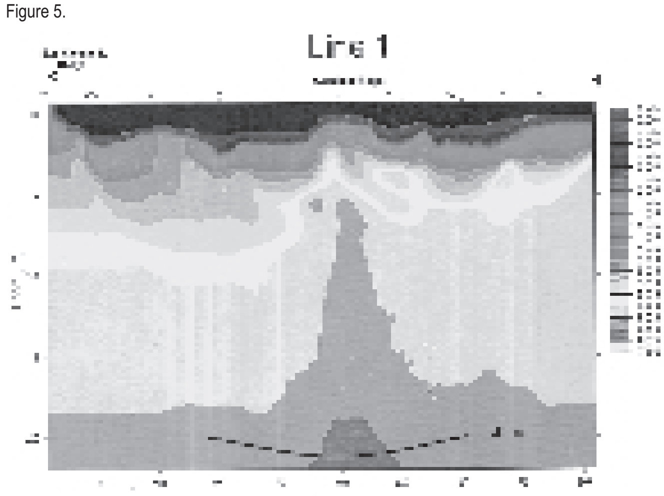
Figure 4.



5) Updated Los Angeles Basin velocity model from LARSE explosion times. The quality of the LARSE I data is shown in Figure 4 where just the explosion travel times are used in a 2D inversion along the Line 1 profile. The main features of the Los Angeles and San Gabriel Basins are evident in the model. Of particular interest is the shape of the intrusion of basement rock into the basin caused by the Whittier Thrust Fault.

6) Marine Crustal Model for Line 1. The Ocean Bottom seismometer (OBS) and Reftek land data from nearby islands indicate large lateral variability in the velocity and velocity gradient of the shallow (7-8 km) crust of the Inner California Borderland between Catalina Ridge and Seal Beach. The results are shown in Figure 5. Most of the velocity anomalies are associated with low velocity (<3 km/s) sedimentary basins and high-velocity metamorphic rocks under Catalina Ridge (5.5-6.5 km/s) and San Clemente Ridge (5-6 km/s). Anomalies associated with the ridges suggest southward directed thrusting of the ridges over the adjacent basins to the south. The mid- to lower-crustal velocity structure below 8 km is apparently very simple and nearly featureless: velocities vary laterally between 6.3-6.7 km/s and has only a very small (<0.01 km/s/km) velocity gradient. High-amplitude PmP arrivals reveal that the Moho is relatively flat at 23-24 km. The upper mantle velocity is not determined from these recordings. ♦

Figure 5.



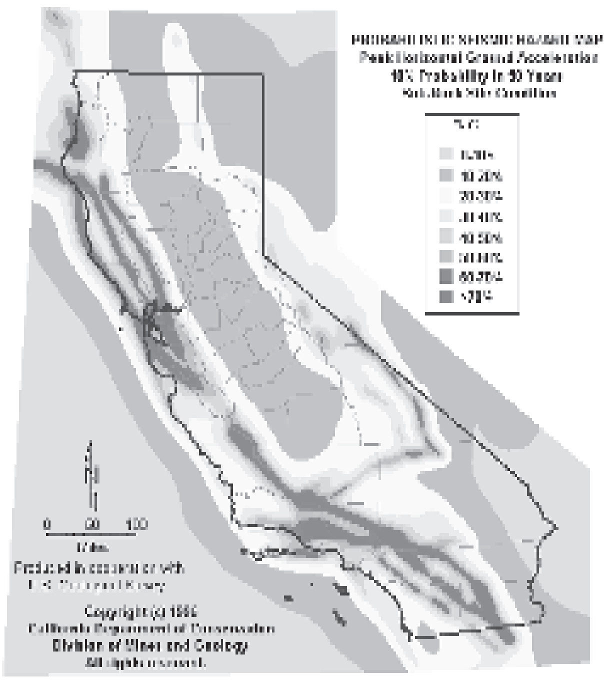
California State Division of Mines and Geology News

California's Earthquake Shaking Hazard Identified

A study by the Department of Conservation's Division of Mines and Geology and the U.S. Geological Survey has identified the areas of California most likely to experience damaging ground shaking. A report, entitled Probabilistic Seismic Hazard Assessment for the State of California, was released on December 18, 1996.

The assessment represents a unified effort on the part of the Division of Mines and Geology and the U.S. Geological Survey to obtain general consensus within the broader scientific community regarding earthquake source characteristics that contribute to seismic hazards. The report describes the input information on which the hazard maps are based.

The scientific consensus regarding the seismic hazard was developed through a series of workshops, meetings and written correspondence with individuals from academia, industry and local government. The authors developed the earthquake source model from interpretation of the most widely recognized methods and parameters. Those individuals represented the scientific, engineering and public policy communities of the state.



Data from both historical seismicity and geologic information pertaining to recurrence of prehistoric earthquakes located within active fault zones of California are incorporated into the hazard analysis. The fault length and width, maximum magnitude, slip rate and magnitude-frequency distribution are described for active faults. Historic seismicity since 1850 was used as input into the source model for the hazard assessment.

The assessment represents the current knowledge of the average value and the uncertainties regarding the earthquake characteristics used in the hazard analysis. The report presents the earthquake source information and the seismic hazard map for peak horizontal acceleration on a uniform site condition of soft rock at a hazard level of 10 percent probability of being exceeded in 50 years. The geologic, geodetic and historic damage data that support the source models and hazard maps are included in the report.

As might be expected, the data, presented as a Probabilistic Seismic Hazard Map shows that the probability of damaging ground shaking is greater on or near an active fault. A high hazard exists in a belt 50 to 75 km on either side of the San Andreas fault zone, along the north-west coast, along the Owens Valley east of the Sierra and in the Western Transverse Ranges, which includes Ventura and western Los Angeles counties.

Most of the high hazard occurs near coastal California where more than 70% of the state's population resides. In comparison to coastal California, the hazard is lower in the Central Valley and many portions of northeastern and southeastern California.

According to the report, Eureka, on the Cascadia Subduction Zone, and San Bernardino, located between two very active faults the San Andreas and San Jacinto are more likely to experience damaging earthquakes than Sacramento or San Diego. Fresno, Redding, and Sacramento have a low hazard level when compared to California's more populous cities because of their location well away from known faults and their low historic seismicity. San Diego is located away from the few moderately active faults in the region and near a fault with a low slip rate.

The state's two most populous cities, Los Angeles and San Francisco, fall between the highest and lowest extremes. Los Angeles is located near many moderately active faults, but somewhat distant from the San Andreas and San Jacinto faults. San Francisco is located near two very active faults, the San Andreas and the Hayward.

The report also summarizes the historical earthquakes and damage patterns in California. The map shows high seismic

See "CDMG" *on Page 21*

Selected Abstracts *continued from Page 11 ...*

Dolan et al. (1995) show that potential hypocentral depths for large-magnitude earthquakes in the western Transverse Ranges are between 15-20 km. For a modest geothermal gradient of 20°C / km, these depths correspond to ambient temperatures between 300-400°C, well within the thermal range of several aseismic deformation mechanisms including pressure solution, reaction softening, and crystal-plastic deformation. Volume losses of up to 40-60% have been documented in sedimentary rocks deformed at moderate temperatures and pressures (e.g., Wright and Platt, 1982; Beutner and Charles, 1985; Wright and Henderson, 1992).

In four cross-strike transects in the Ventura basin, we collected oriented rock specimens from formations buried to depths of 1-14 km. Both mesoscopic and microscopic examination revealed abundant evidence for pressure solution and the effects of pressure solution appear to be positively correlated with depth of burial and lithology. The entire section from the Cretaceous Jalama Formation through the Pliocene Pico Formation shows unequivocal evidence for pressure solution and structures suggestive of pressure solution have been recognized in the Plio-Pleistocene Saugus Formation.

Mesoscopic structures indicative of pressure solution include bedding-normal spaced cleavage and cleavage parallel to the axial surfaces of regional-scale Neogene folds. Microscopic structures indicative of pressure solution include cleavage-parallel selvages of insoluble residues, incipient grain-shape fabric produced by dissolution of grains normal to the shortening direction, and grain impingements that indicate dissolution along grain boundaries.

These findings suggest that pressure solution may have made a significant contribution to permanent strain and may be the dominant mode of deformation during the relatively slow strain rate periods between high strain-rate seismic events. Future work will quantify volume loss due to pressure solution which may reduce or possibly eliminate the proposed seismic deficiency.

Ernest M. Duebendorfer
Department of Geology, Box 4099
Northern Arizona University
Flagstaff, AZ 86011

Jan Vermilye
Vassar College
Department of Geology and Geography
Poughkeepsie, NY 12601

Peter Geiser
CogniSeis Development Corporation
4775 Walnut Street, Suite 2A
Boulder, CO 80301

Thomas L. Davis
Davis & Namson Consulting Geologists
25600 Rye Canyon Road, Suite A
Valencia, CA 91355

References

Beutner, E.C., and Charles, E.G., 1985, Large volume loss during cleavage formation, Hamburg sequence, Pennsylvania: Geology, v. 13, p. 803-805.
Dolan, J. et al., 1995, Prospects for larger or more frequent earthquakes in the Los Angeles metropolitan region: Science, v. 267, p. 199-205.
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Molnar, P. , and Chen, W.P., 1982, Seismicity and Mountain Building, in Hsu, K.J. ed., Mountain Building Processes: Academic Press, London, p. 41-57.
North, R.G., 1974, Seismic slip rates in the Mediterranean and Middle East: Nature, v. 252, p. 560-563.
Wright, T.O., and Henderson, J.R., 1992, Volume loss during cleavage formation in the Meguma Group, Nova Scotia, Canada: Journal of Structural Geology, v. 14, p. 281-290.
Wright, T.O., and Platt, L.B., 1982, Pressure solution and cleavage in the Martinsburg Shale: American Journal of Science, v. 282, p. 122-123.

See "Selected Abstracts" *on Page 22*

CDMG *continued from Page 20 ...*

hazard in many areas of the state as manifested by large earthquakes that have occurred in historic time. Large and great earthquakes of magnitude 7 to 8 that have ruptured on or near the San Andreas fault zone include the 1812 Wrightwood earthquake (7.5), the 1838 San Francisco peninsula earthquake (7.5), the 1857 Great Fort Tejon earthquake (7.9), the 1872 Owens Valley earthquake (7.8), the 1906 Great San Francisco earthquake (7.8) and the 1989 Loma Prieta earthquake (7.0).

Many large earthquakes have also occurred on faults with low seismic activity and low slip rates. These include the 1952 Kern County earthquake, (7.5), the 1971 San Fernando earthquake (6.7), the 1992 Landers earthquake (7.4), and the 1994 Northridge earthquake (6.7).

Engineers, geologists, and public policymakers can use the probabilistic information in structural design and land use planning to mitigate the effects of the hazard. The probabilistic seismic hazard maps and supporting fault data are available on the Division of Mines and Geology's home page at:

http://www.consrv.ca.gov/dmg/

Seismic Hazard Mapping Bulletin #2
Department of Conservation
Division of Mines and Geology
801 K Street, MS 12-31
Sacramento, CA 95814

Selected Abstracts *continued from Page 21 ...*

Damage and Restoration of Geodetic Infrastructure Affected by the 1994 Northridge, California, Earthquake -- *http://www-socal.wr.usgs.gov/fema/*

We resurveyed 979 leveling bench marks (BMs) and 66 GPS monuments, and added 128 new GPS monuments and 252 new BMs along critical highways for rapid damage assessment after future earthquakes. Because half of the BMs are located on engineered structures, their displacement not only records the permanent change in height caused by the earthquake, but also any disturbance of the structures caused by shaking. After correcting for non-tectonic subsidence and surveying error, we fit the geodetic data to a variable-slip coseismic model. The 40 BMs with residuals more than 3 cm are considered to be anomalous. Those located in engineered structures include railroad and highway bridge abutments and spans, tower and building foundations, catch basins, retaining walls, and culverts; the remainder are typically in engineered fill. Structures associated with anomalous BMs may be in a weakened state, making them vulnerable to shaking during future earthquakes. Because few structures have been assessed for earthquake effects except by visual inspection, subtle or hidden damage suggested by the settlement or uplift of the structures merits re-inspection. To ensure faster and more accurate post-earthquake damage assessments in the future, we further suggest that more geodetic monuments be placed on critical transportation arteries, structures, and lifelines. This study is published as U.S.G.S. Open-File Rep. 96-517 [1996], including text, map, and CD-ROM. All files can be viewed and downloaded on the web site.

Ross S. Stein, Kathleen M. Hodgkinson, and Jennifer Horsman
U.S. Geological Survey
MS 977
Menlo Park, CA 94025
rstein@usgs.gov

Kenneth W. Hudnut
U.S. Geological Survey
Pasadena, CA 91125
hudnut@seismo.gps.caltech.edu

Jay Satalich
Caltrans, Los Angeles, CA
JSatalich@aol.com

John H. Richards
National Geodetic Survey
NOAA
Silver Spring, MD
johnr@ngs.noaa.gov

Educating the Public About Earthquake Hazards and Risk: An IASPEI General Assembly Workshop Announcement

The 29th General Assembly of the International Association of Seismology and Physics of the Earth's Interior (IASPEI) will be held in Thessaloniki, Greece, August 18-28, 1997. The purpose of the Assembly is to give the opportunity to scientists from different disciplines to meet and exchange ideas about present-day problems of the seismological community.

The program will include a workshop on "Educating the Public About Earthquake Hazards and Risk," with Jill Andrews, SCEC Knowledge Transfer Director, and Dr. K. Ioannides (Greece) acting as co-conveners. The call for papers will be issued later in the fall, but if you are interested in participating, please contact Jill Andrews for further information at:

SCEC Knowledge Transfer
University of Southern California
Los Angeles, California, USA 90089-0742
email: *jandrews@usc.edu*

The following is a description that appears in the call for papers:

Session #W9(W15a): *Educating the Public About Earthquake Hazards and Risk*

Scope: This session will consist of an opening lecture / presentation on Earthquake Education and Information Dissemination (What is it? Why is it important? How do you do it? What are the benefits?); followed by short presentations by several volunteers who have successful ongoing outreach programs; and finally, formation into small breakout groups to discuss a list of education-information-related topics.

We seek input from participants who have experience with, or interest in, local earthquake response plans; cultural influences on earthquake education, preparedness, and / or response issues; identification of and interaction with specific target groups in both urban and agrarian communities; recruitment of community volunteers to aid in dissemination of earthquake education, awareness, and preparedness; building of mutual beneficial relationships among academic, government, and industry leaders to cultivate community support; use of available aids for information acquisition such as the Internet; publications; achived data resources; and other earthquake education programs.

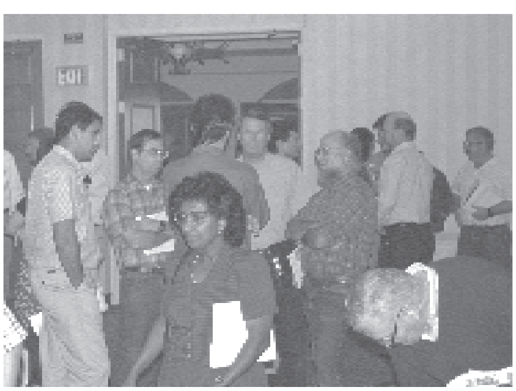
Science Seminar News

Database of Fault Parameters and the SCEC Phase III Report featured in Fall 1996 Seminars

October...

In January, 1996, SCEC co-sponsored an Association of Engineering Geologists' one-day short course for about 180 of its members. The purpose of the short course was to develop a product for AEG members in response to their request for an updated fault slip rate database with basic parameters. The October 17, 1996 seminar, "Progress Report on the Database of Fault Parameters," updated AEG members on the progress of the database construction and hightlighted mapping projects and fault databases under development by the USGS and the CDMG. The scientific program featured formal presentations by David Jackson, Suzanne Hecker, Mark Petersen and James Dolan. The remainder of the seminar was interactive: Panelists engaged in further discussion of the database and its uncertainties, and fielded questions from the audience.

Above and below: Participants of the Faults Database progress report seminar.



Speaker topics were:

- David Jackson, UCLA and SCEC Science Director: "Models for Treating Earthquake and Fault Data Used for Seismic Hazard Analyses"
- Mark Petersen, CDMG: "How Uncertainties in Earthquake and Fault Data are Treated in Seismic Hazard Analyses"
- James Dolan, USC, SCEC: "Fault Parameters: Progress Report"
- Suzanne Hecker, USGS: "USGS Fault Database"

Invited Panelists were:

- James Dolan, USC / SCEC
- Eldon Gath, Leighton & Associates, AEG
- Tom Henyey, USC / SCEC Director
- David Jackson, UCLA / SCEC Science Director
- Michael Machette, USGS Denver
- Mark Petersen, CDMG
- Tom Rockwell, SDSU / SCEC
- Kerry Sieh, CIT / SCEC
- Gary Huftile, Oregon State University / SCEC

November ...

On November 21, 1996, UC Santa Barbara SCEC scientists hosted the final SCEC Science Seminar for FY 1996. The focus of the seminar was the SCEC Phase III report. As the Center approaches the official public release of the Phase III report, the SCEC scientific community has been invited to preview the results that will be published in the report, and give feedback to the Phase III working group.

See "Seminars" *on Page 24*

Seminars *continued from Page 23 ...*

The seminar featured short presentations from the contributors to Phase III, with comments from Mark Petersen (CDMG) and Dave Boore (USGS), followed by an open discussion.

Speakers & Topics addressed were:

- Introduction - Norm Abrahamson, PG&E
- Source Zone Update - Dave Jackson, UCLA
- 3-D Basin Effects - Kim Olsen, UCSB
- Site Classification and Shear wave Velocity - Steve Park, UCR
- Estimation of site response - Jamie Steidl, UCSB
- Attenuation relation Evaluation - John Anderson, UNR
- Hazard Calculation & Sensitivity Analysis - Mehrdad Mahdyiar, UCLA
- Time Histories & wrap up on Phase III - Norm Abrahamson

The guest speakers (Petersen, Boore) discussed where future research should be concentrated in resolving the site response issues and reducing the residuals to the attenuation relations.

For further information on the outcome of the seminar, please contact:

John K. McRaney
Southern California Earthquake Center
University of Southern California
Los Angeles, CA 90089-0742
213-740-5842 (ph); 213-740-0011 (fax)
email: mcraney@coda.usc.edu

or

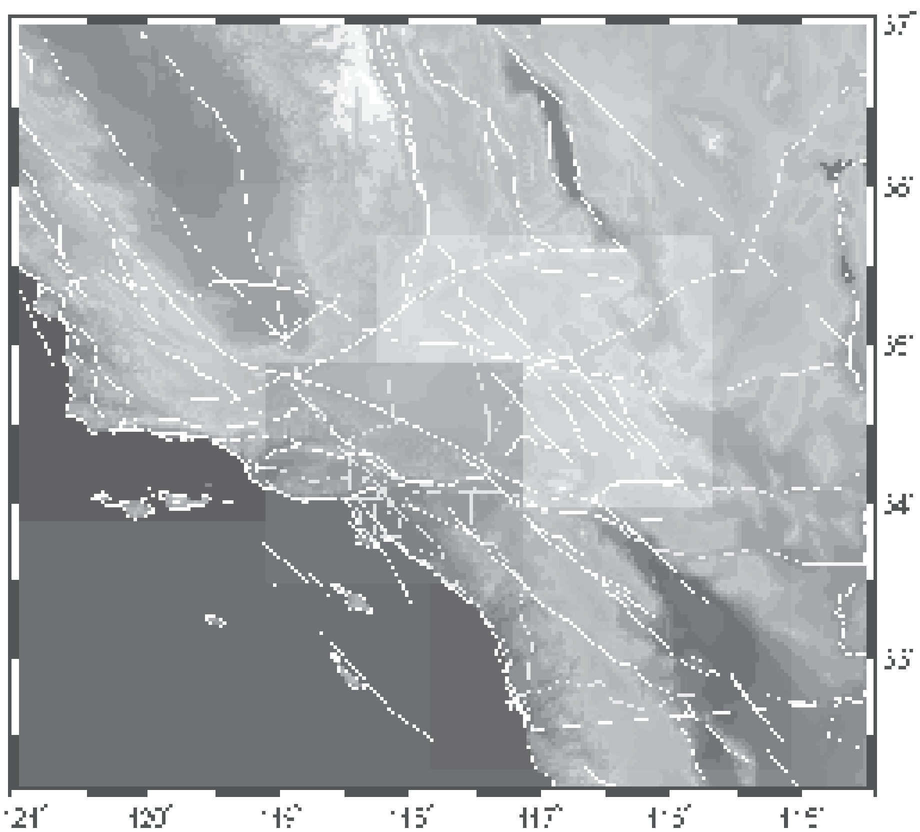
Dr. Jamison H. Steidl
Institute for Crustal Studies
University of California at Santa Barbara
Santa Barbara, CA 93106
805/893-4905 (ph); 805/893-8649 (fax)
email: steidl@quake.crustal.ucsb.edu ♦

Faults of Southern California

You can find this map on the SCEC Data Center WWW site at:

http://www.scecdc.scec.org/faultmap.html

The map highlights, in color, four regions: the southern Coast Ranges and Central Valley area; the Sierra Nevada and Basin and Range areas; the Mojave region; the extreme southern end of California; and the Los Angeles area. The map is clickable. Clicking on a region will take you to an enlarged relief map of the area, with local faults highlighted in a variety of colors, and linked to pages detailing information about these faults. In all of the maps, that segment of the San Andreas fault which is visible will be red, and scales for distances and elevations will be given. A few city and highway labels will also appear on the smaller maps.



SCEC Announces New Post-Doctoral Fellows

It gives us great pleasure to announce that our top four choices for SCEC Post-Doctoral Fellows from the most recent competition have all accepted. Approximately 70 applications/inquiries were received in response to the program announcement and 23 applications were independently rated by the members of the SCEC Board. At the annual meeting in Palm Springs, the directors met to review the applications and rankings and authorize awards.

This outcome is another tribute to the success of SCEC and the quality of scientific work being done. Following are the new Post-docs and their hosts:

Jishu Deng (Ph.D., Columbia) — hosted by Egill Hauksson and Hiroo Kanamori, Caltech
Research Project: Stress Evolution and Earthquake Triggering in Southern California: A 3-D Fully Adaptive Multigrid Approach for Visco-Elastic Rheology

Peng-Cheng Li (Ph.D., Dalian / PRC) — hosted by Ralph Archuleta, UCSB
Research Project: The Mainshock Finite Fault Inversion Using Empirical Green's Function

Andrew Meigs (Ph.D., USC) — hosted by Kerry Sieh and Joann Stock, Caltech
Research Project: Topographic Response to Active Deformation in the Los Angeles Basin

Mousumi Roy (Ph.D., MIT) — hosted by Andrea Donnellan, JPL
Research Project: Evolution and Geodynamics of Fault Systems

Please note that there will be another competition next summer for the 1997-1999 program.

A Tribute to Kei Aki

"People think that you have to find the important problems, but I don't care about the important problems, I just do what is interesting," said Kei Aki in an interview in 1993.

At this years annual SCEC meeting, colleagues, students and friends held a bittersweet retirement celebration for Aki, the father of seismic tomography, the first to interpret "strong ground motion" quantitatively, author of "the barrier model", "seismic moment," the seminal papers on coda waves, first author of "Quantitative Seismology"— the seismologist's "bible," and last, but not least, co-founder of SCEC, and its first and outgoing science director.

His presence in southern California will be sorely missed, now that he is spending much of the year on remote La Reunion island. It is perhaps a bit selfish of us to want Aki to stay with us here for the next thirty years, further contemplating our crust rather than the earth's rumblings at the other end of the world. But have you seen his recent posters and preprints?

In the words of one graduate student, who exited a seminar Aki gave at USC a few months back, "You stick that guy on an island, pretty much by himself, thousands of miles away, where there's nothing, where he can't speak the language, where there's no big university, no real big research facilities, and look at the amazing stuff he comes up with!"

Michael Forrest, Tom Henyey

Kei Aki and Dave Jackson

Sixth European Workshop on the Numerical Modeling of Mantle Convection and Lithospheric Dynamic

Naurod (Germany), August, 14-16, 1997: The workshop precedes the IASPEI meeting in Greece (starting August, 18). The venue is a small place in a forested area, yet within convenient reach of Frankfurt airport (30-45 min) and Wiesbaden (20 min). The aim of the workshop is to provide a forum of discussion for all aspects of numerical modeling (including technical and conceptual aspects, visualisation, parallel computing, and the 'philosophy' of modeling), but not necessarily for the presentation of 'latest results'. Ample space and time will be given to poster presentations and discussions. Oral presentations will be restricted to a few key topics (yet to be identified). The organizing committee consists of Helmut Harder, Ulrich Christensen, Kevin Furlong and Harro Schmeling.

If you are interested, please send an e-mail to Helmut Harder
hfh@willi.uni-geophys.gwdg.de

and you will receive further circulars (communication with participants will be only by e-mail).

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 conbined 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 *ScecInfo.usc.edu*.

Please email your contributions to:
jandrews@coda.usc.edu

Residential Earthquake Recovery Report Available

Steven Ganz, Executive Director, Western States Seismic Policy Council, received a report from the California Policy Seminar entitled ÒResidential Earthquake RecoveryÓ and shared it recently over the Internet. We think our readers will be interested. A summary of the report can be found below. A more extensive brief of the report is available in text format at:

http://www.ucop.edu/cps/lancome.html

RESIDENTIAL EARTHQUAKE RECOVERY: Improving CaliforniaÕs Post-Disaster Rebuilding Policies and Programs, by Mary C. Comerio, John D. Landis, and Catherine J. Firpo, with Juan Pablo Monzon.

In the five-year period between 1989 and 1994, earthquakes, hurricanes, and floods took a heavy toll on America's housing stock. Two hurricanes, Hugo and Andrew; two earthquakes, Loma Prieta and Northridge; and one 100-500-year flood in the Midwest, caused $75 billion in damage, half of it in residential structures. More than 200,000 housing units were completely destroyed or substantially damaged. An additional 600,000 housing units required significant repairs.

Between 1989 and 1994 California alone suffered 13 federally declared disasters. On January 17, 1994, California's streak of bad luck culminated in the 6.8 magnitude Northridge earthquake. Northridge would quickly become the most expensive earthquake ever to strike the United States. It would also change the way California planners and policymakers would look at natural disasters, shifting their emphasis from preparation and relief issues, to those concerning recovery. Many of the lessons of Northridge were immediate; others are only now being learned and applied.

This report examines the current state of earthquake recovery practice in California, with special emphasis on housing recovery. Public and private payments for residential rebuilding in the aftermath of Northridge have so far totaled $12-13 billion, or about 50-60% of the total recovery cost. In this report, authors consider the complementary and overlapping roles of different federal, state, private, and nonprofit recovery and rebuilding institutions. They look at what has been learned since the Loma Prieta earthquake of 1989 regarding residential response and recovery policy. And they take a new and closer look at the distribution of post-Northridge rebuilding funds.

The complete report is available free of charge to California state government offices and to others for $30. A check payable to UC Regents should accompany your order. Credit cards are not accepted. Please address inquires to:

California Policy Seminar
2020 Milvia Street, Suite 412
Berkeley, CA 94704
telephone (510) 643-9328

SEISMIC SAFETY MANUAL

A Practical Guide for Facility Managers and Earthquake Engineers

This document is a revision and expansion of the original *Seismic Safety Guide* published in 1983 by the Lawrence Berkeley Laboratory, based upon its experience strengthening 34 buildings over a 20 year period following the San Fernando Earthquake in 1971. The 1980 Livermore earthquake also stimulated an extensive program at the Lawrence Livermore National Laboratory. In contrast, earthquake safety programs elsewhere were slow to develop. Generally, they were too sophisticated, complex, and expensive to achieve results. Consequently, the primary purpose of the *Seismic Safety Manual* was then and is now to provide practical advice about earthquake safety to managers of DOE facilities so that they can get the job done without falling into common pitfalls and prolonged diagnosis. Its guidelines include hazard identification and evaluation, site planning, the evaluation and rehabilitation of existing facilities, the design of new facilities, lifelines, operational safety, emergency planning, and the management of risks and liabilities.

The format for the *Seismic Safety Manual* follows that used in the original edition. Each technical section was written by an experienced professional for an audience composed of managers or engineers with little background in earthquake engineering. Comments and advice from the operator manager's perspective are provided in the foreword to each author's section. The manual has also been extensively reviewed.

The *Seismic Safety Manual* may be of assistance to you in meeting the requirements of Executive Order 1 2699 "Seismic Safety of Federal and Federally Assisted, Leased or Regulated New Building Construction" and Executive Order 12941 "Seismic Safety of Existing Federally Owned or Leased Buildings."

This document has been in development since 1991 and represents a major effort on the part of the authors reviewers and staff who assembled it. Support for this project was provided by the U.S. Department of Energy, Office of Environment, Safety and Health, Office of Nuclear and Facility Safety.

If you have any questions or need information on obtaining copies please contact:

Robert C. Murray
Lawrence Livermore National Laboratory
Mail Stop L-224
P.O. Box 808
Livermore, CA 94551
(510) 422 0308
(510) 423 2163 FAX
Email: Murray6@llnl.gov

Risk Management and Mitigation for Natural Hazards Symposium and Banquet Announcement

The Department of Civil Engineering at Stanford University is sponsoring this event in the spring of 1997. The symposium and banquet are being presented to honor Professor Haresh Shah on his retirement from Stanford, and to celebrate the reopening of the John A. Blume Earthquake Engineering Center, after completion of seismic reconstruction. The Symposium will be held on the Stanford campus, Friday and Saturday April 25 and 26, 1997. The technical program will feature invited speakers from many countries and cover topics relevant to the field of risk analysis. The retirement banquet will be held on Friday evening and is open to everyone.

For additional information, contact:

Carol Strovers
Shah Symposium
M/C 4020
Stanford, CA 94305-4020
415/725-9072 (ph); 415/725-9755 (fax)
email: ShahSymp@ce.Stanford.edu
WWW site: http://blume.Stanford.edu

STUDENT OPPORTUNITIES IN ACTIVE TECTONICS

Department of Geological Sciences, University of Colorado, Boulder

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An opportunity exists for funded graduate study in Structural Geology and Active Tectonics at the University of Colorado, Boulder. Our structural geology and active tectonics research group is seeking two graduate students who wish to pursue a Masters degree in Geology starting in the Fall of 1997. Research is focused on the kinematics and geomorphic evolution of active fault-related folds in transpressive orogens and its relation to earthquakes on blind thrusts. Possible directions for student research include: 1) subsurface mapping of fault / fold geometry in oilfields using UNIX-based software and workstations for active structures in the southern San Joaquin Valley, 2) mapping and analysis of very high resolution digital elevation models derived from Raster Scanning Airborne Altimetry (NASA's RASCAL system) and 3) surface mapping and analysis of soils and landforms produced by active folding.

For more information contact Karl Mueller by email at:
Karl@lolita.colorado.edu

Dr. Karl Mueller
Assistant Professor of Geology
Department of Geological Sciences CB-250
University of Colorado
Boulder, Colorado 80309
(303) 492-7336 (office)
(303) 492-2606 (fax)

Calendar

January, 1997

30-31 SCEC Board Meeting and Proposal Panel Review @ USC

February, 1997

4 SCEC Palos Verdes Field Trip led by Tom Rockwell and Tom Henyey.

20 SCEC Science Seminar, Caltech. Title: The Beginning of Earthquakes. Hosts: Kanamori, Hauksson, Ellsworth, and Beroza.

March, 1997

12 "Making the Most of New Real-Time Earthquake Information Technologies in Managing Earthquake Emergencies," An Invitation Only Workshop co-sponsored by SCEC, Caltech, USGS, CDMG, California OES, SCESA, EQE. Pasadena Civic Center. Contact: Jim Goltz, EQE International, 714/833-3303.

20 SCEC Science Seminar, (site to be confirmed). Stress Interactions; Hosts: Ross Stein, USGS, and David Jackson, UCLA.

April, 1997

7-8 NSF Center Directors/Administrators Meeting, Washington, DC.

9-11 Seismological Society of America 92nd Annual Meeting, Honolulu, HI. Contact: email *ssa7@ginger.bachman.hawaii.edu* or WWW: *http://www.soest.hawaii.edu/ssa97.html*

17 SCEC Science Seminar, U.C. Los Angeles. Subject to be announced.

May, 1997

15 SCEC Science Seminar, U.C. San Diego. Host: Yehuda Bock. Subject to be announced.

27-30 AGU Spring Meeting, Baltimore, MD.

August, 1997

18-29 IASPEI Meeting, Thessaloniki, Greece. See WWW site at: *http://www.csd.net/~bergman/iaspei/g_a_greece.html#aa80*

October, 1997

5-7 SCEC Annual Meeting, Costa Mesa, CA.

December, 1997

8-12 AGU Fall Meeting, San Francisco, CA.

Personal Notes

SCEC Researcher Submits FY 1997 Proposals While Giving Birth

(Well...almost, anyway!)

Kevin Stenersen Grant was born on Nov. 22, 1996 to Lisa and Stanley Grant. He weighed 8 lbs, 6 1/2 ozs, and was 21 inches long. Mother and father are doing fine -- and proposals were submitted on time!

Other birth news:

Michael Forrest, SQN's Associate Editor, and his wife Eleanor, welcomed to the world Thomas Everett Forrest, who was born on Nov. 6, 1996. He weighed 8 lbs. 11 oz. and was 22.5 inches long. Michael says his hair is the yellow-white color of dandelion fluff in summertime. According to Michael, he laughs easily and has learned his first word, "HLO" which he says often, with great zest and relish.

Congratulations to both families!

SQN Ed.

SCEC's Web Site Chosen for November ERD Way Cool Site Award

The Emergency Resource Directory announced last fall that the SCEC Web Site was chosen as the November 1996 "Way Cool" site. The ERD Graphics webmaster hyperlinked SCEC's WWW site on the ERD Way Cool page during the month of November. It has now been placed as a text hyperlink in their archive of Way Cool sites.

"We reviewed many sites for our "first" monthly web awards, and yours was truly one of the finest," wrote Dave, ERD's Webmaster. To access the Emergency Resource Directory, go to:

http://www.clarknet.com/erd/

Earthquake Information Resources On Line

SCEC Data Center Pages

Current Southern California Seismic Network (SCSN) Weekly Earthquake Reports:
http://www.scecdc.scec.org/earthquakes/current.txt (text)
http://www.scecdc.scec.org/earthquakes/current.gif (map)

SCSN Weekly Earthquake Reports back to January 1993:
http://scec.gps.caltech.edu/ftp/ca.earthquakes

Caltech/USGS Seismocam: Waveform displays of data only 30 seconds old:
http://scec.gps.caltech.edu/seismocam/

Earthquakes in Southern California:
Includes aftershock maps, animations of aftershock sequences and rupture models, and a clickable map of historic Southern California earthquakes and Los Angeles Basin earthquakes. Main Page:
http://www.scecdc.scec.org/eqsocal.html

Southern California Clickable earthquake map:
http://www.scecdc.scec.org/clickmap.html

Los Angeles Basin Clickable earthquake map:
http://www.scecdc.scec.org/laseiskiosk.html

LARSE home page:
http://www.scecdc.scec.org/larse.html

USGS OFR 96-85, Data Report for 1993 Los Angeles Region Seismic Experiment, Southern California: A Passive Study from Seal Beach Northeastward through the Mojave Desert.
http://www.scecdc.scec.org/larse/93title.html

USGS OFR 95-228, Multichannel Seismic-Reflection Profiling of the R/V Maurice Ewing During the Los Angeles Region Seismic Experiment (LARSE), California.
http://www.scecdc.scec.org/larse/LMtitle.html

USGS Response to an Urban Earthquake -- Northridge '94, electronic version:
http://geohazards.cr.usgs.gov/northridge/

New GMT Web Page

This web page that may helpful to those who want to make nice looking shaded relief maps with GMT. It is a catalog of maps produced by Geoffrey Ely for various research projects at the Institute for Crustal Studies (UCSB). For each map, Geoff provided a simple shell script used to create the map for use and / or modification. Users can also download a digital elevation model for Southern California in a GMT readable (netCDF) format. This grid, generated from USGS DEMs, covers the region 121W 115W 32.5N 35.5N at a resolution of 3 arc seconds. You can get to the web page from the ICS
home page at:

http://quake.ucsb.edu.

From there click on Mapping, and then Geoff's Map Catalog.

Geoffrey Ely
Institute for Crustal Studies
University of California, Santa Barbara
email: geoff@quake.crustal.ucsb.edu

Up-to-the-minute Southern California Earthquake Map:

This site takes the earthquake locations broadcast via e-mail from Caltech and makes a map of the last approximately 500 earthquakes. It works for Java-enabled browsers only.

http://www.crustal.ucsb.edu/scec/webquakes/

The Nevada Seismological Laboratory

http://www.seismo.unr.edu

This site offers information on current earthquakes and its research and teaching programs. The site features some work by two SCEC-funded researchers, John Anderson and Steve Wesnousky. Users can access lists, maps, and seismogram data from the latest earthquakes, and can report any events they have felt. There are background geologic and seismicity maps, and on-line searching of earthquake catalogs. General information is available on-line in contact lists, brochures, geophysics degree program information for students, and courses in earthquake fundamentals and scientific visualization.

John Louie
(louie@seismo.unr.edu)

See "On Line Resources" *on Page 31*

Earthquake Information Resources On Line, cont.

SCEC World Wide Web Home Page

SCEC WWW URL
http://www.usc.edu/go/scec

More GIS Web Sites

One of the best sites to can explore for GIS and environmental applications bibliography is:

http://www.geoplace.com/book/index.html

Other sites are:

http://pasture.ecn.purdue.edu/~engelb/
http://sparky.sscl.uwo.ca/gimda/index.htm
http://sparky.sscl.uwo.ca/gimda/intres3.htm
http://www.lib.berkeley.edu/cgi-bin/print_hit_bold.pl//UCBGIS/
http://www.nwi.fws.gov/thinktank.html
http://www.nr.usu.edu/lab-book/unix/unix.html
http://www.nr.usu.edu/lab-book/lab-book.html
http://fgdc.er.usgs.gov/linkpub.html
http://mis.ucd.ie/staff/pkeenan/gis_as_a_dss.html
http://spsosun.gsfc.nasa.gov/EOSDIS_services.html
http://www.ggrweb.com/

Geodetic Information Web Site

http://lox.ucsd.edu

This site is the Scripps Orbit and Permanent Array Center (SOPAC) and features Global (IGS) and Regional (SCIGN) Continuous GPS Archive, SCIGN maps, time series, and site velocities.

SCEC on the Internet

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.

ScecInfo@usc.edu

Other WWW Sites for Exploration

EQNET
http://www.eqnet.org/

Recent Quakes (with a great map viewer)
http://www.civeng.carleton.ca/cgi-bin/quakes

Southern California Network Bulletins Web Site Address Changed

The Web site for the Southern California Network Bulletins has been changed. The new Web address for the USGS Pasadena Field Office is:

http://www-socal.wr.usgs.gov/

So the new Web address for the Southern California Network Bulletins is:

http://www-socal.wr.usgs.gov/lisa/NETBULLS/netbull_list.html

Lisa Wald
USGS Pasadena

USGS Web Sites with Earthquake Information and More

General USGS site: ***http://www.usgs.gov***
National Earthquake Information Center: ***http://gldss7.cr.usgs.gov/***
Earthquake Information: ***http://geology.usgs.gov/quake.html***
USGS Menlo Park: ***http://quake.wr.usgs.gov/***
USGS Pasadena: ***http://www-socal.wr.usgs.gov***

Seismo-surfing the Internet
http://www.geophys.washington.edu/seismosurfing.html

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Two NEW Web Pages from the Pasadena USGS Home Page

One of the goals of the upgrade of the seismic network in southern California is to produce rapid maps of ground shaking from significant earthquakes. On our home page

http://www-socal.wr.usgs.gov

we are now producing automatic maps of contoured ground motions for M > 4.0 earthquakes within about 5 minutes of the event. These maps use data from both new digital stations and FBA's on analog telemetry. This map is a prototype. Many changes will be made to produce more useful maps as this process evolves, as feedback is incorporated, and as more data becomes available in real-time.

The peak ground motion contour maps are displayed on top of high resolution topography and they are interactive in that one can obtain earthquake parameters and station amplitudes by pointing to and choosing the epicenter or station of interest on each map. The first motion focal mechanism is also provided.

The maps are accessible from the USGS Pasadena Home Page (URL above) under the heading "Last Significant Earthquake", or it can be directly accessed with the following URL:

http://www-socal.wr.usgs.gov/pga.html

In addition, we have also put together a Web page to provide digital slip models and maps of strong ground motions for important California earthquakes. Specific earthquakes can be interactively selected by epicenter or name, and each has individual pages that include source information, maps of strong ground motion overlayed on high-resolution topography, slip maps and tabulated slip values, peak acceleration maps, rupture movies, and pointers to related web pages. The file containing the rupture model contains all necessary information recreate the model in space and time (as provided by a variety of researchers). Again this can be found on the USGS Pasadena Home Page or the specific URL is:

http://www-socal.wr.usgs.gov/slipmodels.html

Your feedback will be greatly appreciated.

David Wald, USGS Pasadena

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Southern California Earthquake Center
University of Southern California
University Park
Los Angeles, CA 90089-0742
Tel: 213/740-1560
Fax: 213/740-0011
Email: *ScecInfo@usc.edu*

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SCEC Quarterly Newsletter

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Editor, Writer, and Production Artist: Jill Andrews
Associate Editor: Michael Forrest

Contributing Writers:
Mark Benthien, SCEC
Rob Clayton, Caltech
Michael Forrest, USC
Thomas Henyey, USC / SCEC
David Jackson, UCLA / SCEC
James Mori, USGS
Robert Nigbor, USC
Zheng-kang Shen, UCLA

Photographs:
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Mark Benthien

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Southern California Earthquake Center
University of Southern California
Los Angeles, CA 90089-0742

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