Southern California Earthquake Center

Quarterly Newsletter
Summer 1996

Volume 2, Number 2

A view south, through the Los Angeles high rise district, which sits atop active folds of the Elysian Park system. What potential hazards are posed by the underlying folds? See Page 12.

From the Center Directors...

Thomas Henyey
Center Director

David Jackson
Science Director

A Win-Win Opportunity for California and the Nation

As most of our readers probably know, the National Science Foundation's Engineering Directorate has recently issued a request for proposals (RFP) to establish up to three earthquake engineering centers in the country next year. The National Earthquake Engineering Center in Buffalo, New York (NCEER) will probably continue to exist, and a new earthquake engineering center may be established in California. The California Universities for Research in Earthquake Engineering (CUREe) coalition has taken the lead in developing a proposal in response to the RFP.

The RFP contains the following statement: "To facilitate cross-disciplinary fertilization, centers...will be expected to develop ties with the earth science-oriented Southern California Earthquake Center [SCEC],which will lead to information exchanges and other interactions." This statement from NSF should be taken as a challenge, not only by newly-established engineering center(s), but also by SCEC. SCEC has already initiated meaningful interactions with the geotechnical engineering community. The new engineering centers will provide an opportunity for even more extensive interactions with a broader segment of the engineering community throughout the State and Nation.

These interactions will have many benefits. Earth scientists will gain a better understanding of what information engineers need, while engineers will develop a better appreciation of what earth scientists have to offer. This will result in better products for end users interested in practicing hazard mitigation. Furthermore, our own experience with multidisciplinary research suggests that such interactions inevitably reveal new insights, spawn new research initiatives, and encourage us to focus on the truly relevant issues.

And last but not least, there is strength in numbers. With declining budgets for research, it is important that the earthquake scientific and engineering communities not engage in fractious debate over resources, but rather reach some common ground as to the future direction of earthquake research.

We can turn these new developments into a win-win situation. We, as directors, are committed to the notion that cross-disciplinary interaction is an important part of our future. ♦

Thomas L. Henyey
David D. Jackson

What Is the Southern California Earthquake Center?

The Southern California Earthquake Center (SCEC) actively coordinates research on Los Angeles region 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 Education and Knowledge Transfer programs are co-funded by the Federal Emergency Management Agency (FEMA). The Center's primary objective is to develop a "Master Model" of earthquakes in southern California by integrating various earth science data through probabilistic seismic hazard analysis. The 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*

A Layman's Version of the Phase II Report: Probable Earthquakes, 1994-2024, Part II — Results

Figures and tables referred to by number in the following text can be found in the original publication (Bulletin of the Seismological Society of America, Vol. 85, No. 2, pp. 379-439, April 1995); a reprint can be ordered through the SCEC Knowledge Transfer office. Phone 213/740-1560 or e-mail ScecInfo@usc.edu.

As described in Part I of this summary (SCEC Quarterly Newsletter, vol. 2, no. 1, page 1), the *Phase II* report combined geologic, geodetic, and seismic information to estimate the frequency of damaging earthquakes in southern California. Using these data, the report examined the probabilities of large earthquakes on the region's major faults (originally estimated by the 1988 Working Group on California earthquake probabilities), and throughout the rest of southern California. An important contribution of the report was an updated database for the region's major faults and other seismotectonic zones (see Table 5), which formed the basis for the *Phase II* seismic hazard analyses. Path and site effects were not dealt with in the Phase II report, but will be presented in Phase III, to be released later this year. (SCEC's Quarterly Newsletter will publish a similar Layman's Version.)

The *Phase II* report contains three principal results: 1) The probabilities of large earthquakes on the San Andreas, San Jacinto, and Whittier-Elsinore fault systems have been calculated based on

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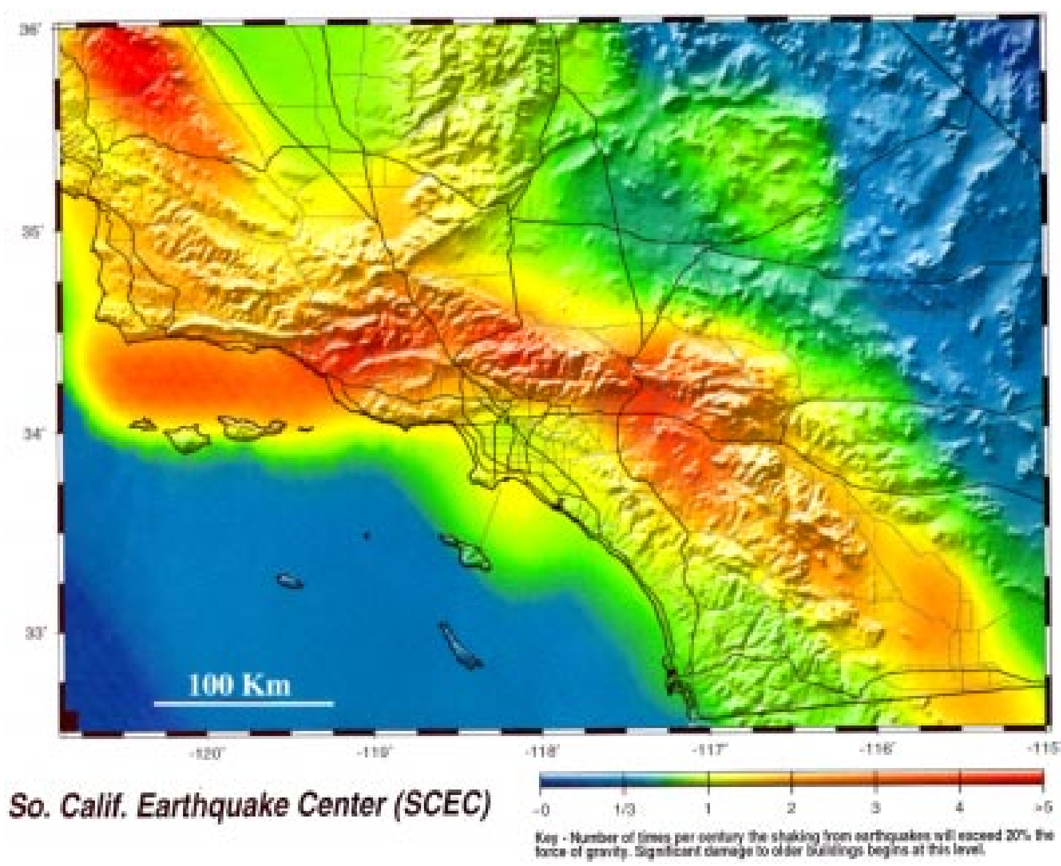
Figure 18.



Phase II *continued from Page 3 ...*

a combination of new and existing slip rate, earthquake recurrence, and past earthquake data. 2) New probabilistic seismic hazard assessments have been generated for all of southern California using a combination of the best geologic, geodetic, and seismic data. 3) Models of annual earthquake rates as a function of magnitude have been developed for southern California; interestingly, the models predict rates that are higher than the historic rate. These results are summarized in the following sections.

Updated Probabilities on the Major Fault Systems

Probabilities for fault-rupturing earthquakes in the coming 30 years were determined for the so-called "Type A" fault segments (those with reasonably well documented paleoseismic data), using three different models developed by earlier investigators. The Type A segments are those of the San Andreas, San Jacinto, and Whittier-Elsinore fault systems (see Table 1).

As in earlier reports, *Phase II* assumed that the probability of a segment-rupturing earthquake increases with elapsed time (since the previous earthquake) as a result of continuing tectonic deformation, which increases the stress on locked fault segments. Following precedent, *Phase II* also adopted a probability model which assumes a lognormal probability density function of earthquake recurrence intervals.

Probabilities calculated for three models — the "Dates," Time-Predictable," and "Renewal" models — are shown in Table 2 of the *Phase II* report. The models differ in how the mean recurrence intervals are estimated. The Dates model can be applied to those segments for which dates of past earthquakes have been estimated from radio-Carbon dating, and the recurrence interval calculated according to the method of Savage (1991). The Time-Predictable and Renewal models estimate the expected time until the next rupture from a combination of the displacement in past earthquakes and the long-term slip rate. In the Time-Predictable

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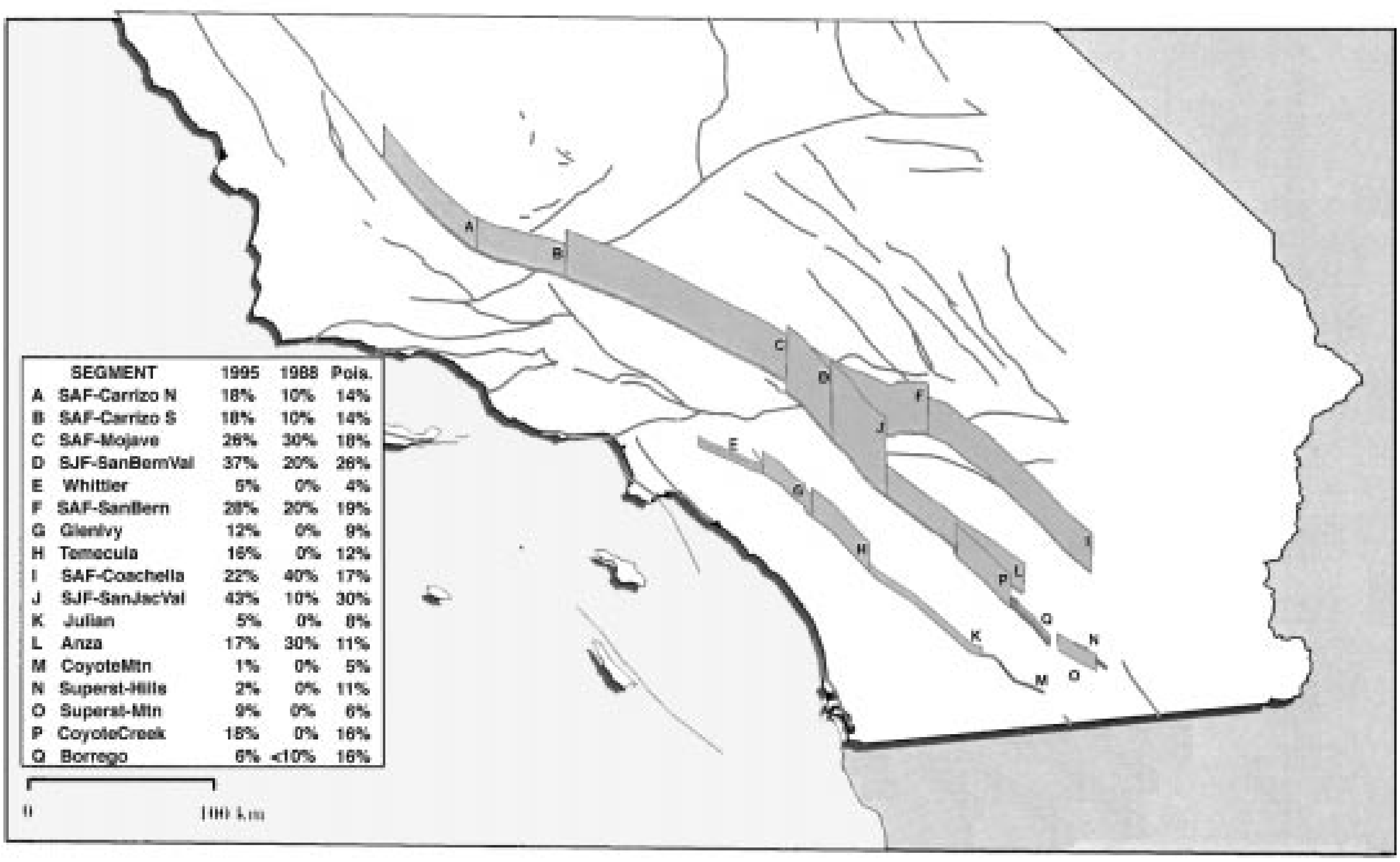
Figure 5. Fence diagram illustrating ruptue probabilities for the time period 1994 to 2024 for fault segments associated with type A zones.



	SEGMENT	1995	1988	Pols.
A	SAF-Carrizo N	18%	10%	14%
B	SAF-Carrizo S	18%	10%	14%
C	SAF-Mojave	26%	30%	18%
D	SJF-SanBernVal	37%	20%	26%
E	Whittier	5%	0%	4%
F	SAF-SanBern	28%	20%	19%
G	Glenivy	12%	0%	9%
H	Temecula	16%	0%	12%
I	SAF-Coachella	22%	40%	17%
J	SJF-SanJacVal	43%	10%	30%
K	Julian	5%	0%	8%
L	Anza	17%	30%	11%
M	CoyoteMtn	1%	0%	5%
N	Superst-Hills	2%	0%	11%
O	Superst-Mtn	9%	0%	6%
P	CoyoteCreek	18%	0%	16%
Q	Borrego	6%	<10%	16%

Phase II *continued from Page 4 ...*

model, the expected recurrence interval is taken to be the ratio of the displacement in the last earthquake to the long-term slip rate. In the Renewal model, the expected recurrence interval is taken to be the ratio of the mean displacement for all known earthquakes on that segment to the long-term slip rate. Both the Time-Predictable and Renewal models depend on the natural variability of the recurrence intervals. *Phase II* assumed a greater variability than earlier studies (e.g., 1988 Working Group), based on more recent data.

Also shown in Table 2 and Figure 5 on page 4 of this newsletter (with an abbreviated table) are the mean probabilities calculated from a weighted average of the three models with weights proportional to the reciprocal of variance (*1995*), and for comparison, the probabilities calculated by the 1988 Working Group (*1988*), and according to the Poisson model (*Pois.*) in which rupture probabilities are assumed independent of time.

Comparing the mean probabilities with those of the 1988 Working Group, some differences are apparent as a result of new data, particularly for the San Jacinto Fault and the Coachella Valley segment of the San Andreas Fault. Also, *Phase II* has added new probability results for the entire Whittier-Elsinore Fault, and three segments of the San Jacinto Fault. The most spectacular changes are the roughly two-fold and four-fold increases in the estimated probabilities of major earthquakes on the San Bernardino and San Jacinto Valley segments of the San Jacinto Fault, respectively. On the other hand, the *Phase II* results show a significantly lower probability than the 1988 Working Group for the Coachella Valley segment of the San Andreas.

Hazard Assessment for Southern California

Using the integrated approach to estimate earthquake potential for southern California (i.e, combining geologic, geodetic, and seismic data), *Phase II* carried out a probabilisitc seismic hazard analysis (PSHA) for the region assuming generic path and site effects (attenuation relations). PSHA requires a knowledge of both the moment rates within the various seismotectonic zones, and how that moment rate is “spent” as a function of magnitude.

We chose a probability of exceeding 20% g (20% the acceleration of gravity) over a 30-year time frame to illustrate the effects of the new data and integrated approach on PSHA in southern California. The results were presented in a color map in the report (Figure 18) — a copy of which is reproduced in grayscale on page 3 of this newsletter. The areas with the highest probabilities of exceeding 20% g in the next 30 years largely coincide with the Transverse Ranges and portions of the San Andreas Fault.

We wish to emphasize two things about the map. First, it is an example of how everything we have done can come together in a reasonable PSHA product. It is *not* intended to be used by emergency preparedness officials, earthquake engineers, the insurance industry, or the general public — hence the choice of 20% g and small scale of the map. Second, the same data that were used to generate the map *can* be used to generate maps at other scales and for different time frames and levels of exceedance. However, it is important that such maps, which have public policy and engineering implications, be carefully reviewed and “certified” by appropriate organizations such as the U.S. Geological Survey and the California Department of Conservation’s Division of Mines and Geology.

To illustrate other PSHA products, we calculated seismic hazard curves for the Los Angeles and San Bernardino City Halls (Figures 16 and 17, and reproduced on page 6 of this newsletter). These curves show the 30-year probabilities of exceedance versus peak ground acceleration (PGA) for a “rock” site (LA City Hall), and versus 1-second spectral acceleration for a “soil” site (both LA and SB City Halls). Also shown are the contributions from events on the San Andreas and San Jacinto faults, separately. These curves contain significantly more information than the map in Figure 18. In the case of San Bernardino, it can be seen that the bulk of the seismic hazard comes almost exclusively from the San Andreas and San Jacinto faults.

Earthquake Rates

The data in Table 5 can be used to calculate earthquake rates for southern California. Table 5 is referred to as the ”preferred seismic source model” since it contains the maximum magnitude earthquakes for each of the 65 seismotectonic zones most preferred by geologic consensus. Figure 14 (also simplified on page 7 of this newsletter) shows the predicted cumulative magnitude distribution that follows from the data in Table 5, along with the observed distribution as reported in the catalog for southern California (Table 4).

The average rate of $M \geq 6$ earthquakes is predicted to be about 0.61 per year for the next 30 years, corresponding to an average recurrence interval of 1.6 yr. This rate is about double the observed rate since 1850, which is 0.32 per year. Allowing for an increase in the maximum magnitude in all zones would reduce the number of $M \geq 6$ earthquakes, but it would take a very large increase — nearly a full magnitude unit — to bring the predicted rate down to the observed level.

The difference between the predicted and observed rates could be due to natural variations in seismicity. The prediction is based on geological and geodetic data which reflect the long-term moment release, whereas the earthquake catalog covers a relatively brief

See ”Phase II” *on Page 6*

Phase II *continued from Page 5 ...*

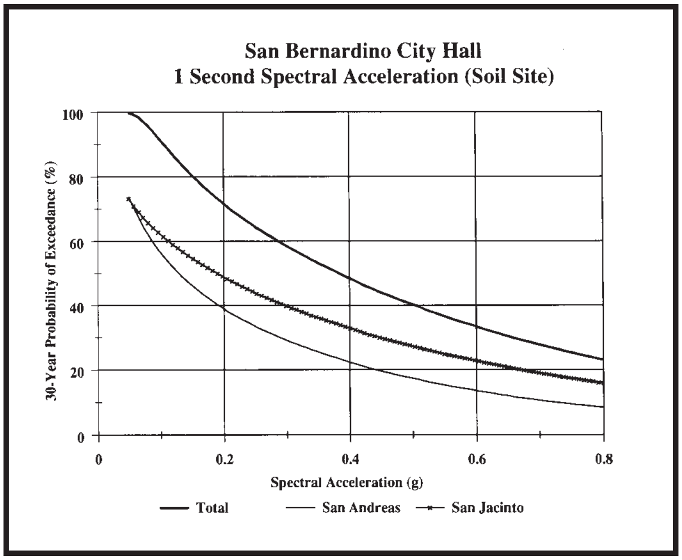


Figure 17. The 30-yr exceedance probability of the 1-sec-period spectral acceleration for the San Bernardino City Hall assuming a soil site. (Page 414, BSSA publication)

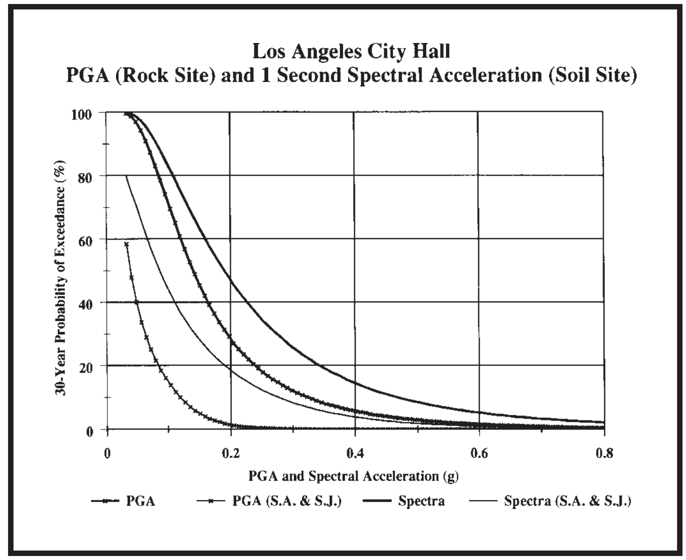


Figure 16. The 30-yr probability of peak ground acceleration exceeding a given value at the Los Angeles City Hall assuming a rock site. (Page 414, BSSA publication)

time interval. Also, some M≥6 aftershocks from the 1857 Fort Tejon earthquake may not be included in the catalog. Another Fort Tejon earthquake would make up the deficit.

The predicted rate of M≥7 earthquakes is 0.067 per year, again about double the average rate since 1850 (0.035 per year). All of the above arguments regarding the comparisons of observed and predicted M≥6 earthquakes also apply for M≥7 events. The predicted annual rate for M≥7 corresponds to a 30-year probability of 86%. Great earthquakes of M≥7.8 should occur at the rate of about 2 or 3 per 1,000 years, corresponding to a 6 to 9% probability in 30 years.

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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:

- Report from the 1995 Research Utilization Council Workshop
- Insurance Industry Workshops; Proceedings; Audio tapes
- Engingeering 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
- SCEC-Sponsored Publications; Scientific Reports

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

Phase II *continued from Page 6 ...*

We also calculated earthquake rates for an alternative seismic source model (Table 6) for which the predicted earthquake rates conform more closely to the observed distribution of earthquakes since 1850. For this model, we raised the maximum magnitudes in each of the 65 source zones to 7.0, or 0.5 magnitude unit above the values in the preferred model, whichever is greater. Also, we assumed a Poissonian, instead of lognormal, behavior for cascades (see the *Phase II* report or Part I of this summary for a description of cascades), and reduced the geodetic moment rate estimate in several of the seismotectonic zones.

Figure 15 (also simplified in the panel below) shows the predicted cumulative magnitude distribution that follows from the data in Table 6 (alternative model), along with the observed distribution as reported in the catalog for southern California (Table 4). The predicted rate of M≥6 earthquakes is 0.43 per year, only slightly above the observed rate of 0.32 per year, while the predicted rate of M≥7 earthquakes is 0.064 per year compared to an observed rate of 0.035 per year — still almost a factor of 2 greater. According to the alternative model, the probability of an M≥7 earthquake in southern California before 2024 is 85%.

The discrepancy between predicted and observed earthquake rates for both the preferred and alternative models is an important issue that will be addressed by the Center over the next few years. If the discrepancy is real, the implication is that, in order to "catch up," we must have a significant increase in the number of M≥6 earthquakes in the future in southern California. On the other hand, the discrepancy may not be real if the actual magnitude distribution is different from that which we have assumed in our models.

And finally, our models have assumed that all fault slip (moment release) occurs elastically in the form of earthquakes. If a portion of the moment is released aseismically, then the discrepancy may be simply a reflection of the non-elastic portion of the strain release. The major problem with this scenario is the lack of field evidence for significant aseismic strain release, or creep, on exposed faults in southern California. ♦

Thomas L. Henyey

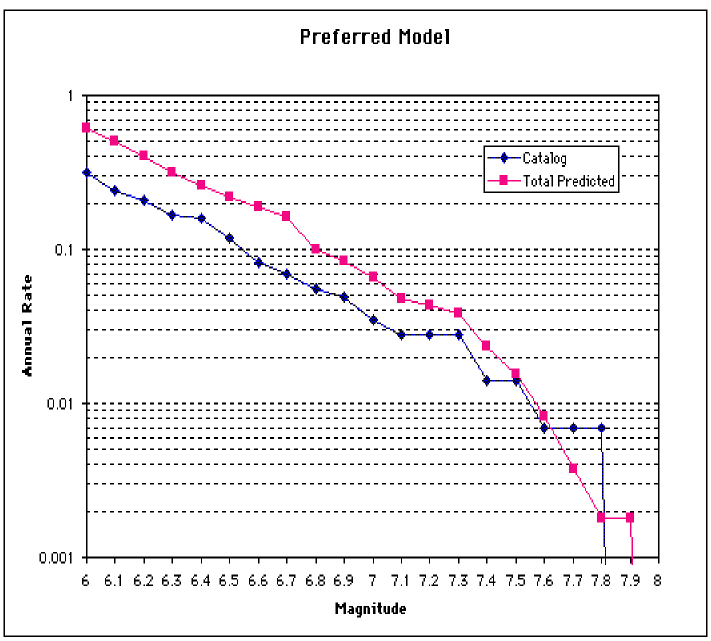

Figure 14. Annual rate of earthquakes with magnitude greater than *M* predicted for the preferred model, compared with the rate observed since 1850. Also, the contributions to the predicted rates from the type A, B, and C zones are shown separately for characteristic and distributed earthquakes. (Page 413, BSSA publication)

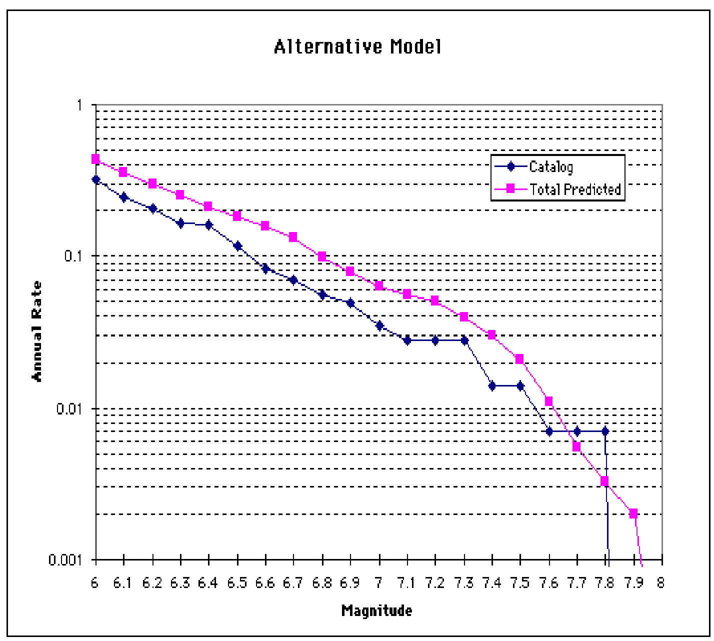

Figure 15. Annual rate of earthquakes with magnitude greater than *M* predicted for the alternative model, compared with the rate observed since 1850. Also, the contributions to the predicted rates from the type A, B, and C zones are shown separately for characteristic and distributed earthquakes. (Page 413, BSSA publication)

SCEC Research
...What Are We Studying?

Funded research projects for SCEC's fiscal year 1996-1997

Name	Project Title
Abdouch	1996 SCEC Education Program
Abrahamson	Coordination and Preparation of Phase III Report
Abrahamson	Uncertainty in Probabilistic Hazard Analysis
Agnew	GPS Infrastructure: Data Archiving
Agnew, Johnson, H. & Wyatt	Understanding and Reducing Monument-Related Noise in Geodetic Measurements
Aki & Chin	The Validation of Coda-based Site Classification Map in Southern California
Anderson, Su & Zeng	High Frequency Ground Motion by Regression and Simulation
Andrews	1996 SCEC Knowledge Transfer Program
Archuleta	Portable Broadband Instrumentation
Archuleta & Tumarkin	SCEC Strong-Motion Database SMDB and Empirical Green's Functions Library EGFL
Ben-Zion	Coupled Self-Organization of Seismicity Patterns and Networks of Faults, and Basis for Evaluating Seismic Risk and Precursors
Bock	Southern California Integrated GPS Network/Permanent GPS Geodetic Array (SCIGN/PGGA)
Clayton	SCEC Data Center Operations
Clayton	Analysis of LARSE Line 1 Onshore-Offshore Data
Cornell	Southern California Probabilistic Seismic Hazard Analysis
Davis, P. & Gao	Analysis of Northridge Aftershock Amplitudes and Damage
Davis, P. & Kohler	Integration and Analysis of LARSE Passive and Active Data, and Preparation for SMORSE
Day & Bielak	Workshop on 3D Modeling of Earthquake Ground Motion in Sedimentary Basins
Day & Harris	Dynamic Modeling of Earthquakes on Inhomogeneous Faults
Day & McLaughlin	Three-Dimensional Simulation of Long Period Ground Motion in L.A. Basin
Dolan	Preparation of SCEC Phase III
Dolan	Paleoseismology and Seismic Hazards of the Cucamonga Fault
Dong	Mapping Horizontal Velocity Field in Southern California From the Combination of Geodetic Data
Donnellan & Lyzenga	Geodetic Signals Expected from Fault Models in the Los Angeles Region
Duebendorfer & Davis, T.	Determination and Analysis of Aseismic Deformation in the Upper Crust of Southern California
Field & Aki	Site Response from LARSE Data
Gath & Munro	Neotectonic Uplift of the San Joaquin Hills Based on Marine Terrace Chronology, Orange County, California
Grant	Neotectonic Uplift, Quaternary Deformation and Earthquake Potential of the San Joaquin Hills, Orange County, California

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Studies *continued from Page 8 ...*

Name	Project Title
Gurnis	Dynamic Models of the Geodetic Signals Expected for the Dense Network's AA' Line
Hafner, Clayton & Hauksson	SCEC Earthquake WWW
Hager	Continuum Mechanics Models of Blind Thrusts in the L.A. Basin
Hauksson	L.A. Basin Tomography with the LARSE and Northridge Datasets
Haukson & Kanamori	Towards, Real-Time, Routine Broadband Seismology
Heaton	The Effects of Phase III Time Histories on Flexible Buildings
Henyey/Jackson	1996 Post-Doctoral and Visitor Program
Henyey/Jackson	1996 SCEC Management Operations
Henyey/Jackson	1996 SCEC Meetings and Workshops
Herring & King	GPS Data Error Spectrum Analysis
Humphreys	The Fully 3-D Visco-Elastic Faulting Response: Coseismic Displacement, Post-Seismic Relaxation, and Time-Dependent Earthquake Shadowing
Humphreys	Modeling of the Southern California Deformation: An Initial Physical Master Model
Jackson, Kagan, Ge & Potter	Seismic Hazard Estimation
Jin & Aki	Study of Surface Layer Effects on Spectral Scaling Using Mojave Borehole Data
Kagan & Jackson	The Influence of Stress on Future Earthquakes
Kanamori	Initiation of Earthquake Rupture
Kanamori & Hauksson	Enhancement of TERRAscope
Keller & Gurrola	Earthquake Hazard of the Santa Barbara Fold Belt
King & Herring	Support for GPS Analysis
King, Herring & Reilinger	Geodetic Constraints on Interseismic, Coseismic, and Postseismic Deformation in Southern California
Knopoff	Model of Dynamic Fractures in a Continuum
Knopoff	Model of the Southern California Fault Network
Knopoff	Simulations of Dynamical In-Plane Rupture Source Effects
Li & Aki	Monitoring Post-Seismic Changes of the Landers Fault Using Fault-Zone Trapped Waves Excited by Explosions
Lin & King	Investigation of 3-D Time-Dependent Coseismic and Postseismic Coulomb Stress Changes on the Southern San Andreas Fault and Blind-Thrust Systems in the Los Angeles Basin
Lindvall	Paleoseismic Investigations of the Western Sierra Madre Fault Zone
Magistrale	Integrated Los Angeles Area Velocity Model
Mahdyiar	Probabilistic and Sensitivity Analysis of Ground Motion Parameters in Southern California
McGill	Paleoseismic Studies of the San Andreas and Other Faults in the San Bernardino Area
Minster	ROC Curves for Intermediate-Term Earthquake Prediction Algorithms
Mueller	Structural Analysis of Active Folding and Blind Thrusting in the San Joaquin Hills
Mueller	Characterization of Active Faults in East Los Angeles
Nielsen & Knopoff	Fault Geometry and Seismic Rupture

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Studies *continued from Page 9 ...*

Name	Project Title
Okaya & Henyey	Crustal Setting of the Northridge Earthquake: Analysis of the LARSE Malibu-Northridge-West Mojave Transect (Line 2) Via Refraction and Wide Angle Reflection Methods
Okaya & Henyey	Structural Geometries of the Northridge Epicentral Region and Transverse Ranges Fold & Thrust System: Application of Industry Seismic Reflection Profiles
Olsen & Archuleta	Long-Period Site Response in the Los Angeles Basin from 3-D Simulations of Ground Motion
Park	Phase III - Site Amplification Map Creation
Rice	New Methodology in Computational Seismology for Dynamic Rupture Along Complex Fault Systems
Rice	Elastodynamic Simulations of Rupture Propagation and Earthquake Sequences Along Complex Fault Systems
Rockwell	Paleoseismic Studies Along the Sierra Madre, San Fernando, and Santa Susana Faults
Rubin	Paleoseismic Studies Along the Southern Flank of the Central Transverse Ranges: Slip Rates and Recurrence Interval on the Sierra Madre Segment
Shearer	Precision Relocation of Los Angeles Region Seismicity
Scott & Sammis	A Granular Model of Earthquake Mechanics and Radiation
Seeber & Armbruster	Earthquakes, Faults, and Stress in Southern California
Shen & Jackson	Tectonic Deformation in the Greater Los Angeles Region
Shen, Sung & Jackson	Geodetic Velocity Map
Sieh	Seismic Source Characteristics of the Southern San Andreas Fault and Related Structures: San Gorgonio Pass/San Bernardino Mountains
Sieh	Characterization of Active Faults in East Los Angeles
Sieh & Lilje	Computational Support for Paleoseismic and Neotectonic Studies
Steidel & Tumarkin	Response Spectral Amplification Factors: Correlation with Geological and Geotechnical Site Characteristics
Stock	Compilation of New and Existing Stress Observations for Southern California
Sykes & Buck	Development of a Physical Model of Stresses in Southern California and Changes in Rates of Historic Seismicity as an Intermediate-Term Earthquake Precursor
Tumarkin & Archuleta	Empirical Time-Series Simulation of Phase-III Scenario Earthquakes
Vucetic	Densification and Enhancement of the SCEC Geotechnical Data Base
Ward	A Multidisciplinary Approach Toward the Master Hazard Model
Wesnousky	Construction and Comparison of Seismic Hazard Maps
Wyatt & Agnew	Monitoring Structure Stability with Tiltmeters
Wyatt & Agnew	Pinon Flat Observatory - Continuous Monitoring of Crustal Deformation
Yeats & Huftile	Northern Los Angeles Basin Configuration and Fault Geometry: A Study of Earthquake Paths
Zeng & Anderson	Simulations of Ground Motion in the Los Angeles Basin: Simplified Approaches

SCEC Scientists' Publications, as of Summer 1996

The complete SCEC scientists' publications listing is updated and available on a continuous basis. Please contact the SCEC Administrative Office, 213/740-1560, to obtain updated listings from Mark Benthien. Selected publications may be available through a cooperative agreement between SCEC and the NISEE-Caltech Library. The Spring quarterly newsletter includes all publications; subsequent issues include newly submitted papers only.

325. Hauksson, E. and J. Haase, Three-Dimensional VP and VP/VS Velocity Models of the Los Angeles Basin and Central Transverse Ranges, California, *Journal of Geophysical Research*, submitted, 1996.

326. Saleur, H., C. G. Sammis, and D. Sornette, Discrete Scale Invariance, Complex Fractal Dimensions and log-periodic fluctuations in Seismicity, *Journal of Geophysical Research*, in press, 1996.

327. Aki, K., Interrelation between Fault Zone Structures and Earthquake Processes, *PAGEOPH*, 145, no.3/4, pp, 647-676, 1995.

328a. Bock, Y. et al, Scripps Orbit and Permanent Array Center and the Southern California GPS Geodetic Array: NRC Report on Improving GPS Infrastructure, submitted, 1996.

328b. Bock, Y., S. Wdowinski, P. Fang, J. Zhang, J. Behr, J. Genrich, D. Agnew, F. Wyatt, H. Johnson, S. Marquez, K. Hudnut, R. King, T. Herring, K. Stark, S. Dinardo, W. Young and W. Gurtner, Southern California Permanent GPS Geodetic Array: Continous Measurements of Crustal Deformation, *Journal of Geophysical Research*, submitted, 1996.

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330. Wdowinski, S., Y. Bock, J. Zhang and P. Fang, Southern California Permanent GPS Geodetic Array: Spatial Filtering of Daily Positions for Estimating Coseismic and Postseismic Displacements Induced by the 1992 Landers Earthquake, *Journal of Geophysical Research*, submitted, 1996.

332. An, L. J. and C. G. Sammis, A Cellular Automation for the Growth of a Network of Shear Fractures, *Tectonophysics*, 253, pp. 247-270, 1996.

333. Sammis, C. G., D. Sornette and H. Saleur, Complexity and Earthquake Forecasting, *Reduction & Predictability of Natural Disasters*, ed. by J. Rundle, F. Klein and D. Turcotte, SFI Studies in the Sciences of Complexity, XXV, Addison Wesley, pp. 143-156, 1995.

334. Nakanishi, H., M. Sahimi, M. C. Robertson, C. G. Sammis and M. D. Rintoul, Fractal Properties of the Distribution of Earthquake Hypocenters, *J. Phys. I France*, 3, pp. 733-739, 1993.

335. King, G. C. P. and C. G. Sammis, The Mechanisms of Finite Brittle Strain, *PAGEOPH*, 138, pp. 611-640, 1992.

336. Steacy, S. J. and C. G. Sammis, A Damage Mechanics Model for Fault Zone Friction, *Journal of Geophysical Research*, 97, no. B1, pp. 587-594, 1994.

337. Hardebeck, and E. Hauksson, Patterns of Stress Drop in the 1994 Northridge Aftershock Sequence; Spatial Correlations with the Mainshock Rupture, *Bulletin of the Seismological Society of America*, unpublished, 1996.

338. Rubin, C. M., Systematic underestimation of earthquake magnitudes from large intracontinental reverse faults; Historic ruptures break across segment boundaries, *Geology*, accepted, 1996.

339. Deng, J. and L. R. Sykes, Evolution of the stress field in southern California and triggering of moderate-size earthquakes: A 200-year prospective, *Journal of Geophysical Research*, submitted, 1996.

340. Stirling, M. W. and Wesnousky, S. G., Geological versus Historical seismicity rates in southern California, *Bulletin of the Seismological Society of America*, submitted, 1996.

Quarter Fault

The Elysian Park Thrust

Each Issue of the SCEC Newsletter features a southern California fault. In this issue...

Does the Elysian Park Thrust Really Exist? Kerry Sieh (Professor of Geology, California Institute of Technology and SCEC Geology Working Group Leader) comments on what may or may not be Los Angeles' biggest seismic hazard.

One of the most hotly debated regions currently studied by Southern California Earthquake Center scientists is the Los Angeles metropolitan area. The densely populated region may or may not be situated on or near the Elysian Park "thrust" Fault. Possibly located at the northwest end of the Whittier Fault, the Elysian Park slip rate is thought to be between one and two millimeters per year. "Prospects for Larger or More Frequent Earthquakes in the Los Angeles Metropolitan Region," published in Science (13 January 1995, Volume 267, pp. 199-205) by SCEC scientists James Dolan (University of Southern California), Kerry Sieh (California Institute of Technology), Thomas Rockwell (San Diego State University), Robert Yeats (Oregon State University), John Shaw (E&P Technology Dept., Texaco, Houston, TX), Eldon Gath (Leighton and Associates, Irvine, CA), and John Suppe (Princeton University), suggests that the Elysian Park Fault could produce a M7.1 earthquake.

A blind thrust fault has no surface expression, so no one has actually seen the Elysian Park Fault. Geologists who take the "thick-skinned" approach hold that the reverse faults in the Los Angeles area have steep dips that project into the lower crust. Scientists who take the "thin-skinned" approach suggest that major horizontal to shallow thrust faults are quite common. In the following interview, Sieh discusses the evidence for both the shallowly dipping Elysian Park Thrust, and its thick-skinned, steeply dipping rival and neighbor, the proposed Los Angeles Fault.

Two views of an active fold scarp in east L.A. This feature, the Coyote Pass escarpment, is part of a series of east-west trending anticlines and synclines related to faults underlying east L.A. and the downtown area.

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The Interview

MF: Who first thought the Elysian Park Thrust might exist?

KS: It all started with the 1983 Coalinga earthquake which was caused by a blind thrust. [Thom] Davis and [Jay] Namson (Davis and Namson, Consulting Geologists) inspired by that earthquake, first realized that there could be active blind thrusts underneath Los Angeles. A month before the Whittier Narrows earthquake, they had written a paper that showed a cross section going right through downtown [Los Angeles]. It depicted [what we call] a "fault propagation fold"—as evidenced in the surface sediments in the Los Angeles downtown area and in subsurface wells. In their paper in 1989, Davis, Namson and Yerkes suggested—based on the expression of this fold in the subsurface—that in fact there was this Elysian Park Fault [A Cross Section of the Los Angeles Area: Seismically Active Fold and Thrust Belt, The 1987 Whittier Narrows Earthquake, And Earthquake Hazard, *Journal of Geophysical Research*, Vol. 94, No. B7, Pages 9644-9664, July 10, 1989]. They placed it at twelve to fifteen kilometers depth or so and they depicted it as a fault propagation fold because they felt that best fit the data. They considered the Whittier Narrows earthquake to be confirmation of their interpretation.

MF: Their method of using "balanced cross sections" to find blind thrusts originated with John Suppe, didn't it?

KS: Suppe is the geologist who developed this technique, beginning in Taiwan, a couple of decades ago. Basically, he doesn't see faults directly—he infers them from observed deformation of the overlying sediments. During the past several years he's been looking at the Los Angeles area. He and his Ph.D. graduate student, John Shaw, see "growth wedges" in the sediments just south of downtown Los Angeles and southeast toward Whittier. Now Shaw and Suppe say, a few years after Namson and Davis, is that seismic reflection data show a "growth fold" in the subsurface just south of downtown, running southeast toward Whittier. They think the growth wedge is best explained as a fault bend fold, caused by a fault at sixteen kilometers depth below East Los Angeles, which shallows up-dip and southward, to about ten kilometers depth. The fault would then go flat into a "detachment" at ten kilometers [depth]; then hook up to a ramp from ten kilometers to six kilometers in West Los Angeles. The Shaw and Suppe kinematic analysis suggests that the Elysian Park ramp is not a fault propagation fold, but a fault bend fold.

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Term Definitions, "Elysian Park"

Thrust fault: a fault with a dip of 45 degrees or less over much of its extent, on which the hanging wall (block of crust above the fault) appears to have moved upward relative to the footwall (block of crust below the fault), as a result of horizontal compression.

Blind Thrust: a thrust fault which does not reach the earth's surface.

Reverse fault: a fault along which the hanging wall has also been raised relative to the footwall, but the angle of dip is generally greater than 45 degrees.

Normal fault: a fault in which the hanging wall appears to have moved downward relative to the footwall. The angle of dip is usually 45-90 degrees.

Detachment: a nearly horizontal thrust fault in which the overlying crust has been deformed, or moved horizontally, relative to the crust below.

Thin-skinned structure: a concept that, in regions of crustal compression, portions of the upper crust detach from the middle and lower crust, along nearly horizontal thrust faults, perhaps due to major changes in physical properties with depth. Often these faults do not reach the earth's surface, and are manifested by large folds in the near-surface rocks.

Thick-skinned structure: a concept that, thrust and reverse faults, in a compressional environment, root deeply into the crust, and do not flatten appreciably with depth. This implies that the upper, middle, and perhaps lower crust behave as a unit during crustal deformation.

Fold: a bend in crustal rocks. A fold is usually the product of crustal compression, but the definition does not specify manner of origin.

Anticline: a fold, generally convex upward, whose core contains the stratigraphically older rocks.

Syncline: a fold of which the core contains the stratigraphically younger rocks; it is generally concave upward.

Fault propagation fold: a fold which develops and grows at the tip of an active blind thrust fault.

Fault bend fold: a fold that develops over a bent thrust fault at the point where the fault's dip changes.

Growth wedges and growth folds: deformed structures above buried faults.

Slip: the relative displacement of formerly adjacent points on opposite sides of a fault.

Balanced cross section: cross sections that are constructed in a way to preserve the original cross-sectional area of layers of rock that are involved in deformation.

Dip: the angle that a stratum or any planar feature makes with the horizontal, measured perpendicular to the strike and in the vertical plane.

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MF: But now there is a question whether either of these fault "models" are valid?

KS: The question is whether Suppe's data from the upper-most kilometers of sediment, seen in seismic reflection profiles, require a fault bend fold at depth. Craig Schneider, Charly Hummon, Robert Yeats, and Gary Huftile (all Oregon State University) published a paper [Structural Evolution of the Northern Los Angeles Basin, California, Based on Growth Strata, *Tectonics,* April, 1996, Volume 15, issue 2, pp. 341-355.], and present the case for a different kind of fault. They call it the Los Angeles Fault. They looked at evidence west of downtown Los Angeles, in the area near Western Avenue, La Brea Avenue, and La Cienega Boulevard. In three cross sections running north-south, they see strong evidence for a steeply dipping fault. It would be collinear with the structure Shaw and Suppe show extending from downtown Los Angeles to the southeast. But west of downtown, the sediments are bent in such a way that they conclude the area is underlain by a fairly steeply dipping, blind reverse fault, with a steep, sixty- or seventy-degree dip to the north. That fault has produced a 3-kilometer high mountain range buried by sediment, beneath and north of the Santa Monica Freeway, west of downtown. That fault would be about twice as steeply dipping as what Suppe and Shaw infer.

Their Elysian Park ramp, southeast of downtown Los Angeles, would dip only about thirty degrees, consistent with the Whittier Narrows earthquake dip to the north. However, the Yeats group says that a dip of sixty to seventy degrees is more appropriate. I think both have some very strong points.

MF: So what's your opinion?

KS: The fault that produced the 1987, M5.9 Whittier Narrows earthquake had a shallow dip and an east-west strike. That strike doesn't really fit the Shaw and Suppe model. The 1987 fault slip was pure thrust motion on an east-west striking fault. Shaw and Suppe's structure strikes northwest-southeast. In addition, the early June 1996, M3.8 earthquake was produced by a fault with a strike just a little bit north of east-west—and the fault dipped about forty-five degrees north. This orientation is almost halfway between the shallow dipping Suppe and Shaw model and the seventy-degree dipping Yeats group model. So the latest earthquake supports neither perfectly, but suggests both groups are on the right path.

To understand the tectonics of downtown Los Angeles, one must look at the geomorphology from the east to the west. Observed at the surface (if you look through the eyes of a geologist) is a series of minor folds, running almost due east-west. East of downtown Los Angeles, between the Interstate 10 Freeway and Highway 60, are two major anticlines and a couple of minor anticlines and synclines. They all appear to have been active in the last 60,000 years. In that period of time they have vertically risen tens of meters. The tectonics of the Los Angeles area are more active than geologists would have guessed twenty years ago. ♦

Michael Forrest

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Feature: visit with a SCEC scientist

Andrea Donnellan: Searching for the Final Frontier

Profile

Andrea Donnellan received her B.S. (1986) from Ohio State University, with a geology major and mathematics minor. She received her M.S. (1988) and Ph.D. (1991) in geophysics from the California Institute of Technology. On completion of her Ph.D., she held a National Research Council Postdoctoral Fellowship at NASA Goddard Space Flight Center. Now employed as a Member of Technical Staff at NASA's Jet Propulsion Laboratory (JPL), she uses the Global Positioning System (GPS) satellite technology to study earthquakes and the corresponding movements of the earth's crust. Donnellan is also a Visiting Associate at the Seismological Laboratory at Caltech and a member of the Southern California Earthquake Center's Crustal Deformation Working Group.

She has conducted field studies in California in the region of the January, 1994 Northridge earthquake, the Ventura basin, and on the San Andreas fault. She has also carried out field work in Antarctica on the West Antarctic Ice Streams, on the Altiplano of Bolivia, and on the Variegated Glacier in Alaska. She has published in *Nature*, *Science*, *The Journal of Geophysical Research*, *Geophysical Research Letters*, and *The Bulletin of the Seismological Society of America*. Donnellan received national attention in 1994 for publishing a paper in *Science* which forecast a large earthquake in the Ventura area some three months before the Northridge earthquake occurred.

She plays the piano, dances ballet and likes reading old English and Russian literature. She is interested in becoming an astronaut, and has recently earned her pilot's license.

The Interview

by Michael Forrest, Associate Editor

MF: You're a principal investigator for the new southern California integrated Global Positioning System (GPS) network. What is it, and what is your role?

AD: It's a collaboration of several institutions, and the Southern California Earthquake Center (SCEC) is the umbrella organization for a committee of people from the geodesy community. Many organizations contributed to the planning of the network. The major players are the Jet Propulsion Laboratory (JPL), the US Geological survey (USGS), and the University of California at San Diego's Scripps Oceanographic Institute (Scripps). These three are the network and analysis centers. Dave Jackson, the science director of SCEC, local agencies and Massachusetts Institute of

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Technology are also involved. The chair of our coordinating committee is Will Prescott, USGS Menlo Park.

The geodetic network goals are earthquake hazard assessment and improved understanding of the earthquake cycle. With geodesy, we can measure the "quiet" part of the earthquake cycle as well as the seismic part.

I'm mostly interested in the network from a scientific standpoint. I've been very involved in planning the network design, writing the proposals, and selecting the sites for equipment. Now I want to see the data, model it, and try to understand the earthquake process.

MF: How many GPS stations exist and how many new stations are planned?

AD: At the time of Northridge (early 1994) there were nine stations in southern California, including two in Los Angeles. Now there are 40 stations in southern California, and 20 or 25 are in or near Los Angeles. Within the next year we plan to install about 80 more stations with funding from the National Science Foundation (NSF) and NASA. At that point, we'll be about halfway to our goal of 250 stations.

MF: How are the stations spaced?

AD: We have three north-south profiles across Los Angeles and the spacing of stations on those profiles is about two to three kilometers. Then we have a smattering of stations in southern California for the three-dimensional and far-field effects. Near Los Angeles the station spacing is 10 to 15 kilometers and it's more sparse further out.

MF: Japan is planning to add more stations to their network as well. Is their station spacing denser?

AD: Yes, Japan has over 100 operating stations. They have a network in all of Japan and a network around Tokyo. They will soon have 600 stations. JPL is helping them analyze data from their network. They plan to have 3,000 stations there soon.

MF: These will feed back information 24 hours a day?

AD: Yes. They analyze their data every day. They've had interesting results from Kobe and from some offshore earthquakes. They see some interesting post-seismic as well as co-seismic signals.

MF: Art Sylvester (University of California at Santa Barbara) recently suggested the Ventura anticline deformation is being taken up aseismically. What do you think about this?

AD: I think the deformation is aseismic. We question whether the deformation is from a past earthquake that produced increased stress above the earthquake, resulting in "folding," or is a continuous process.

There are a few unique things about the western part of Ventura where Sylvester is working. The sediments there are very soft with a lot of clay. So they may deform constantly, aseismically. That may not be appropriate for the Los Angeles Basin, however, because it doesn't have as much clay in its sediments, and there is more crystalline material to the north. So we're trying to investigate that.

For example, Oat Mountain rose 15 inches/38 centimeters, and continued to rise after the Northridge earthquake, about three centimeters. We think it's a combination of fault slip and folding of the sediments. Sylvester sees this as continuous aseismic folding. In the first eight months after the earthquake, we saw 65% of the post-seismic motions. Two years after the earthquake the movement has almost stopped.

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"I've been collaborating with Andrea for about 3 years on GPS and southern California tectonics. During that time, I've really been impressed with the energy and ambition with which she tackles problems. She's a virtuoso both at the computer and in the field, and her soft-spoken manner belies her tremendous energy. "

Greg Lyzenga, Associate Professor, Physics, Harvey Mudd College

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MF: Could there be broad crustal deformation occurring in the Los Angeles region, that isn't being taken up by slip on faults?

AD: We're trying to find an answer through this network. We don't know yet. You can't answer that question in five years, which is the minimum life of this network; but we are addressing questions like that because seismic hazard estimates are affected.

MF: Did you ever read a certain paper by E.A. Nagy and K. Sieh entitled "The use of paleomagnetic analysis to assess nonbrittle deformation within the San Andreas Fault Zone" [Journal of Geophysical Research, v. 98, issue B10, (Oct 10, 1993) pp. 17965-17979.] In this paper, they examined rotations beside the San Andreas Fault, using paleomagnetism. They found that a big earthquake causes significant slip on the fault and substantial deformation in the zone right next to it.

AD: I think that's probably what happens. I think faults are stiffer the deeper they are; the movement is more discrete and spreads out as it comes to the surface. Lisa Grant (Chapman University, Woodward Clyde Consultants) and I did some surveying on the San Andreas Fault in the Carrizo Plain, and the results were consistent with Sieh's observations further south. We also saw similar deformation after the 1994 Northridge event. Once into soft sediments, motions spread out and away from the fault; but at depth, the total movement is on the fault.

MF: Does geodetic data from the Santa Monica Mountains support the idea that the slip on the reverse fault underneath is dying out or dead?

AD: We don't have good vertical solutions for anywhere in southern California, except co-seismic in Northridge and post-seismic observations. GPS data, however, are consistent with the (dying out or dead) hypothesis. With a thrust fault there is also

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Above: Andrea, Mark Smith, and Jeremy at Oat Mountain.

Left: Andrea's first solo cross country, Santa Barbara Airport.

Thesis Advisor Brad Hager (MIT) and Andrea Donnellan at Santa Paula Peak, Ventura Basin.

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horizontal motion, and we don't se a lot of horizontal motion in that area. It's mostly to the north, right across the Ventura Basin.

MF: In terms of the overall deformation action in southern California, what's moving fast and where?

AD: The whole frontal fault system is being squeezed. Most of the movement is in a strip 10 to 20 kilometers wide, from Santa Barbara through the Ventura Basin, through Pasadena, and out to the Upland/Rancho Cucamonga area. This seems to be where most of the convergence is taking place. Then there is the motion on strike slip faults.

MF: Marcia McNutt (Massachusetts Institute of Technology) thinks there's an intracontinental subduction zone under the frontal fault system, and the peninsular ranges are diving under the Transverse Ranges. If so, would you say all the crustal contraction is occurring in the "hanging wall" of the crust?

AD: I have a student working with me who will address exactly that problem. Debbie Dauger (California Institute of Technology) is partially funded by SCEC. She just won a NASA fellowship to work with us at JPL. She will be using GPS data to constrain some of these things. She'll be examining whether there's subduction, symmetric down welling, or something else going on under the Ranges. If what happens in the mantle translates to what we see at the surface, I suspect the deformation is at the boundary between the hanging wall and footwall.

MF: So south of the range front system, there's not much contraction?

AD: If you look at a profile from Palos Verdes to the University of Southern California (USC) you see virtually no deformation. And from USC across to JPL, we see about eight millimeters/year of shortening. So it goes from zero to eight. It's interesting.

MF: And areas like the Santa Monica Mountains are rotating?

AD: The Santa Monica Mountain block is rotating at about 11 degrees per million years, which is very consistent with the paleomagnetism results.

MF: You forecast an earthquake in the Northridge area in a paper in Science a few months before it happened. That's pretty amazing.

AD: Yes, it was fortuitous that we had published a paper. Ultimately if an earthquake would have occurred there in twenty years, it would have been the same as the next day or two months later, as far as the accuracy of our forecast was concerned.

I think these results really demonstrate the value of GPS for studying earthquake hazards. We're trying to use GPS to see what the faults are doing at depth. GPS is really the only way (beside imaging or geologic reconstructions) of determining whether they flatten out, go straight, creep, or not. The paper highlighted the strengths of GPS.

MF: Describe the instruments you use.

AD: The GPS receivers and the antennae are very heavy. When we first started using them in 1987 we had to lug pairs of heavy,

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deep-cycle marine batteries around.

We always thought the receivers would get smaller (though some of them are hand held now), but the total poundage we carry hasn't gotten any lighter. The problem is, as the instruments have shrunk, memory capacity has increased! So we're stuck with these heavy batteries because we want to get as much data as possible. That's why continuous data is nice.

MF: You've been to Antarctica?

AD: I've been in Antarctica three seasons: for two months the first two years and one month the third year, out on the Siple Coast, across the Ross Ice Shelf from McMurdo. We were studying the ice streams. The ice sheets are very thick there (two to three kilometers). There are 30 kilometer-wide tongues within the ice sheet moving very quickly—about 800 meters a year. We were studying those to figure out if the ice sheets are disintegrating—and if so, what's the cause. We were the first people out in that part of Anarctica.

MF: Ever worry about losing your fingers or toes?

AD: No, the cold wasn't too bad. In the beginning of the season with the winds blowing it would be about -5 degrees Farenheit with twenty-knot winds. We slept and cooked in tents. I did turn blue once—I was hypothermic. But there were so many interesting things out there. We once spotted a Skua (a sea bird) a thousand kilometers from any coast! The bird had made its way out to our camp.

Since the ice is moving so fast, there are a lot of crevasses, so we had to be very careful. When you're on a glacier, you can see them. But if you're on an ice sheet the snow blows across the chasm, forming snow bridges, and you can't see the crevasses. On Christmas Day one year we climbed down a crevasse about 25 or 30 feet.

The other interesting things in Antarctica are the "ice-quakes." The moving ice rumbles and sounds like a thunder storm.

MF: You've also worked in Bolivia and Alaska?

AD: I've been on the Altiplano in Bolivia and on Variegated Glacier in Alaska. Bolivia was miserable, comfort-wise, but spectacular in every other way. We were studying the Salar de Uyuni (or the Uyuni Salt Flat). It was our summer so it was their winter (in their summertime it's so wet that you can't drive on it). We were out in the middle of nowhere and the Altiplano was freezing. In the morning it was ten degrees *inside* the tent. My room at our hotel was a constant 32 degrees. The shower was heated electrically, and scary. It only allowed a trickle of warm water.

Altiplano in Bolivia.

We tried to recharge our GPS receivers and used up the power in the whole building. We were basically recharging camcorder batteries, so that gives you an idea of the power levels there.

MF: You play the piano? Who do you like to play?

AD: Oh, anything, popular music to classical music—whatever I feel like.

MF: When did you start playing piano?

AD: When I was about five. My mom taught us when we were little. I liked to play so my grandmother gave me a piano.

MF: You also do ballet?

AD: Yes, my class is giving a performance soon, which I will be only watching. My work keeps me traveling, and I was also working toward my pilot's license, so I didn't have time to rehearse.

MF: You fly?

AD: Yes, I like to fly and combine it with geology. I planned all my solo cross countries around field areas. I flew to Santa Barbara over the Ventura Basin. I flew to Santa Paula. I flew to Blythe. I photographed the San Andreas Fault from the air and then I flew across the Mojave section of the fault and took more photos. Lisa Grant started learning how to fly but she said she had to stop because she was too interested in looking at the geology.

MF: One of your goals is to be an astronaut, isn't it?

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AD: I did interview two years ago, but I wasn't selected. I'm still trying—the next interviews are next summer.

MF: What would you like to do in space? What have they done out there that interests you?

AD: The SIR-C (Spaceborne Imaging Radar C-band) mission, a shuttle radar mapping mission. There are plans to do more—and that interests me. There is a new mission called SRTM (Shuttle Radar Topographic Mission) that will also fly. I'd like to do earth observing activites from space.

MF: I assume you don't suffer from claustrophobia.

I was tested for that. They put me into a little ball three feet in diameter. I was left there, hooked up to monitors, with no knowledge of how long I was to be left in there. I had a microphone so I could talk to them in case of panic. I passed the test, so I guess I'm not claustrophobic.

MF: How long did they leave you in the ball?

AD: It turned out to be about ten minutes. I just sort of dozed off.

MF: What else did they have you do?

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Setting up a GPS station, and measuring antenna height and reference to the monument. (Hager, left; Donnellan, right.)

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AD: Many medical and psychological tests, and an hour-long interview. They also encouraged me to talk to astronauts to find out what it's like.

MF: Who'd you meet?

AD: Several people, but John Young impressed me most, because he's done everything. He's walked on the moon and been on several missions, all fascinating. He had studied southern California and knew about the Ventura Basin. We were at a gathering and he introduced me to people by saying "This is Andrea Donnellan! She works in the Ventura Basin!"—as if they should be impressed [Andrea laughs]. So that was fun. I also met Jim Weatherby, Janice Voss, Tom Jones, Jay Apt, Linda Godwin and several other astronauts. Everybody said the best thing about the astronaut experience was the ability to look out the windows in the space shuttle. They said it's the best job in the world.

MF: Did John Young talk about walking on the moon?

He talked about it as though everybody had done it. He said he was very tired from the heavy space suit and from trying to collect the right rocks. He had been trained by Lee Silver (California Institute of Technology), and didn't want to let him (or anyone) down.

MF: Back to GPS. Based on the data you have so far, what area in southern California worries you most?

AD: I guess I would be the least surprised if the San Andreas, or the frontal fault system broke. I also wouldn't be surprised if any other random or previously unknown faults broke. There are just so many faults in southern California, each with 2,000-year recurrence intervals (like Landers).

MF: How did you get into all of this?

AD: I knew from about five years old that I wanted to be a scientist. When I was probably eleven or twelve, I decided I wanted to be involved in some kind of study of nature, and then in high school I decided I wanted to be a geologist. I was in 4-H and I collected rocks for my projects. I eventually had a career exploration class, where I decided that geology was my interest. In college I visited Antarctica, where I was involved in a glaciology project, and that was related more to geophysics. I minored in math. After my undergraduate years, I wanted to do something more quantitative so I switched to geophysics for graduate school.

I like seeing things move and want to understand processes. With glaciology I could do that, such as measuring ice motions. Studying southern California is the same. It's complicated and

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slower, but very interesting. I've always been into measuring motions, from glaciology through crustal deformation.

MF: When you think about the crust do you think of southern California as a mosaic made up of hard pieces and soft pieces caught between the plates?

AD: Yes, Gregory Lyzenga (Associate Professor, Physics, Harvey Mudd College) actually describes it best: a "big squishy jigsaw puzzle." All these blocks are rotating and banging together. Some of them are soft and are deforming, and some of them are more rigid. But when we construct our models they're often isotropic—modeled as an elastic half space. We're working on

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Mark Smith at Paramount Studios for an episode of Voyager.

MF: Tell us about Mark [Smith].

AD: Mark is a field engineer. He installed the USC GPS station, as well as San Nicholas, Whittier, Catalina, Long Beach, Saddle Peak, and Oat Mountain. He's done most of the JPL stations.

He's a Native American Indian (Shoshone) from Kern County. East of Lake Isabella there's a town called Weldon. He has relatives there that speak in their native tongue. I missed their reunion last year because I was sick, but he says it's literally like getting cowboys and Indians together. It's a very "youthful" older generation and they have compelling stories to tell.

MF: Are you about to be married?

AD: [Laughter] Well, we aren't organized, but yes, we'd like to be married. It's just a matter of organization and pulling myself out of debt from learning how to fly. Mark has an acting career as well as his work at JPL.

MF: He appears on Star Trek Voyager?

AD: He's been in three episodes of the "Next Generation" and five episodes of "Voyager."

Solo to Blythe??!!

"Student pilots are required to do a 300 nautical mile solo cross-country flight during their training. I usually joke around with my students that if they mess up, or make me mad, I will send them to the most desolate, hot, boring, miserable place I can think of: Blythe. There is nothing there ... no where to eat, no one to talk to, nothing of any interest to the average student pilot.

The time came for Andrea to do her long cross country flight, and I asked her where she wanted to go, thinking she would choose somewhere along the coast, by the beautiful Pacific Ocean, you know, somewhere with a view. But she wanted to go to, of all places, Blythe! In the middle of the stinking desert? Was she crazy? And she was so excited about 'getting to go to Blythe!' I was just amazed ... It was those earthquake faults on the way to Blythe that she took aerial photos of ... that was the first time I had heard that one! She is definitely one of a kind."

Sheri T. Petzel
Andrea's flight instructor

See "Donnellan" *on Page 23*

Donnellan *continued from Page 22 ...*

On Inspecting Northridge

Andrea Donnellan is a dynamo, a phenomenon, a force of nature. The day of the Northridge quake I rode with her to the top of Oat Mountain which at the moment of our arrival shook furiously, sending great dusty billows into the sky—a respectful greeting to Her that Hath Understanding and Will Know My Secrets. Whether the intent was wicked or charitable I can't say, but I don't doubt that if anyone can wrestle the beast into the light it's Andrea.

Tom Yunck, Andrea's Deputy Section Manager, JPL

improving that.

MF: What's coming up in the future?

AD: I'll be in Mongolia in September to study the crustal deformation there. One mountain range there is similar to the San Andreas and Sierra Madre fault systems. Essentially, they both broke at the same time. I think it's really important to step back and look at other parts of the world to get a new local perspective. Mongolia is an interesting place because it's away from any plate boundaries. It has intracontinental deformation, away from subduction zones and from the Indian collision.

In December I may be going back to Antarctica to examine uplift from unloading of the ice-sheet and tectonics. That relates to my undergraduate work. A question we may answer is whether spreading under the ice or global warming is controlling these ice sheets. The West Antarctic Ice Sheet may be disintegrating. It appears that more is flowing out than is being added. It is also grounded below sea level. That might mean it is less stable than an ice sheet grounded above sea level. I'll focus on the question of whether rebound is occurring because the ice sheet is thinning, and if there's a geological explanation for the ice streams in West Antarctica. Doing these things brings me full circle with my undergraduate work.

MF: Since you've become famous for forecasting the Northridge earthquake and you made Time magazine and the Los Angeles Times, I've heard you have a following. In fact I've even heard you've had marriage proposals sent to you.

AD: Yes, all kinds of things. There was one person who decided I could tell *where* an earthquake would occur, but not *when*. He claimed to be able to tell *when* but not *where* and surmised we should hook up. I also got a "letter of introduction" from a Liberian! It took a while for that letter to reach me.

MF: Whom do you admire?

Tom Dibblee. I attended a University of California at Santa Barbara workshop last year and we went on a field trip near the 101 Freeway. It was a rainy day and Dibblee was all bundled up. We were on a roadcut, high up and off the freeway some 50-100 feet. In the corner of my eye I suddenly thought I saw a bear clambering up the slope near me. I quickly turned around and saw Tom Dibblee in his big, brown coat, crawling up this hill! It was a very steep slope but he just had to see this high rock—and he's in his eighties now! Just amazing. The image has never left my mind of this man who's still so interested and has done so much. ♦

World Wide Web: Geodetic Information

GPS Time Series and SCIGN Map: ***http://sideshow.jpl.nasa.gov/mbh/series.html***

SCEC Data Center Geodetic Information: ***http://www.scecdc.scec.org/scign***

JPL Web Site: ***http://milhouse.jpl.nasa.gov/***

SCEC Summer Interns on the Leading Edge

Diversity of interests and institutions marks this year's SCEC Summer Intern Initiative. Now in its third year, the program includes community colleges, state and private colleges, universities in Southern California, and SCEC institutions. As a result, the number of applicants increased beyond previous years.

Awards were made to two interns who successfully completed projects last summer. The interns for 1996 are listed (see inset right) with their home institutions; titles of their projects; research advisors and their affiliations. SCEC encourages all undergraduate students in earth science-related studies to participate.

The program places special emphasis on recruitment of women and underrepresented minorities with majors in the earth (geological) sciences. From the first class in 1994 to the present, the program has met its goal: eight non-minority men and five minority men and women in 1994, to two men and eight women in 1996. SCEC also sponsored a minority woman student at the NSF Conference on Diversity in the Scientific and Technical Workforce in 1995. Virtually all students have reported a very positive internship experience and several have advanced to graduate studies or careers in the field.

Diversity also is evident in the projects that students will be doing this summer. From science education research to earthquake engineering to fault studies, students make their projects a fulltime summer occupation.

In late July, students will convene for a Technical Orientation. This year's theme is Coastal Geological Processes and Earthquake Hazards. All SCEC Summer Interns will present posters of their projects at the SCEC Annual Meeting in Palm Springs, October 19-21, 1996.

With funding from the Federal Emergency Management Agency (FEMA), SCEC will seek its first Academic Year Interns in the fall of 1996. These interns will be involved in science education projects relating to earthquakes and mitigation issues.

Interns and Sponsors

Donna Rathman, Intern
Irvine Valley College
University of California Irvine
The Post-Earthquake Flow of Resources from the California Department of Education to Local Schools: An Organizational Problem
Ann Tanouye, Sponsor, Governor's Office of Emergency Services

Margaret Glasscoe, Intern
University of Southern California
Developing a Scientific Education Module for the Southern California Integrated GPS Network
Andrea Donnellan, Sponsor, Jet Propulsion Laboratory

Carmen von Stein, Intern
Western Washington University
The Interaction of the Main Palos Verdes Fault with the Cabrillo Strand, Los Angeles, CA
Thomas Rockwell, Sponsor, San Diego State University

Mandy Johnson, Intern
University of Southern California
Pleistocene to Recent Uplift of the Santa Monica Anticlinorium
Andrew Meigs, James Dolan, Sponsors, University of Southern California

Jeni Tucker, Intern
California State University San Bernardino
Quaternary Geologic Mapping of the San Andreas Fault in San Bernardino
Sally McGill, Tim Ross, Sponsors, California State University, San Bernardino

Armando Hurtado demonstrates an advanced brace retrofitting technique on the "Leaning Wall of Pasadena."

SCEC's Global Science Classroom Participates in AIA Seismic Design Exercise

The Earthquake Center participated in the development and implementation of an American Institute of Architectural Research seismic design exercise June 7-10, 1996. The exercise was hosted by the College of Environmental Design at California State Polytechnic University, Pomona.

The seismic design-focused exercise targeted architectural faculty and students from southern California schools of architecture, and included lectures by scientists, planners and architecture faculty. Featured were an urban structure and open space analysis of Old Town Pasadena, a studio planning session of an Earthquake Emergency Information Center and the actual construction of full scale model Information Centers resulting from the design studio session.

SCEC consulted on curriculum design, provided earthquake scenario information, recommended and supplied educational materials and other resources, and participated in the urban analysis field study.

In the future, SCEC is planning to participate by providing resource kits and identifying experts to provide background on natural hazards for the AIA-sponsored Institutes.

Right: members of an urban analysis team from the Newschool of Architecture in San Diego: Newschool Chair and faculty member, Mitra Kanaani and two of her students, Tyson Cline (left) and Armando Hurtado (center).

Interns and Sponsors

Marcy Davis, Intern
University of California, Santa Barbara
Tectonic Geomorphology of the Mesa Hills, Santa Barbara Fold Belt, California
Larry Gurrola, Edward Keller, Sponsors, University of California, Santa Barbara

Dawn Cheng, Intern
University of Southern California
Development of Data Base for Evaluating Earthquake Performance of Tile Roofing
Yan Xiao, Sponsor, University of Southern California

Gretchen Mullendore, Intern
Orange Coast College
Analysis of Strong Motion Data Recorded at the Van Norman Complex
Ralph Archuleta, University of California, Santa Barbara

Erik Bartsch, Intern
University of California, Santa Barbara
Sea Floor Geologic Map of the Hanging Wall of the North Channel Slope Fault System Santa Barbara between Santa Barbara and Ellwood Beach
Bruce Luyendyk, Sponsor, University of California, Santa Barbara

Allan Tucker
University of Southern California
Using Shallow Seismic Reflection for Fracture Zone Identification
William Doll, Sponsor, Oak Ridge National Laboratory

Risk Mapping and GIS

A collaborative effort among earthquake engineering faculty from Stanford University (group led by Anne Kiremidjian), the University of Southern California (Southern California Earthquake Center led by Geoff Martin), and the University of California at Los Angeles (led by Mladen Vucetic), has produced a GIS-based correlation between soil type and earthquake damages for two Californian regions.

Vucetic's group contributed the development of a three-dimensional database of geotechnical properties (soil properties). They digitized into GIS format, a relatively large number of geotechnical boring logs which contain various soil properties with depth. Such types of 3-D database can be used for various purposes, depending on the input information. Those interested in risk analysis from the database should contact Dr. Kiremidjian at Stanford.

For more information on the 3-D database, contact:
Mladen Vucetic, Associate Professor
Civil and Environmental Engineering
University of California at Los Angeles
Los Angeles, CA 90095-1593L
email: *vucetic@seas.ucla.edu*
phone (310) 206-6260

or

Macan Doroudian at (310) 825-5853.

Earthquake Hazards Reduction Fellowship Announced

Under a cooperative agreement with FEMA, the Earthquake Engineering Research Institute offers the 1997 Professional Fellowship to provide an opportunity for a practicing professional to gain greater skills and broader expertise in earthquake hazards reduction, either by enhancing knowledge in the applicant's own field, or by broadening his or her knowledge in a related, but unfamiliar discipline. The fellowship provides a stipend of $30,000, commencing January 1997, to cover tuition, fees, relocation and living expenses for a six-month period. Applicants must provide a detailed work plan for a research project that would be carried out in the six-month period. Candidates may obtain an application form from:

EERI
499 14th Street, Suite 320
Oakland, CA 94612-1934
Telephone: 510/451-0905
Fax: 510/451-5411
e-mail: *eeri@eeri.org*

SCEC Visitors Program

Call for Applications - 1996-1998 Post-Doctoral Fellowship/Visitors Program

The Southern California Earthquake Center (SCEC) solicits applications to its 1996-1998 Post-Doctoral Fellowship/Visitors Program. SCEC is a National Science Foundation (NSF) Science and Technology Center, pursuing research in the scientific basis of earthquake hazard estimation. SCEC member institutions include the University of Southern California, the California Institute of Technology, Columbia University, the University of California at Los Angeles, San Diego, and Santa Barbara, and the U.S. Geological Survey.

Through its post-doctoral fellow/visitors program, SCEC seeks to bring scientists to SCEC institutions to collaborate on the goal of the Center. Preference will be given to scientists from outside the SCEC institutions and to applicants who propose to work at one of the seven institutions listed above. U.S. citizenship is not required. Post-doctoral fellowships for up to two years are available for young scientists. Senior appointments are usually awarded for up to six months at a SCEC institution. Each applicant must have a sponsoring scientist from one of the member institutions, who is actively participating in Center projects.

Applications should be sent by letter to the Center Director no later than September 15, 1996, and must include a brief research prospectus, not to exceed three pages. Funding may begin as early as October, 1996. A full curriculum vitae, including a publication list, should accompany the application. A letter of recommendation from the SCEC sponsoring scientist is required. In the case of postdoctoral applications, an additional letter of recommendation is also required. Applications from women and other under-represented groups are especially encouraged.

Applications should be sent to:

Dr. Thomas L. Henyey, Center Director
Southern California Earthquake Center
University of Southern California
Los Angeles, CA 90089-0742

Telephone inquiries may be directed to:

John McRaney
Southern California Earthquake Center
University of Southern California
Los Angeles, CA 90089-0740
213-740-5842 (phone)
213-740-0011 (fax)
e-mail: *mcraney@coda.usc.edu*

Seismic Hazards in the Las Vegas Region: Working Towards an Understanding

First Call for Papers

A Conference to be held at the University of Nevada, Las Vegas, November 14, 15, and 16, 1996

Sponsored by:
Nevada Earthquake Safety Council
Geosciences Department, University of Nevada, Las Vegas
Association of Engineering Geologists, Southwestern Section
Nevada Bureau of Mines and Geology
University of Nevada, Reno Seismological Laboratory
Federal Emergency Management Agency

Schedule:
Abstracts: 15 July 1996
Pre-Registration: 1 September 1996
Papers: 1 November 1996 (draft)
15 December 1996 (final)

Conference sessions will include: Quaternary faulting, seismicity, and ground motion. Emphasis will be given to the seismic hazards of Las Vegas basin, distinction between compaction and tectonic faulting, local seismicity, and basin amplification of ground motion. The conference will feature panel and general discussions, poster sessions, a field trip, and a proceedings volume.

Las Vegas is the fastest growing metropolitan area in the United States. With its unique entertainment, Las Vegas attracts visitors from throughout the world. Population in the area now exceeds one million people and with the additional potential for over 100,000 visitors, understanding the seismic risk is essential for public safety, emergency preparedness, and construction. The earthquake threat in Las Vegas is poorly understood. Although efforts are underway to complete geologic mapping of Las Vegas Valley, detailed studies needed to characterize faults in the area have not been undertaken. Strong ground motion within the valley has not been thoroughly evaluated, and zones of potential liquefaction have not been mapped. Debate continues over the origin of Quaternary faults within the valley -- whether they result from tectonic forces or aseismic compaction. Accordingly, it is important to assess the state of knowledge of the earthquake potential for the faults in and near Las Vegas.

For more information, contact:

Jim Werle, Conference Coordinator
c/o Converse Consultants SW
731 Pilot Road, Suite H
Las Vegas, Nevada 89119
Telephone (702) 269-8336
FAX: (702) 269-8353
e-mail: *converse@enet.net*

EQIP Establishes EQNET Home Page and Web Site

The Earthquake Information Providers' Group (EQIP, pronounced "equip") now has a Web site under construction. Called "EQNET" (Earthquake Hazards Mitigation Information Network), the site links to 43 sites featuring resources related to earthquake hazards mitigation. Check out:

http://www.eqnet.org

The page has an alphabetic listing of information sources (linked); information sources by subject; bibliographic resources (indexes, libraries, etc.); images, multimedia and computer software providers; and a page which describes the mission of the EQNET Web site working group.

The working group, comprised of volunteer Earthquake Hazard Mitigation Information Providers, have created the home page and site and will endeavor to assist the community of earthquake information providers with Web-related support.

Members of the EQNET working group include:

Patricia Coty, Chair (NCEER)
Jill Andrews (SCEC)
Clifford Astill (NSF)
Jim Buika (FEMA Region IX)
Dave Butler (NHRAIC)
Karen Gahagan (IIPLR)
Steve Ganz (WSSPC)
Lind Gee (UCBSS)
Chuck James (UCB-EERC)
Scott McAfee (OES)
Dick McCarthy (CSSC)
Sarah Nathe (OES)
Chris Rojahn (ATC)
Doroty Tao (NCEER)
Jeanette Zerneke (UCB)

Calendar

August

2 LARSE workshop; 10 am at the University of Southern California, Room 133 South Science Building. RSVP to David Okaya (*okaya@coda.usc.edu*) and request parking pass.

22-24 Passive Energy Dissipation Course, NCEER & EERC, Los Angeles. Provides an in-depth look at the history, development and implementation of passive energy dissipation systems in the U.S. and abroad. For information, contact Andrea Dargush at NCEER, phone 716/645-3391; fax 716/645/3399, e-mail: *dargush@acsu.buffalo.edu*.

27-29 SCEC Site Review, USC Campus, with Center Steering Committee and Board of Directors.

September

18-21 Western States Seismic Policy Council Annual Meeting, Polson, MT. Contact Fred Naeher, Montana Disaster and Emergency Services, phone 406/444-6982.

October

1-6 SEAOC Annual Convention, Maui, Hawaii. Information: SEONC, phone 415/974-5147, fax 415/764-4915.

4 SCEC Annual media workshop, "Earthquakes and the Media." Goal of the workshop is to identify needs of radio, television, print and wire representatives in the context of SCEC's capabilities. Call 213/740-1560 for more information.

12-14 SCEC Annual Meeting, Palm Springs, California. Call 213/740-5843 for more information.

20-22 Association of Contingency Planners (ACP) National Symposium, San Antonio, Texas. Call 512/463-3950 and ask for Tommye White for more information.

25 SCEC-Sponsored field trip with Dr. Tom Henyey, SCEC Director, and Dr. Tom Rockwell, San Diego State University. We will spend the day inspecting the Palos Verdes Fault zone. For more information, call 213/740-1560.

October, continued

28-31 Geological Society of America (GSA) Annual Meeting, Denver, Colorado. Meeting will include sessions on seismicity of North America and on numerous other geologic hazards. Contact: GSA, 3300 Penrose Place, Boulder, CO 80301; 303/447-2020; 800/472-1988.

30-31 A Workshop to Explore the Feasibility of Seismic Microzonation in the City of Los Angeles. Co-sponsored by the City of Los Angeles and SCEC. Call 213/740-1560 for more information.

November

5-7 3rd US-Japan Conference on Corporate Earthquake Programs, San Jose, CA. Information: Steven Vukazich, 408/924-3858, fax 408/924-4004, e-mail: *vukazich@isc.sjsu.edu.*

December

6-8 SCEC-Sponsored Field Trip with Dr. Kerry Sieh. We will inspect the southern San Andreas Fault system. We'll begin in San Bernardino and head south, ending up in Palm Springs Friday evening. Don't miss this opportunity to learn more about the largest fault in California! Call 213/740-1560 for more information.

16-20 American Geophysical Union Annual Meeting, San Francisco, CA. Call 202/464-6900. Venue to be announced.

January, 1997

15-17 Fifth U.S.//Japan Workshop on Urban Earthquake Hazard Reduction. Sponsored by EERI and Japan Institute of Social Safety Science (ISSS). Los Angeles, CA. "Recovery and Reconstruction from Recent Earthquakes: Implications for Urban Earthquake Hazard Reduction." Contact EERI, phone 510/451-0905; fax 510/451-5411.

FEMA Chosen as Lead Agency in New National Earthquake Program

May 20, 1996: John Gibbons, President Clinton's chief science advisor, announced the formation of the National Earthquake Program (NEP) and the designation of FEMA as the lead agency. The new program will focus scarce government research and development money on mitigation efforts — saving lives and property and limiting social and economic disruptions due to future damaging earthquakes.

FEMA will be responsible for the management, planning, reporting, and budgetary coordination of the program, with the guidance of a federal interagency committee. The agency will serve as the single point of contact within the federal government for information related to earthquake research and mitigation and will undertake various outreach activities to transfer research to state and local governments and the private sector.

Robert Volland was appointed by FEMA Director James Lee Witt to direct the NEP. For more information, visit the FEMA Web site: *http://www.fema.gov* or contact FEMA's Office of Emergency Information and Public Affairs, e-mail: *eipa@fema.gov*. ♦

SCEC Representatives Visit FEMA

SCEC Director Thomas Henyey and Knowledge Transfer and Education Outreach directors Jill Andrews and Curt Abdouch visited FEMA in mid-June. The purpose of the visit was to update Mitigation Directorate and Preparedness, Training and Exercise Directorate personnel on SCEC's current activities and successful outreach efforts.

SCEC and FEMA are already partners in several pilot projects which promote earthquake hazard mitigation. SCEC plans to expand the partnership to include other organizations already working with SCEC on locally successful hazard mitigation programs. Included in this article is a brief summary of portions of the material presented during the discussions.

Inovative New Social Strategies to Engage in Effective Knowledge Transfer and Education Outreach

The SCEC Knowledge Transfer Program, led by Jill Andrews, promotes ownership among end users by reaching consensus on end user needs, and implementing identified priorities for product development, dissemination, and communication. Center end users include disaster preparedness and response officials (city, county, and state); practicing design professionals (aiding development of practical usage of new data); policy makers; business communities and industries (insurance businesses — building consensus on incentives for mitigation; shortcourse series for underwriters); local, state and federal government agencies (city and county building officials, engineers, and decision-makers on vulnerability issues as they relate to steps toward mitigation); the media (development of materials to promote preparedness and community safety before, during and after earthquakes; educational materials to disseminate on an ongoing basis); and the general public (e.g., "Putting Down Roots in Earthquake Country").

The Education Program, led by Curt Abdouch, highlights SCEC science and earthquake mitigation through the development and dissemination of educational experiences, materials and exhibits and through creative approaches to teacher enhancement and student activities. Significant advances have been made to move from initial visibility to sustainability; from exploration and experimentation to measuring the impact of educational efforts; from providing services to all educational levels to focusing on secondary and undergraduate levels; and using educational materials from FEMA and other sources, to developing products of its own. Educational end users cultivated and served have been in both the formal (school) and informal (museum, library) sectors and the general public.

Projects Planned or in Progress

We have assembled a group of end users whom we call the SCEC *Research Utilization Council* (RUC). This group of professionals represents a wide range of earthquake-related end users from industry, academia, and private and public agencies. Their advice, through a series of workshops, has been incorporated into the Center's Knowledge Transfer "business plan." Because the RUC *owns* a part of the technology transfer effort, they have also provided considerable ongoing support (e.g., participation in organizing hazard mitigation activities and workshops; introduction to important contacts in industry, business, and the private and public sectors). We plan to develop partnerships in the community-at-large to turn these SCEC-RUC experiences into a national Guidebook for building Community Coalitions for Mitigation. The Guidebook could address taking personal responsibility, building a safer community infrastructure, and minimizing future disasters from multiple hazards.

With partial FEMA support, we launched a workshop and continuing education series for the *Insurance Industry*, specifically primary insurers, with emphasis on mitigation of the earthquake hazard, especially the built environment. Although the earthquake hazard alone is a major threat to the Insurance Industry, other hazards threaten insurability. The SCEC pilot workshops could be used as a national model for building educational/incentive programs that could serve to implement portions of the National Mitigation Strategy.

In 1995, SCEC launched a *"Vulnerability" Workshop* series in partnership with the City and County of Los Angeles. (The next workshop will be held October 30-31, 1996.) We promote technical information exchange with officials whose concern is mitigation against the effect of large urban earthquakes on the built environment. These workshops provide the opportunity to introduce mitigation strategies (e.g., microzonation and code enhancement) to the community. Two products from these efforts are 1) Specific recommendations for the City and County of Los Angeles, and 2) Steps to develop a model process to address with local governments the earthquake hazard (or multiple hazards) in the urban environments throughout the nation.

A real concern among providers of information for

See "FEMA" *on Page 31*

Earthquake Information Resources On Line

SCEC World Wide Web Home Page

SCEC WWW URL
http://www.usc.edu/dept/earth/quake

Cruising the Internet? Check out the new SCEC WWW Home Page.

Here is a sample list of what you'll see:

Home Page:
"What is SCEC?"--a summary of the Center's history and purpose, including a description of the Master Model concept.
"Formal Mission"--Mission statement and list of Working Groups and Leaders, with links to more detailed descriptions of the research conducted by each of the groups.
"Organization"--a classic organizational chart which shows, at a glance, the structure of the Center.
"Research"--a layer accessible through the home page and the "Mission" page, with detailed descriptions of each Working Group's research to date.

The page also features links to:

- SCEC Core Institutions
- SCEC Infrastructure Facilities--such as the SCEC Data Center at Caltech; the SCEC GPS Centers at UCLA and Scripps Oceanographic Institute; and the Portable Broadband Instrument Center at UCSB.
- SCEC Outreach Programs
- SCEC Products--such as the earthquake hazard analysis map; the Quarterly Newsletter; and SCEC Publications List.
- "Surfing the Net for Earthquake Data"

Jill Andrews

SCEC on the Internet

SCEC Knowledge Transfer and Education Programs are now 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

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

EQNET
http://www.eqnet.org/

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

Annual Southern California Network Bulletins from 1991 - Present
The bulletins are now available on the Web (minus the figures). They describe the activities of the USGS Pasadena Field Office and include a summary of annual seismicity and a list of magnitude 3.0+ events each year. Contact Lisa Wald, USGS Pasadena, e-mail *lisa@usgs.gov* for information.

http://aladdin.gps.caltech.edu/lisa/NETBULLS/netbull_list.html

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***

The Council of the National Seismic System Merged Earthquake Databases
The databases can be tracked down with hypertext jumps through two Web sites:

http://www.geophys.washington.edu/cnss.cat.html
and
http://quake.geo.berkeley.edu:80/cnss

The first address has a very long current catalog that is hard to read, but prints out fairly legibly.

Jack Popejoy, KFWB News Radio 98

Southern California Earthquake Center Administration

Center Director - Thomas Henyey
Science Director - David Jackson
Administration - John McRaney
Education - Curt Abdouch
Knowledge Transfer - Jill Andrews
Outreach Specialist - Mark Benthien

FEMA *continued from Page 29 ...*

hazard mitigation is in the area of communications with the media. SCEC's annual *Media Workshop* promotes better communication with radio, TV, and print media representatives; introduces guidelines for efficient and informative knowledge transfer during and after significant earthquakes; and provides a platform for discussion of how to disseminate hazard mitigation information and encourage public awareness, preparedness and mitigation practices. In the next year, we plan to produce a Media Handbook with visual aids on diskette, to be used by all local news media representatives before, during, and after significant events.

Activities that promote attention to National Science Education Standards and the National Mitigation Strategy. Influence seismic safety in schools through the training of educators: This is a new area of educator training for which SCEC can make a contribution. The first phase, in cooperation with the California Office of Emergency Services will be a research project to determine the system by which resources and responsibilities flow from the State Department of Education to the county departments of education and finally to local school districts. Unresolved issues and lack of a plan relating to this system presently are troubling, confusing and potentially dangerous. A series of school district workshops will be developed and implemented when an understandable system is determined and diagrammed. This process could be a model for multi-hazard planning for schools throughout the nation.

Encourage public participation in and understanding of earthquake science through interactivity with SCEC. Seismosociates Pilot Program for Public Participation and Education: SCEC will pilot a program designed to showcase SCEC scientific advances to the general public and to begin to make mitigation common practice in households. This program's activities will be interactive and more fully participatory than previous public programs. Seismosociates expands on models in which families and households have monitored and reported local weather, ozone pollution levels, acid rain or water quality. Projected to be a self-sustaining program, services will include a newsletter, field trips, museum activities, and electronic data acquisition as part of the Center's outreach program. The program will be jointly planned, developed and managed by both Education and Knowledge Transfer over the period of five years. Many of the activities will be introduced and piloted through SCEC's partnership schools as a school-to-community link.

Multi-Hazard Workshops for Architectural Faculty: The American Institute of Architectural Research (AIA) has been conducting a series of national architecture faculty institutes under contract with FEMA. SCEC has begun furnishing these institutes with earthquake experts, resource materials and curriculum planning services for seismic design exercises at these institutes. SCEC plans further collaboration in 1997 with natural hazards training sponsored by the AIA. ♦

Jill Andrews and Curt Abdouch

Inside this issue:

Feature Articles

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SCEC

SCEC Quarterly Newsletter

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A. Donnellan (pp. 15, 17, 18, 19, 21, 22)
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→ **Subscription Information: see page 31**

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