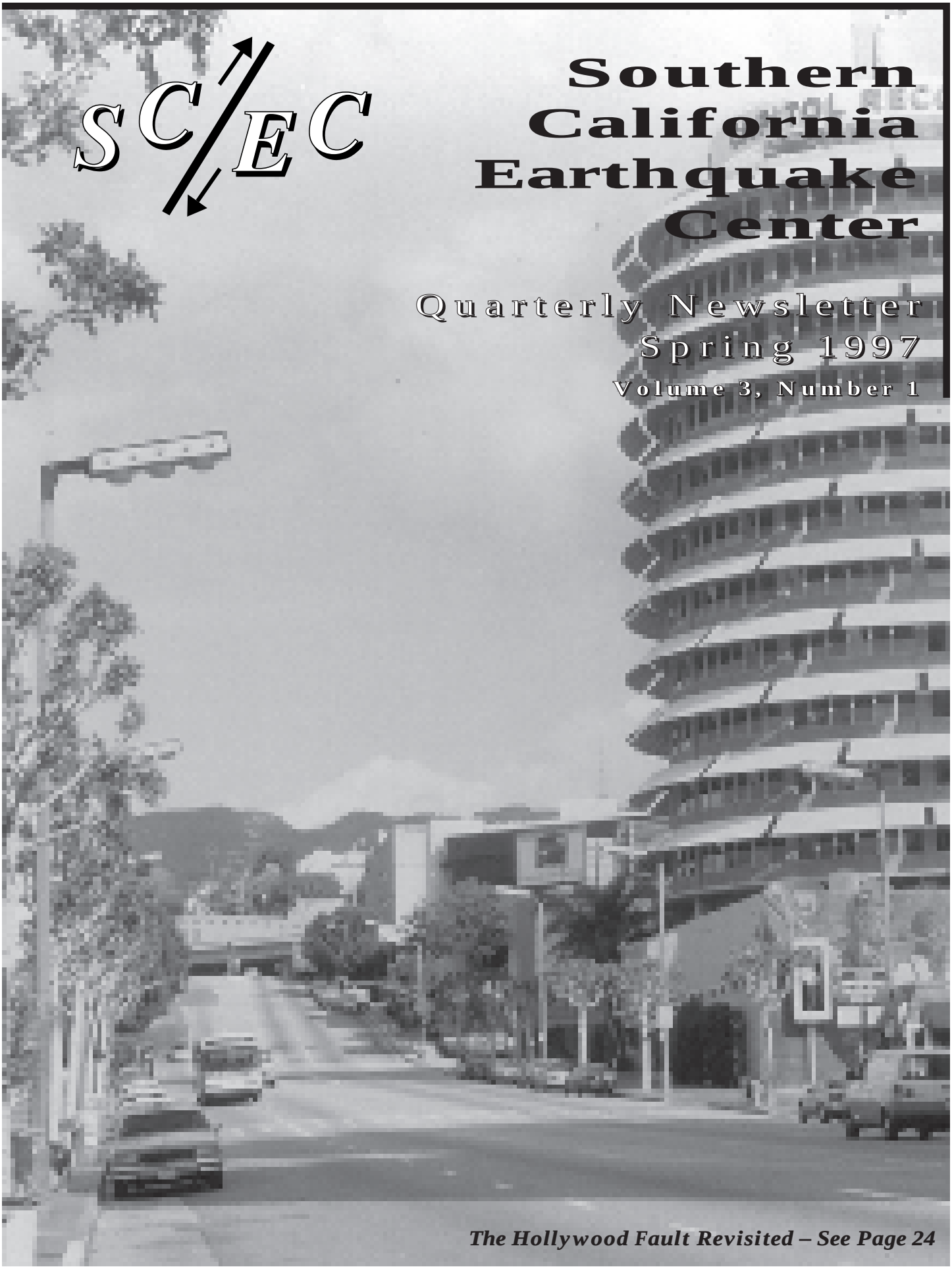


Southern California Earthquake Center

Quarterly Newsletter
Spring 1997
Volume 3, Number 1

The Hollywood Fault Revisited – See Page 24

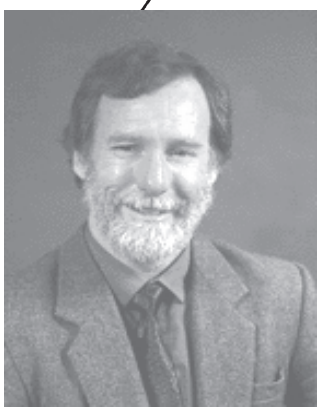
From the Center Directors...

Center Director

Thomas H. Heaton

Science Director

David D. Jackson



Science into Practice

The Southern California Earthquake Center is primarily a national Science and Technology Center, with a mission to push forward the science of earthquake hazard estimation. The National Science Foundation, which provides the largest share of our funding, will evaluate our success primarily on the basis of publishable scientific results. On the other hand, we accept a responsibility to help users of earthquake information who have high-stakes decisions before them. Specific efforts to reach users include our "Phase I" report on the implications of the Landers earthquake for future earthquakes; the "Phase II" report on the 30 year probabilities of earthquakes throughout all of California; the upcoming "Phase III" report which will add a comprehensive study of site effects, and a thorough uncertainty analysis; a major collaborative project with the City of Los Angeles and the Structural Engineers Association of Southern California on the risks posed to certain types of buildings; and numerous workshops with city, county, state, and industrial groups.

We have learned that attention to the users does not compromise basic science; rather, connecting research to practice sharpens both. While forging the consensus reports we forced ourselves to ask how best to read the geologic record, how much will the future resemble the past, whether strain accumulation signifies exceptional earthquake potential, and why strong ground motion varies so much from place to place. Old questions, yes, but now more focused and tangible. And the users are interested in the basic research. They want to know the uncertainties, the implications of the models, and whether there are other viable hypotheses. Forthright answers to these questions will lead to better economic and policy decisions and to improved public safety. Academic scientists and information users have far to go yet to understand each other, but the efforts to date have been extremely constructive.

What Is the Southern California Earthquake Center?

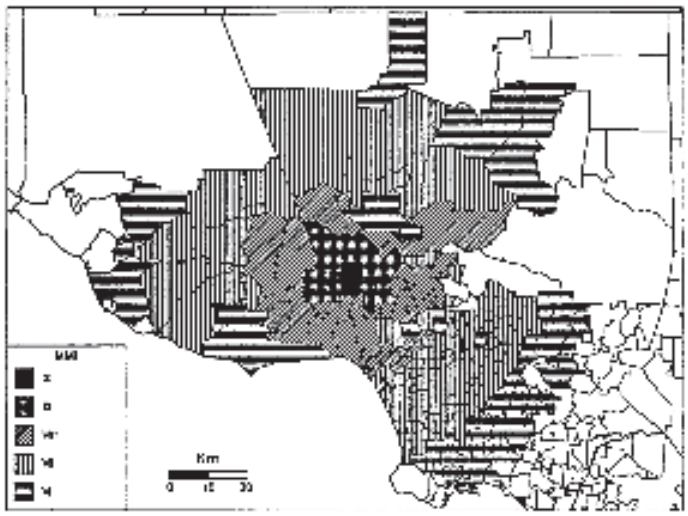
The Southern California Earthquake Center (SCEC) actively coordinates research on southern California earthquake hazards and focuses on applying earth sciences to earthquake hazard reduction. Founded in 1991, SCEC is a National Science Foundation (NSF) Science and Technology Center with administrative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

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

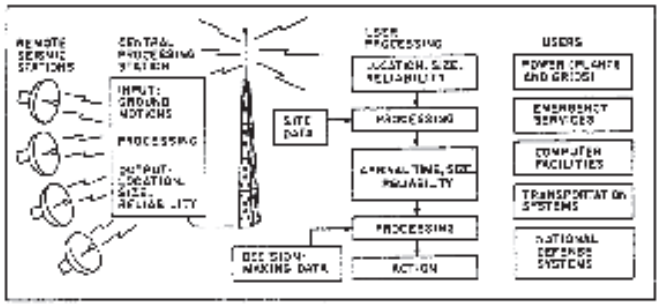
To date, SCEC scientists have focused on the region's earthquake potential. Representing several disciplines in the earth sciences, these scientists are conducting separate but related research projects with results that can be pieced together to provide some answers to questions such as *where* the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

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

New Real-Time Information Technologies in Managing Earthquake Emergencies Presented at Pasadena Workshop



Left: Estimated Modified Mercalli Intensity for the Northridge Earthquake based on models developed for the Early Post-Earthquake Damage Assessment Tool (EPEDAT). EQE International, Inc.



Above: TriNet, a joint project of the USGS, Caltech and the California Division of Mines and Geology, will integrate remote sensors and centralized data analysis with automated communication of the location and severity of the earthquake.

M*aking the Most of New Real-Time Information Technologies in Managing Earthquake Emergencies* was the title of a one-day, mid-March workshop jointly hosted by the Southern California Earthquake Center (SCEC), the US Geological Survey (USGS), the California Department of Conservation's Division of Mines and Geology (CDMG), the California Emergency Services Association (SCESA), the Governor's Office of Emergency Services (OES), and the California Institute of Technology (CIT). The event was coordinated by the Center for Advanced Planning and Research at EQE International, Inc.

The workshop was designed to address the information and planning needs of emergency services coordinators and managers, both public and private sector; public information officers; building and safety officials, and disaster planners and risk managers. A special invitation was extended to journalists representing both broadcast and print news media.

Issues addressed by panelists and speakers included the challenge of major earthquake emergencies; new developments in earthquake monitoring in southern California; strong ground motion in real time; new earthquake response and recovery tools; real time scientific assessment of major earthquakes; and future real time information technologies.

Los Angeles City Councilman Hal Bernson delivered the opening remarks, and commented on the importance of highlighting current research to end users in the community. Although response and recovery efforts are enhanced by the rapid transfer of scientific data and information, Bernson reminded participants that the value of preplanning must not be overlooked.

Governor's Office of Emergency Services (OES) Director Richard Andrews discussed the challenges and opportunities presented to us by new real-time technologies, and cited several ways the State benefits from innovative, technology-based programs such as the California Strong Motion Instrumentation Program (CSMIP), the Caltech-USGS Broadcast of Earthquakes (CUBE) system, the Response Information Management System (RIMS), and the Early Post Earthquake Damage Assessment Tool (EPEDAT). These are developing technologies and at times, user expectations exceed performance levels of certain systems. But as Andrews pointed out, "a better solution tomorrow is preferable to the perfect solution one or two years from now."

James Mori, Scientist-in-Charge, USGS Pasadena Office, and

See "New Technologies" *on Page 4*

New Technologies *continued from Page 3 ...*

CDMG State Geologist James Davis both spoke about new developments in earthquake monitoring in southern California. Davis recognized the challenge of producing strong motion reports on significant earthquake activity within 30 minutes, as opposed to a decade earlier when a similar report took up to 30 days. The CDMG has collaborated with Caltech and the USGS in launching the TriNet Project, a state-of-the-art seismic monitoring network for southern California, funded by the Federal Emergency Management Agency (FEMA), TriNet members, and several private-sector partners. TriNet is one of the new projects featured at the workshop. Both Davis and Mori underscored the importance of user feedback in determining the effectiveness of real-time capabilities in a response and recovery setting.

Ronald Eguchi, Director of the Center for Advanced Planning and Research at EQE International, Inc., described recent milestones achieved through development of Geographical Information Systems (GIS), introduction of real-time monitoring systems, and the availability of comprehensive loss estimation tools, such as the OES's new EPEDAT system and the NIBS/HAZUS program.

Ken Hudnut, Project Chief of Global Positioning Satellite (GPS) studies for the USGS in Pasadena, led the group through an overview of real-time earthquake assessment using GPS. Three types of uses for GPS were described: Deformation field measurements (vertical deformation mapping, tilts and strains of critical systems, and source modeling for interpolation); engineered structures monitoring; and immediate mapping of vertical deformation.

Following the general presentations and lunch, participants divided into four groups for panel sessions on emergency public information, emergency response operations, building/facility assessment and safety, and planning, policy and risk management. Panel moderators summarized each session in the final plenary. Pre- and post-event applications of the new technologies, future planning based on new capabilities, the need for a decision support system, and facilities hardening were topics examined by the groups.

In summary, workshop moderator Jill Andrews (SCEC) pointed out that while many of these "new" technologies have already been demonstrated in pilot projects, useful applications are now emerging. These applications demonstrate the commitment on the part of scientists, engineers, government representatives, and technical professionals to form partnerships and seek ways to integrate, share information, and minimize duplication of effort. On the flip side, Andrews reminded participants of a question asked by Jack Popejoy (KFWB Radio) during the public information panel ("What do we DO with early warning?"), which rightfully raises concern about the growing number of social and public policy issues that must be addressed as we move into the "real-time" information age. ♦

Jill Andrews

NSF "TIPSHEET" FEATURES SCEC

SCIENCE AND TECHNOLOGY CENTERS STIMULATE NEW APPLICATIONS OUT OF BASIC DISCOVERIES: The National Science Foundation (NSF) established a program of Science and Technology Centers in 1987 to exploit new opportunities in fundamental science and technology as well as education. The centers are also designed to stimulate technology transfer and applications for various sectors of society. NSF funds 24 centers with an operating budget of more than $60 million. A few examples of ongoing projects at major research institutions were featured, including the following excerpt on SCEC's outreach to a local government:

NSF EARTHQUAKE CENTER EXPLORES SEISMIC ZONATION OPTIONS

Recent earthquakes around Los Angeles, including the 1987 Whittier Narrows and 1994 Northridge events, have intensified scrutiny of the region's earthquake hazard plans. At a National Science Foundation Southern California Earthquake Center (SCEC) workshop in Los Angeles, engineers, earth scientists and city planners discussed the current level of understanding about regional earthquake hazards and whether new strategies might be implemented to reduce future earthquake risks.

"The primary goal was to find out to what makes sense, given our current level of knowledge about earthquake hazards in the L.A. region," Tom Henyey, SCEC director, said. Henyey cited the ongoing concern of risks to critical public facilities such as hospitals, schools, and emergency response centers, and the evaluation and retrofitting of unreinforced structures.

Participants reviewed implications of future code requirements for new buildings and developed a plan that lays out the next steps for establishing a vehicle for continuing dialogue, continuing the education of public officials about new scientific information and identifying projects that would benefit the city over both the short-and long-term.

Cheryl Dybas, National Science Foundation
For more information on Science and Technology Centers, contact Beth Gaston (703) 306-1070.

Science Seminar News

Beginnings of Earthquakes, Stress Triggers, and Borehole Initiative Featured in Spring '97 Seminars

February...

THE BEGINNINGS OF EARTHQUAKES

Hosted by Caltech, this SCEC-sponsored seminar was held on February 20, 1997. Readers interested in seminar topics presented should access ***www.scec.org/calendar*** or the speakers for more information.

Topics addressed during the seminar were "Seismograms and the beginnings of earthquakes" (Bill Ellsworth, USGS); "Nucleation of unstable fault slip" (Jim Dieterich, USGS); "Looking at rupture initations across several orders of magnitudes from earthquake sequences in southern California" (Jim Mori, USGS); "Detailed observations of California foreshock sequences: Implications for the earthquake initiation process" (Doug Dodge, LLNL); "What Will it Take to Discriminate Between the Cascade and Preslip Models?" (Greg Beroza, Stanford); and "Prologram: Beginning of Earthquakes and Its Implications for Earthquake Process" (Hiroo Kanamori, Caltech).

March...

EARTHQUAKE STRESS TRIGGERS, STRESS SHADOWS, AND THEIR IMPACT ON SEISMIC HAZARD

The Southern California Earthquake Center and the United States Geological Survey co-hosted a two-day workshop held March 21-22, 1997, at the U.S. Geological Survey in Menlo Park. Co-conveners were Ross Stein, Ruth Harris, and Lynn Sykes. The focus of this meeting was to assess the strengths and weaknesses of stress-based analyses of earthquake sequences, earthquake interactions, and probabilistic earthquake hazard assessment. Earthquake interactions over both short (seconds) and long (decades) time scales; and static, dynamic and secular stresses, were pertinent.

The workshop featured 25 invited talks, with 4 wide-open half-hour discussion sessions. Invited speakers were Renata Dmowska and Jim Rice (Harvard), Lynn Sykes and Bruce Shaw (Lamont), Juliet Crider (Stanford), Dave Jackson and John Vidale (UCLA), Andy Freed (Univ. Arizona / WHOI), Susanna Gross (Univ. Colorado), Jeanne Hardebeck (Caltech), John Anderson (Univ. Nevada), Gene Humphreys (Univ. Oregon), Yehuda Ben-Zion and Charlie Sammis (USC), Steve Ward (UCSC), Ross Stein, Ruth Harris, Bob Simpson, and Lucy Jones (USGS).

The first session (convenor, Lynn Sykes) included an introduction by Stein and Harris, with presentations on the following subjects:

- Kobe and Northridge: Correlation of Stress Change with Aftershocks, and Stress-based Probabilities
- Static Stress Changes and Earthquake Triggering during the 1954 Fairview Peak and Dixie Valley Earthquakes, Central NV
- Model of Tectonic Stress State and Rate using Northridge Aftershocks
- A Quantitative Look at Static Stress Change Triggering of Aftershocks: Where, When, and How Much Stress?
- Stress Change Induced by the 1992 Landers Sequence Detected by Regional Seismicity in Southeastern California
- Effect of the 1989 Loma Prieta earthquake on nearby Creeping Fault Segments

The second session (convenor, Ross Stein) included:

- Stress Shadows: Coulomb Failure Stress or Rate-and-State: Which Should be used to Identify Faults that will NOT Produce a Large Earthquake in the next 5 or 10 or 50 Years?
- Time-dependent Stress Changes during Earthquakes
- Triggering of Earthquakes in the Far Field by Dynamic Waves
- Structural Heterogeneity: Modeled 3D Static Stress Distribution around Segmented Normal Faults
- Earthquake Stress Changes in Extensional Regimes: Evidence from the Central Apennines (Italy)
- Earthquake Triggering Effects with Time-dependent Nucleation

Second day, first session (convenor, Ruth Harris) covered:

- Evolution of Stresses, Triggering of Earthquakes and Implications for Intermediate- and Long-term Prediction
- A Non-precursory Seismic Cycle
- Evidence for Temporal Clustering of Large Earthquakes in the Wellington Region, New Zealand from Computer Models of

See "SCEC Seminars" *on Page 29*

Highlights of the Annual Report

Each year, SCEC produces an Annual Report that includes research focus summary statements by working group leaders, proposals funded, and education and outreach directors' program descriptions. We feature portions of them here for our readers, but in future years, we will make them available on the SCEC Web pages.

Group A (Master Model)

Group A concentrated on three foci in 1996: methods to estimate earthquake probabilities, sensitivity and uncertainty in probabilistic seismic hazard analysis, and hypothesis testing.

Earthquake Probabilities

Jackson, Kagan, Ge and Potter (University of California, Los Angeles) constructed a suite of source models for use in the Phase III report. The report will investigate the sensitivity of seismic hazard analysis to major assumptions, provide realistic uncertainty estimates, add site corrections, and include a suite of theoretical seismograms incorporating different methods. Various source models are being included to test the sensitivity of the results to assumptions such as the characteristic earthquake model and maximum magnitudes. Models that have been developed include a purely historic model based on historic earthquakes, a smoothed seismicity model with a uniform maximum magnitude, a model based on geodetically observed strain rate with a uniform maximum magnitude, a characteristic earthquake model based on geological slip rates only, and a combined geologic/geodetic model with both faults and area sources. The models are expressed in a form such that they can be tested against future earthquakes, and they each match the observed seismic moment rate so that in principle linear combinations of the these end-member models could also be used in hazard analysis. In developing the models, we also developed a new table of slip rate values, and a new earthquake catalog.

Several investigators addressed the problem of estimating the maximum magnitude of earthquakes on a given fault or in a given region, and how the maximum magnitude choice affects the estimates of earthquake frequency. Jackson and Kagan (UCLA) showed that if the maximum magnitude is uniform throughout southern California, and if the b-value is 1, then M_{max} must be at least 8 to be consistent with both the historic seismicity rate and the moment rate at the 95% confidence level. Stirling, Wesnousky, and Shimazaki (University of Nevada, Reno) concluded that either a characteristic or Gutenberg-Richter model would fit the observed seismicity and moment rate, if allowance was made for errors in both the earthquake catalog and the models themselves, and if faults were assumed to rupture for their entire mapped length. The characteristic earthquake model included earthquakes up to magnitude 8.1, but only on major faults. Ward (UC Santa Cruz) examined the problem of maximum magnitude by studying the stress interactions between faults. He found that faults behave essentially independently if their separation exceeds 5% of their length, and that multi-segment triggering increased the maximum magnitude to only 0.3 units above the characteristic magnitude.

Working Group

Stress Interaction

Stress interaction was a major topic of study, made especially interesting as a hypothesis to explain why the observed earthquake rate might depart from the long term average during the historic period. Hardebeck (Caltech), Seeber (Lamont-Doherty), Lin (Woods Hole Oceanographic) & King (Massachusetts Institute of Technology), and Sykes (Lamont-Doherty) each showed cases where earthquakes and other small shocks occur more frequently where Coulomb stress has been increased by a previous earthquake, and less frequently where it has been reduced. Kagan, however, showed that the correlation between seismicity and Coulomb stress depends very sensitively on arbitrary choices such as earthquake catalog, fault geometry, etc. Sykes hypothesized that the 1812 and 1857 great earthquakes in southern California cast a stress shadow that prevented large earthquakes in much of the region. According to his hypothesis, the gradual accumulation of tectonic stress could be accompanied soon by a resumption of large earthquakes close to metropolitan Los Angeles and San Bernardino. Humphreys (University of Oregon), Lin & King, and Seeber all made important technical improvements that will allow a more accurate stress model (including inelastic relaxation and other nonlinear effects) and better estimation of focal mechanism solutions to compare with theoretical stress effects. All are working on methods to estimate the effect of stress transfer on earthquake probabilities. Ward has developed a quasi-static model that accounts explicitly for stress

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Annual Report *continued from Page 6 ...*

interaction between faults segments, using a breaking criterion related to the rate/state friction laws developed recently by Dieterich (USGS) and colleagues.

Probabilistic Seismic Hazard Estimation

The Phase III Report will include sensitivity and uncertainty studies, and several SCEC investigations are contributing to this effort. Mahdyiar (Vortex Rock Consultants) computed many seismic hazard estimates at selected points in southern California, each time varying choices of important parameters or assumptions. He has investigated the effect of slip rate uncertainty, M_{max}, and seismogenic thickness by choosing values at both limits of acceptance. He has compared characteristic vs. Gutenberg-Richter magnitude distributions and models based purely on geology, geodesy, and seismic history against one another. Cornell (Stanford) has explored the process of "deaggregation," or finding the parameters of earthquakes that contribute most strongly to seismic hazard at a particular site. These parameters are then used to select hypothetical earthquakes, for which theoretical seismograms are calculated for use in building design and retrofit decisions. Wesnousky has compared several probabilistic hazard models directly, point-for-point. The report shows a comparison of predicted peak ground acceleration at 10% probability in 50 years on soft rock for three models: (1) Wesnousky (1996) used fault slip rates and paleoseismic data, assuming all earthquakes to be on mapped faults; Ward (1994) used a combination of geodetic and geologic data, and allowed model earthquakes on and off faults; and Frankel (USGS) et al. used geologic data and historical seismicity to determine earthquake probabilities, both on and off faults, in the combined USGS/CDMG model. Differences between models are quite significant, amounting to over 0.5 g at some locations. In general the Wesnousky model shows higher acceleration in a more confined area, the USGS/CDMG model shows a broader region for which the expected acceleration exceeds 0.5 g, while the Ward model is in between.

Hypothesis Testing

A major goal of SCEC is to develop procedures for testing hypotheses relevant to earthquake probabilities and seismic hazard estimation. Jackson has developed a likelihood test for comparing any forecasts that can be expressed as probability density functions in epicentral location, magnitude, and time. This method can be used to test the source model in the Phase II Report and the alternate source models to be used in the Phase III Report.

David Jackson

Summaries...

Group B (Strong Motion Modeling)

Objectives

The primary focus of Group B is on the prediction of strongmotion time histories. Ongoing work towar d this objective isdistributed among the following ar eas: (1) research on site effects, (2)development of gr ound motion estimates for L.A. Basin scenarioearthquakes, and (3) investigations of high-frequency focusing. Insupport of these ef forts, we are also developing ground motion andsite pr operties databases. Where necessary to improve themodeling methodologies or to better understand their uncertaintiesand limitations, the working gr oup is also engaged in morefundamental r esearch on source and site effects. A summary ofpr ogress during 1996 follows.

Site Effects Research

Databases The uppermost few tens of meters of the Earthis by far the most accessible, and for most earthquake hazardstudies is the only regime for which substantial site-specificinformation can be expected. The SCEC *C-cubed* project hasacquir ed shear velocity profiles for the uppermost 30 meters of thesubsurface underlying a large number of strong motioninstr umentation sites in Southern California. During 1996,V ucetic (UCLA) continued development of the SCEC geotechnicaldatabase of shallow geotechnical properties for L.A. Basin sites. Strain-dependent modulus and damping data were incorporatedinto the database, and the database was linked to software for thesimulation of nonlinear site effects. During 1996, theydemonstrated the capability to generate maps of site-modifiedgr ound motion throughout L.A. Basin using this method.

The UCSB group continued development of the StrongMotion and the Empirical Green's Function databases (EGFDB). A newW orldwide Web version of the Strong Motion Database (SMDB) is operational, makingdatabase access mor e convenient for strong motion researchers andengineering practitioners. A similar approach is being planned forthe EGFDB. The EGFDB will play an important role in effortsover the next year to sear ch for high-frequency focusing effects insouthern California, and will be instrumental in simulations ofgr ound motion for scenario earthquakes.

Nonlinearity Most seismological methods for groundmotion simulation assume that the approximations of linearelasticity ar e applicable. The University of Nevada at Reno (UNR) group is continuing to modelsoil nonlinearity to assess the limits of the linear methods anddetermine the seismically observable consequences of nonlinearity. This work is necessary in or der for us to assess the range ofconditions under which gr ound motion modeling of the scenarioevents is valid without special corr ections for nonlinearity. It isalso important for understanding the physical phenomenacontr olling empirical regression relation-

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ships. Nonlinear effectswer e found to be important at periods less than 0.3-0.5 seconds, especially when the water table is shallow. At longer period, thenonlinear ef fect is substantially less important. It was found that those PGA and SA regression relations in which the shape (i.e., the shape of the amplitude-versus-distance curve) is permitted to change with site condition agree well with the theoreticalpr edictions at all distances.

Scenario Ground Motion for L. A. Basin

Seismic velocity structure for L. A. Basin Group B has as agoal the modeling of ground motion from scenario earthquakes,taking into account the complexity of regional geologic structure in3 dimensions. This requires a model of earth structure with spatialr esolution comparable to seismic wavelengths of interest. Thislevel of r esolution is not currently possible from seismic traveltimes alone. The SDSU / Maxwell Labs team has continueddevelopment of geological and geotechnical constraints on thesouthern California seismic velocity model using data on geologicinterfaces together with sediment compaction models. In addition,during 1996, Gr oups B and D collaborated in development of amethodology to integrate the geologic constraints with constraintsfr om seismic travel time tomography. The modeling is beingextended into the V entura Basin and the San Bernardino Valley. Our practice has been to make the pr ovisional model available tonumer ous researchers inside and outside SCEC for use in groundmotion modeling. Results of these applications ar e leading to theidentification of limitations in the model and will result in furtherimpr ovements.

Modeling methodologies and results Group B hascontinued development of the ground motion modeling methodsr equired for studying phenomenology expectedfr om SCEC scenario earthquakes developed by Group C. For high frequency modeling, several research teams have developedcomplementary approaches. The UNR group has applied thecomposite sour ce model to better understand the physical basis ofempirical prediction methodologies. UCSB has developed ahybrid empirical / theoretical Green's Function summation method for ground motion simulation that effectively integrates empiricalsite effects information into the simulation process. W oodward-Clyde has shown that a hybrid 1D / 2D modeling approach can capture some elements of basin response and otherpath complexity.

Much progress was made during 1996 on our ambitiousef fort to predict the effects of 3D basin structure on ground motionin the Los Angeles region. This work, as well as related workbeing done elsewhere in the U.S., Mexico, and Japan, wasr eviewed at a SCEC workshop in San Diego in June, 1996. Planswer e laid for a SCEC-led project to validate 3D computational models. An important highlight of work on 3D effects was thepr ogram by the UCSB team to study the sensitivity of groundmotion pr edictions to source location. Much progress was madetowar d developing a statistical characterization of basin effects. Pr eliminary results indicate that 3D effects lead to strong upwardbiases in the expected value of long period ground motion whenthe earthquake is located outside the basin. Conversely, forearthquakes located inside the basin, the expected value of longperiod gr ound motion parameters is less affected, but variances areincr eased substantially. Thus, the 3D modeling is now yieldingpractical engineering guidelines for basin sites.

High Frequency Focusing

Studies of the Northridge earthquake by Group B areestablishing clearly that path-dependent focusing effects can have avery strong influence on ground motion levels. From analysis ofr ecorded waveforms for aftershocks of the Northridge earthquake,Gao and Davis (UCLA) have shown convincingly that a pocket ofheavy damage in Santa Monica r esulted from focusing associatedwith a still unidentified deep str ucture. Further analysis of theNorthridge earthquake aftershock data showed that, in the SantaMonica damage zone, mainshock damage is correlated withaftershock S-wave peak amplitudes and S-wave spectralamplitudes, but not with coda amplification factors. Thisobservation pr ovides further corroboration that the Santa Monicadamage zone is attributable to high fr equency focusing (rather thanto site r esponse).

Additional studies are required to determine ther elative importance of site effects and focusing in controllinggr ound motion in the Sherman Oaks damage zone. These r esults indicate that focusing effects may beidentifiable in advance fr om a study of the amplitudes of smallearthquake r ecordings obtained from short-period instruments.They further suggest that amplitude anomalies of the S-waver elative to the coda spectrum may be a useful quantitative tool foridentifying potential focusing.

Steve Day

Group C (Earthquake Geology)

Objective

Group C geologists worked on several neotectonic and paleoseismic problems throughout 1996. As in years past, our efforts focused on determining theparameters of active faults that are relevant to understanding thecharacter and fr equency of future earthquakes. A few of these efforts aredescribed briefly, below.

San Joaquin Hills The existence of raised marine terraces in the hills behind Newport Beach and Laguna Beach raises the possibility of large earthquakes generated by ablind thr ust fault beneath the northern San Joaquin Hills of coastal Orange County.Lisa

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Summaries...

Grant (Chapman University) and Eldon Gath (Leighton and Associates) compiled existing data from geotechnicalr eports to map this series of at least eight marine terraces. The rate ofuplift of these terraces appears to be about 0.25 mm/yr, but radiometricdates on the terraces ar e sparse, so additional age assessment iscontinuing. The shape of the uplift and better constraints on the ageswill enable Karl Mueller (University of Colorado) to determine plausible geometries and rates for ablind thrust fault that may underlie the coastal communities of northernOrange County.

Active structures in the Santa Barbara region In 1996, Ed Keller (UC Santa Barbara) and his student, Larry Gurrola, continued to documentevidence of surficial deformation in the Santa Barbara area. They havecompiled r egional and local maps of the active folds and reverse faults ofthe coastal plain and ar e beginning to investigate their rates and stylesof vertical deformation. The rate of uplift at Isla Vista, for example, isabout 1.2 mm/yr. They have also identified several plausible paleoseismicsites, wher e recurrence information might be preserved.

Pressure solution as a mechanism for aseismic deformation Ernie Duebendorfer (Northern Arizona University) and his colleagues are investigating thepossibility that aseismic deformation may account for a large fraction ofthe north-south shortening seen in geodetic measurements and geologicr econstructions. In 1996, they surveyed outcrops of Pliocene sediments inthe V entura basin and found that, indeed, evidence for pressure solution iscommon. They plan to quantify this observation in 1997.

Earthquake sources in the metropolitan Los Angeles region Several Group C investigators worked on source characterization in thegr eater Los Angeles region in 1996. Charlie Rubin (Central Washington University), Scott Lindvall (Harza LRB) and Tom Rockwell (San Diego State University) continuedtheir paleoseismic work at the Loma Alta site across a strand of the *Sierra Madre fault* in Altadena. They interpret radiometric and soils ageestimates of two colluvial wedges to indicate that the fault has sustainedtwo slippages totaling about ten meters, in the past eight thousand years.Such lar ge slip events would be consistent with earthquake magnitudes above7.

James Dolan's (University of Southern California) paleoseismic excavation across the *Cucamonga fault*, near Upland,also r evealed two colluvial wedges, each associated with about 3 m of slipon the thrust fault. Dolan suspects, however, that the two wedges of scarpdebris r epresent more than two slip events, and that the associatedearthquakes wer e in the upper M 6 range. Radiocarbon dates on abundantchar coal in the strata will constrain roughly the ages of the events. Dolan, Rockwell and colleagues continued investigations of the *Hollywood fault* at the Camino Palmero site. Difficulties with standard excavationsther e led them to excavate a set of contiguous boreholes to a depth ofabout 10 m. The resulting exposure and radiocarbon dates demonstrated thatthe most r ecent slippage of the Hollywood fault occured between 5,000 and1 1,000 years ago, and that at least one previous event occured betweenabout 10,000 and 20,000 years ago.

Thus, it appears that both the Hollywood fault and Sierra Madre faultr upture only very infrequently.

Mike Oskin and Kerry Sieh (Caltech) continued to characterize the active folds and fold scarpsin *East Los Angeles*, using geomorphic evidence augmented by shallowgeotechnical borings made for the Metrorail crossings of these structures. Their set of parallel East-West anticlines and synclines appear toaccommodate about 1 to 2 mm/yr of North-South contraction and extend fromthe *Newport-Inglewood* structure to the *Whittier fault*. They calculate thata "scenario" 1-meter event on the *Coyote Pass* escarpment would recur onaverage about once every 4,000 years. Karl Mueller began in 1996 tointerpr et subsurface data beneath these structures. The faults that arepr oducing these East L.A. folds are riding piggyback atop a contractionalstr ucture with much greater structural relief. The portion of this 3-kmhigh monocline west of downtown LA was described by Robert Yeats (Oregon State University) and hiscolleagues in a 1996 paper in *Tectonics*. They interpret the structure tobe the r esult of slip on a steeply dipping reverse fault, which they havenamed the *Los Angeles fault*. This interpretation of a trans-crustal sourceis at odds with the [Bruce]Shaw (Columbia University) and [John] Suppe (Princeton) interpretation of a shallowramp-and-flat str ucture.

The San Andreas fault Paleoseismic and neotectonic work along the San Andreas fault advanced onseveral fr onts in 1996. Jim Spotila (Caltech) continued geomorphologic andgeochr onologic work on the *San Bernardino Mountains*. His definition of thegeometry of the ancient uplifted surface that forms most of the mountainrange will be a critical element for interpr eting the geometry and rate ofslip on the lar ge thrust fault that underlies the range. Spotila also madea surprising discovery, using the new Uranium-Helium dating method. Hisanalyses r evealed that the *Yucaipa block*, a wide sliver of crust betweenthe Mill Cr eek and South Branch strands of the San Andreas fault, has risenseveral km in the past 1.5 million years. This rapid uplift has veryimportant implications for the curr ent geometry and seismic potential ofthat portion of the fault zone between San Bernardino and Palm Springs. Doug Yule (Caltech) investigated the continuity of the San Andreas fault systemthr ough the *eastern San Bernardino mountains*. Understanding the geometryof the major plate-bounding fault in this region is critical to

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forecasting the character of future earthquakes originating or terminating in this region. Yule confirmed that there is no contiguous, simple active fault trace connecting the Banning fault north of Palm Springs with the active strands in the San Bernardino valley. He did, however, discoverdiscontinuous, active strands in the region. The geometry of the active faults doesn't appear to be consistent with [Leonardo] Seeber's (Columbia University) recently publishedinterpretation of the structural evolution of the region, based uponseismicity. How slip is transmitted through the eastern San BernardinoMountains remains cryptic.

Sally McGill (California State University, San Bernardino) has begun to excavate a paleoseismic site along the San Andreas in the *San Bernardino valley*. That site consists of carbon-richalluvial outwash at the front of the San Bernardino mountains. Thus far,McGill has documented evidence for at least three faulting events that haveoccurred within the past millennium. The prospects for further,significant refinement of the paleoseismic history at this site are verygood.

Kerry Sieh

Group D: Subsurface Imaging and Tectonics

The report on the progress of Group D is divided into 6 topical sections:

1) Velocity Models

Hauksson and Haase (Caltech) (1997) have completed their 3D model for the greater Los Angeles Basin area. This model uses P and S waves times from over 5,000 earthquakes and 50 explosions to invert for the 3D compressional velocity structure as well as the Vs/Vp ratio. The model has also been enhanced with travel times determined from the LARSE experiment and from aftershocks of the Northridge event.

Magistrale (San Diego State University) has developed an alternative geology-based velocity model for the Los Angeles, San Gabriel and San Fernando basins. In these models the geology controls the velocity of the shallow sediments and the contacts between units, while travel time control the deep sediment and basement rock velocities.

2) Fault Zone Waves

Li and Aki (UCLA/USC) recorded additional waves trapped within the Landers Fault Zone from both aftershocks and explosions. These observations allow the width of the fault zone to be determined as ~200 m. The data also reconfirm the presence of the rupture barrier between the southern and northern segments of the fault. Also, repeat measurements of the same source and receiver locations between 1994 and 1996 show that the trapped waves have slowed by 200-300 msec.

Working Group

3) Borehole Studies

Stock and Wilde (Caltech) have determined the stress tensor from some of the aftershocks of the Northridge event to compare to borehole measurements. They earthquake data show N trend of compression while the borehole data favor a NW trend, which is attributed to structural complexities at the region of overlap between the 1971 and 1994 events. There is also evidence that the stress field changes from thrusting at shallow depths (<6 km) to strike-slip at deeper depths (Kerkela (Stanford) and Stock, 1996). They have started analyzing borehole break out data for the east and west Los Angeles Basin and these data also show changes in the stress direction compared to the surface measurements.

4) Source Studies

Mori and Kanamori (USGS/Caltech) (1996) have examined the source rise time as a function of magnitude, and find in a study of the Ridgecrest swarm, that it appears to be virtually independent of magnitude. This observation if verified as a general property will provide an important constraint on source rupture models.

Xi Song and Helmberger (Caltech) have been investigating techniques for rapid retrieval of source parameters by waveform modeling of seismograms recorded on broadband instruments. They use a grid search method to determine the source mechanism and moment, that allows for small time shifts to be introduced between phases. This desensitizes the results to variations in the velocity model.

5) Tectonic Modeling

Humphreys et al. (U of Oregon) are continuing their work on developing a dynamic model of crustal deformation in southern California. The model is driven by both kinematic boundary conditions (plate motions), and density-derived body forces. Results to date show that far field forces cannot not penetrate very far into the continent, and hence cannot be used to explain the big bend. Force such as those due to the "drip" beneath the Transverse Ranges are necessary to explain this. The kinematic version of their model explains the geologic and geodetic strain measurements.

6) LARSE

The scientific results of the first LARSE experiment are available on the WWW at **http://www.scecdc.scec.org/larse.progress.html**. The main results are imaging of the Sierra Madre and Vincent thrust faults, determining the depth of root beneath the San Gabriels to be approximately 45 km., imaging of the Anaheim Nose in the Los Angeles Basin, the imaging of a horizontal detachment surface beneath the San Gabriels, the imaging of the oceanic slab beneath L.A., and a higher resolution image of the

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Summaries...

drip beneath the Transverse Ranges.

Rob Clayton

Group E: Crustal Deformation

The premise of our Working Group is that geodesy contributes towards the main Southern California Earthquake Center (SCEC) goals by accurately estimating the displacement rate (velocity) field for southern California. Precise geodesy measures all inputs and outputs on the earthquake budget ledger sheet, and complements the fault maps, geological slip rates, and seismicity catalogs that had, in the past, formed the input to earthquake hazard maps. SCEC has innovated the combination of geodetic information into probabilistic seismic hazard estimation, and our Working Group strives to improve the geodetic observational basis for future improvements to hazard maps of the region.

Our Working Group continues efforts on several main infrastructure items:

1) SCEC support of the Southern California Integrated GPS Network (SCIGN) collaborative effort,
2) support of the archive especially for campaign data,
3) additional analysis and refinements for the SCEC Velocity Field Map, and
4) additional field data collection in support of scientific and / or velocity map objectives.

As well, we fund several scientific investigations that generally employ crustal deformation data, in an innovative fashion, to address the overall goals of SCEC. Our Working Group contributed an official SCEC product this year that resulted from the SCEC-motivated approach, and from the focus of our group. Notably, this first release of the SCEC Velocity Map incorporated diverse high-precision geodetic data that have been collected during more than two decades of efforts conducted and / or funded by several federal, state, and local government agencies, as well as from SCEC-funded field work.

The SCEC analysis effort has maximized return on the public's long-term investments into loosely coordinated surveys, some of which were performed for the purposes of survey control network maintenance, while others were conducted for tectonic or earthquake research. Trilateration data, along with abundant GPS data from the mid-1980s through the present, were rigorously combined to form the best set of velocity vectors yet obtained for the region.

Production of the SCEC Velocity Map can well be compared with efforts to produce a consistent and reliable seismicity catalog that covers a multi-decadal time interval. In our case, this process requires continuing refinement as we simultaneously develop the tools to properly analyze and understand the data. Specifically, we have to deal with the problematical yet valuable early data, and we must now test new models for atmospheric gradients, ocean loading, and antenna phase center variations. Also, to represent the actual errors in velocity estimates, we must improve our understanding of long period noise such as monument instability.

Despite the significant contribution made by this first release of the SCEC Velocity Map, our Working Group recognizes that continuing work is needed to realize the full potential of the available data sets. For example, the research reports submitted by our Group on their work in 1996 included work in progress on the possibility of a regional variation in deformation following the Landers earthquake sequence. Work led by Yehuda Bock (UC San Diego) indicated a slight difference between velocities at several continuously operating GPS stations, before and after the 1992 event. Analysis of a longer run of solutions from these same stations, and with a different approach led by Tom Herring (Massachusetts Institute of Technology), has been performed as one means of testing the result. The particular significance of this issue is that the possible variation in rates appears to have occurred over a much larger region, and over a longer time interval, than the more typical short to intermediate wavelength (0 to 30 km) and short to intermediate time scale (days to months) postseismic phenomena associated with either the shallow or deep portions of the fault zone itself. This result, if confirmed, could lead to a variety of breakthroughs in earthquake research, and in understanding the earth's crust and its coupling to materials below it, as well as properties of those deeper materials. Because of the potential far-reaching implications of such a result, and because the claimed observations lie close to the measurement accuracy, our Working Group is motivated to perform additional studies in an attempt to evaluate this further.

Our Working Group recognizes that the campaign data will provide better spatial coverage of this possible deformation event. Also, unfortunately, the continuous GPS stations' time series begin less than one year before the Landers event. We recognize that it will be crucial to combine the older VLBI and early GPS data, as well as all the more recent campaign data and continuous data, into a single solution with a consistent reference frame. This needs to be done in order to resolve the issue of a possible regional deformation rate change, and we feel these efforts are of utmost importance. As well, the refined analyses of these data that will occur are bound to greatly improve over the first release of the

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SCEC Velocity Map. Regardless of whether the result is confirmed or denied, the efforts will benefit hazard mapping and other SCEC modeling efforts by resulting in improved estimation of the regional velocity field. Resolution of this issue will certainly lead to developments that will generally help our understanding of actual noise in the GPS and other geodetic data as well. WWW sites for additional information: Velocity Map 1.0: **http://minotaur.ess.ucla.edu/velmap/welcome.shtml** SCIGN Project: **http://www.scecdc.scec.org/scign/**

Ken Hudnut

Group G: Earthquake Physics

I. Properties of Deformable Materials Near Fault Zones

Scott (USC) has published results of numerical simulations of thedeformation of an aggr egate of rough grains under an external stress. This work shows that the material or ganizes into local structures thatr esemble slip planes that allow for large slip without the productionof significant amounts of frictional heating.

Knopoff and students (UCLA) have shown that observations of slip-weakeningin advance of unstable dynamic fractur e, can be explained by a processof dynamical micr ocracking and disappearance of individual asperities,if the micr ocracks remain unhealed (open) after their formation, notunlike a dynamic fiber bundle model but now with local stressr edistribution. It follows that the process of precursoryslip-weakening may have little relevance to the process of decrease ofdynamic friction due to a large-scale breakout rupture event.

II. Models of Regional Seismicity

Knopoff and students have shown that seismicity on a network ofinteracting faults implies that local rates of slip on individualfaults ar e not temporally constant but are highly variable, under theconstraint of constant total slip acr oss the network. (This resultr equires that the network have more than one fault). Indeed somefaults or fault segments may enter into a state of temporary dormancyor lacunarity only to r esume slip at a later time. As a consequenceof the above it has been shown that the intermediate-term statisticsof seismicity is a non-stationary process, in the sense that abruptchanges in seismicity is not predictable from recent and currentstatistics of earthquake occurrence. Interactions of stress amongfaults of a complex network show that the cumulative distribution ofintervals of large earthquakes such as measured at Pallett Creekshould be a truncated exponential distribution, a result notinconsistent with observation.

III. Elastodynamics of Slip

Rice (Harvard University) and colleagues have made considerable progress toward thedevelopment of 3-D vector models of elastodynamic slip, a problem ofextraor dinary difficulty because of the complex nature of the Green's functions.

Knopoff and Abinante (UCLA) have developed an exact fully dynamicalcontinuum mechanics model of seismicity with long range forces ofstr ess redistribution, that allows for the study of future growth andevolution of seismicity in systems with highly geometricallyinhomogeneous str ess and strength distributions that has none of thedefects of the localized model of Burridge and Knopoff.

Harris (USG) and Day (San Diego State University) have found that large slip pulses can be generatedon faults that separate two widely dissimilar materials. This worktakes a significant step toward characterizing the complexity of slipmotion on simple fault systems without invoking complex geometry.

Knopoff has shown that low values of stress drop to slip ratiosr eported for the San Andreas and San Jacinto faults may be explainedby antisymmetric deformation of a fault during r upture on alow-friction interface. The fault under goes transverse motions at thesame time as it under goes longitudinal slip, i.e. it wriggles as itslips. This model of slip develops small amounts of frictionalheating as well.

IV. Slip Pulses

Rice has distinguished between two models of velocity-dependentdynamical friction: one leads to self-healing (Heaton) pulses and theother does not.

Day and colleagues have considered the question of whether theslip-pulse behavior of r upturing faults is due to self-healingassociated with velocity-dependent dynamic friction or due toencounters of fractur e with strong geometrical heterogeneity on thefault. They have devised methods to discriminate between the twomodels and show that the kinematics of the Landers, Northridge andKobe earthquakes ar e consistent with the notion that slip pulses aredue to geometrical constraints. Hence there is no need to invokecomplex velocity dependent friction as proposed by Heaton (Caltech), Madariaga (Ecole Normal Superieur, Paris)and Rice.

Knopoff and Abinante have used a toshow that observations of slip-pulse behavior are consistent with theencounter of fractur e with geometrically induced barriers to rupture,and cite evidence from the final slip on the Landers fault system tosupport the view that inhomogeneous geometry rather thanvelocity-dependent friction is responsible for the development of slippulses.

V. Evolution of Faults Over Geological Time

Ben Zion (USC) has shown how geometrically complex faults can developout of a heter ogeneous set of initial stress conditions in a realisticquasidynamic model of an initially unfractur ed seismogenic plateoverlying a viscoelastic substrate. ♦

Leon Knopoff

SCEC Scientists' Submissions and Research Abstracts

SCEC Quarterly Newsletter Now Highlights Recent Publications/Submissions

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

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

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

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SQN Seeks Contributions from Scientists

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

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

Group A, Master Model: David Jackson, group leader
Group B, Ground Motion Modeling: Steve Day, group leader
Group C, Earthquake Geology: Kerry Sieh, group leader
Group D, Subsurface Imaging and Tectonics: Rob Clayton, group leader
Group E, Crustal Deformation: Ken Hudnut, group leader
Group F, Regional Seismicity and Source Processes: Egill Hauksson, group leader (Will be conbined with Group D)
Group G, Physics of the Earthquake Source: Leon Knopoff, group leader
Group H, Engineering Applications: Geoff Martin, group leader

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

Please email your contributions to:
jandrews@usc.edu

Videotapes of Geology of Earthquakes Course

Robert Yeats (Oregon State University) is teaching Geology of Earthquakes on television this term, and all his lectures were videotaped. The course is keyed to the galleys of the recently published textbook, *Geology of Earthquakes*, by Yeats, Sieh, and Allen (August 1996, Oxford University Press). The class is geared for nonspecialists; it includes civil engineers and geophysicists and geologists.

The videotapes may be of interest in developing (or developed) countries wanting to offer a course in Geology of Earthquakes. The videotapes would include all the slides Yeats used in the course. Yeats is happy to make them available for cost of videotapes, transcription, and mailing. Those interested should make arrangements with him by the end of May:

Bob Yeats
Dept. of Geosciences
Oregon State University
104 Wilkinson Hall
Corvallis, OR 97331-5506, USA
FAX 1-541-737-1200, phone 737-1226

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SURVEY— PRESIDENT'S COMMISSION ON CRITICAL INFRASTRUCTURE PROTECTION

The President's Commission on Critical Infrastructure Protection is requesting information regarding technologies and capabilities for protecting critical infrastructures vital to our nation's economic and national security. Of particular concern are physical and cyber threats. Eight critical infrastructures have been identified: (1) telecommunications, (2) electrical power systems, (3) gas and oil storage and transportation, (4) banking and finance, (5) transportation,(6) water supply systems, (7) emergency services, and (8) continuity of government services.

The Commission has retained the Department of Energy's Argonne National Laboratory to act on its behalf in soliciting and collecting this information. The Commission designed a survey template to facilitate this critical infrastructure data collection effort. The survey template can be requested via e-mail at *formpccip@anl.gov*, or downloaded from *www.dis.anl.gov/survey*.

Responses must be received no later than May 30,1997, to guarantee inclusion in the Commission's report.

Taking time to provide information may increase organizational visibility, not only with the Commission, but also with government agencies and private-sector entities needing infrastructure protection technologies and capabilities. Responses will be entered into a database and made available to the government and private sector. The Commission will use the information to help (1) formulate critical infrastructure protection strategies, and (2) develop recommendations for research and development programs to address technology shortfalls. For more information on this critical infrastructure protection technologies and capabilities data collection or the Commission, please contact Mr. Jerry Gillette at *jgillette@anl.gov*. ♦

Southern California Earthquake Center Knowledge Transfer Program

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

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

Planned and In-Progress Products and Projects include:

- Insurance Industry Workshops; Proceedings; Audio tapes
- Engineering Geologists' Workshops; Proceedings; Geotechnical Catalog.
- Vulnerability Workshops, City and County Officials
- Media Workshops
- Field Trips
- Quarterly newsletter
- "Putting Down Roots in Earthquake Country" Handbook
- WWW SCEC Home Page (*www.scec.org*)
- SCEC-Sponsored Publications; Scientific Reports

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

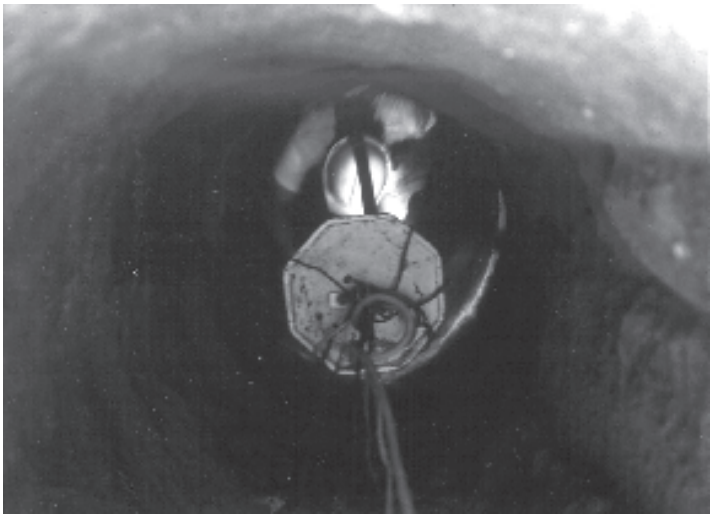
Quarter Fault

The Hollywood Fault, Revisited

University of Southern California geology professor James Dolan has recently trenched and studied the Hollywood fault. In this issue's Fault of the Quarter, Dolan discusses the hazards associated with studying – and living near – the Hollywood fault

- ***Fault Length: 14 km***
- ***Slip Rate: 0.5-1.0 mm/yr.***
- ***Cumulative Offset: 15-45 km***
- ***Max. Mag. Earthquake: unknown***

(probably 7+ in conjunction with the Malibu-Santa Monica coastal fault)



"You get disoriented immediately – you're spinning around on a trapeze-like swing."

SCEC: The Hollywood fault apparently runs under one of the world's most famous streets, under some of the "Dream Factory's" most famous landmarks?

Dolan: Yes, it runs directly beneath the Sunset Strip under the Marlboro man. I like to say that he has more to worry about than lung cancer, because the Hollywood fault runs right between his legs. When you drive on Sunset through the strip at La Cienega, you can look at the north side of the road and see outcrops of granodiorite, the 90-million-year-old basement rock. On the other side of the road, at the corner of La Cienega and Sunset, there was a borehole that showed several hundred feet of alluvium. So clearly one side of the street is on one side of the Hollywood fault, while the other side of the street is on the other side of the fault.

One of the nicest views of the fault is from the corner of Hollywood and Vine. From that vantage point you can look north at the Capitol Records building. The lovely little hill a half block to the north is the Hollywood fault scarp. The Hollywood fault has intermittent scarps that you can trace all the way through downtown Hollywood one to two blocks north of and parallel to Hollywood Blvd. For example, there's a very steep hill just north of Mann's Chinese theater: that's the Hollywood fault scarp.

SCEC: Would you say the Hollywood fault has been one of the most elusive faults in the southland to trench in terms of revealing its slip rate?

Dolan: Yes, the Hollywood fault is the most urbanized fault in metropolitan Southern California. Every square inch of it is completely covered with buildings or streets. You can't excavate a three-dimensional network of trenches to determine the fault's slip rate because there's always an apartment building or department store in the way. Global Positioning Satellite (GPS) data from the Jet Propulsion Laboratory (JPL) group suggests that the Santa Monica mountains block is moving westward relative to the Los Angeles basin at 2 mm per year or less. Most, or possibly even all of that slip, is accommodated along the Hollywood fault. A "best-guess" slip rate for the fault, and it really is pretty much of a guess at this point, is about a 1/2 mm to a mm per year.

SCEC: The Malibu Coast-Santa Monica-Hollywood faults have apparently accommodated some of the clockwise rotation of the Western Transverse Range block. Are the rotations continuing

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Hollywood

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The Hollywood fault runs directly beneath the Sunset Strip under the Marlboro man.

right now?

Dolan: Some paleomagnetic work by Joe Liddicoat (UC Santa Cruz) on Pliocene rocks shows that they've been rotated up to about 20 degrees, which would suggest that maybe the rotations are ongoing. There's really no straight answer to that question, though. It may not be the huge blocks rotating that we tend to think of. It's probably much more complex than that.

SCEC: Is the Hollywood fault capable of a M 7+ event – in conjunction with neighboring faults?

Dolan: The Hollywood fault is only about 14 km long by itself. It extends from (about) the Los Angeles River and in a complicated fashion, it probably connects with the Raymond fault, which is a left-lateral strike-slip fault running through the southern San Gabriel Valley and through San Marino and Pasadena. To the west, the Hollywood fault proper extends through downtown Hollywood and northern Beverly Hills to (about) Benedict Canyon, and then jumps south about one to two km, to the Santa Monica fault, which is the active surface trace in West Los Angeles and Santa Monica.

The Hollywood and Santa Monica faults are part of the same fault system. They're both steeply north-dipping left-lateral reverse faults. Or reverse left lateral faults. It's possible that this one to two km jump in the surface traces of the fault is just a near-surface feature. At depth, they may even be the same fault. The Santa Monica continues offshore along the Malibu Coast for about 40 km to near Point Dume, where it looks like slip steps south to the Anacapa-Dume fault. We also have the Malibu Coast fault on shore, which may be carrying some slip in the system. At the west end of the Anacapa-Dume fault we have what looks like a large blind thrust underneath the channel islands that Bruce Shaw (Columbia University, Lamont-Doherty Earth Observatory) and John Suppe (Princeton) have studied.

Onshore Santa Cruz and Santa Rosa Islands have very large strike slip faults – again left lateral – that look like they're the western part of this system. We call this whole system of faults, from Hollywood to south of Santa Barbara, the "Transverse Ranges Southern Boundary fault system." It's an unwieldy name, but we couldn't figure out anything better. The whole system is more than 200 km long, and it's completely possible that large pieces of these faults, or even several entire faults, could rupture in conjunction with one another in very large earthquakes. So, yes, it's possible that the Hollywood fault may sometimes be part of very large earthquakes.

SCEC: When you tried trenching the Hollywood fault you apparently had difficulties with the loose, wet sediment, and came up with an innovative and quite effective new way of trenching a fault?

Dolan: Yes, we tried trenching the fault on a 30-feet-wide street where Ozzie and Harriet [Nelson] once lived. The fault literally goes beneath their living room – maybe this icon of the archetypal

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Hollywood
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The Hollywood Trench

1950s nuclear family wasn't so stable after all. But when Tom Rockwell (San Diego State University), Donovan Stevens (Caltech) and I opened up the ground, the trench started collapsing, so we immediately filled it in. I didn't want to dig a traditional trench on Ozzie and Harriet's side of the street, because of the presence of a high pressure gas main buried under the street.

So we hit on a rather novel approach. We excavated a series of 2.5-foot-diameter boreholes, down to about 40 to 45 feet deep, into which we were lowered on a winch. So we were hanging from this winch, mapping the fault in this circular little outcrop that we'd created for ourselves, with car headlights hanging over our heads and miners' lamps to show what we were looking at.

SCEC: Describe what it's like "down-hole."

Dolan: It's a very odd sensation. You get disoriented immediately. You're absolutely certain that you know that direction is west, and the people up above on the radio are telling you that it's east and you know you're right and they're wrong – but you're spinning around on a trapeze-like swing.

SCEC: How many of these did you do?

Dolan: I think we did 11 holes total. We were able to expose the entire fault zone down to a depth of about 40 feet, which is at least twice as deep as we could have gotten with a traditional method. The holes were very, very stable. Since they're round, it's the same idea as an archway – it holds itself open.

We ended up getting the information we needed, discovering that it's been a long, long time since the most recent earthquake large enough to cause surface rupture on the Hollywood fault. It's been at least 6,000 years, and possibly as long as almost 10,000 years, since the most recent surface rupture.

We also got the penultimate event, the previous event, that occurred about 10,000 and 20,000 years ago. So in the past 20,000 years we've only had two surface ruptures on the Hollywood fault. That translates into a very long recurrence interval. So the good news is that the fault breaks very infrequently, the bad news is maybe it breaks in very large earthquakes.

SCEC: You led a SCEC-organized field trip which included the Hollywood fault?

Dolan: Yes, on May 5th, we looked at the Hollywood and Santa Monica faults, and discussed what we know and don't know about some of the blind thrusts that underlie the Los Angeles metropolitan region. We also looked at the Sierra Madre fault in Arcadia, where we discussed the implications of a very large reverse fault system right in the back yard of metropolitan Los Angeles.

Michael Forrest

View of the Hollywood fault, looking toward Sunset Boulevard.

Editor's Note: SCEC Knowledge Transfer is currently compiling material for the production of a "Faults of the Los Angeles Region" field guide. The guide is expected to be available in the fall or winter of 1997. ♦

Feature: Visit with a SCEC Scientist

David Jackson, SCEC Science Director

SCEC Science Director, David Jackson, is a professor of Geophysics at the University of California, Los Angeles. Jackson's primary research activities involve the relatively new Global Positioning Satellite (GPS) technology. He has been successful, too, at finding flaws in popular scientific models, such as the "seismic gap hypothesis" (he's probably most famous, amongst his colleagues, for proving that the "Palmdale Bulge," didn't.) In this SCEC interview Jackson discusses his views on science as a vocation, and the importance of GPS to earthquake research.

SCEC: You were educated at the California Institute of Technology and Massachusetts Institute of Technology. What was your major focus when you were at each of these universities, and with whom did you work?

Jackson: I discovered seismology at Caltech. I had entered as a physics major in 1961, just a year after the great Alaskan earthquake. I had a summer job at the seismological laboratory, working first with Bob Kovach, then later with Frank Press. I worked on the Alaskan earthquake records while I was an undergraduate, and published a paper on that earthquake with Press.

SCEC: Were you at MIT at the same time as Kei Aki [SCEC Science Director, Emeritus]?

Jackson: Yes, I first met Kei at MIT in 1965. It was just after Frank Press had gone there as chairman of the department. I met several interesting faculty members there: my advisor was Gene Simmons, and I worked quite a bit with Frank Press, enjoyed classes and discussions with Kei Aki, and also with Hiroo Kanamori (now Director of the Seismological Laboratory at Caltech), who was visiting at that time.

SCEC: You delivered a beautiful speech about Aki at his retirement dinner last fall. How do you feel about stepping into his shoes?

Jackson: Oh, I'm delighted, I have such tremendous respect and admiration for Aki, and I'm deeply honored to have some of his "aura" rub off on me (a chuckle).

SCEC: Let's talk about some of your previous research. You had doubts about the "Palmdale Bulge." What made you think that something was wrong when you originally saw that data?

Jackson: First of all I was impressed by how astounding it was. It

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Jackson *continued from Page 27 ...*

was quite a remarkable report—that a huge area of southern California had been uplifted by approximately a foot in a matter of a few years. On the surface it sounds like something you'd definitely want to check. We got some of the original leveling data that were used to infer the Palmdale bulge and we noticed there were some symptoms of specific kinds of errors in those data. As we checked it out, sure enough, we found that the data had really strong systematic errors.

SCEC: You're much more careful than most in drawing the line between scientific fact and theory. You've inspired other scientists to take another cold, hard, critical look at a number of previously unquestioned theories, by raising objections to such things as the "seismic gap hypothesis."

Jackson: I think that's what science is. You are testing hypotheses against new data as they come in. The whole scientific method is a process of formulating ideas and then subjecting them to intense scrutiny and modifying those ideas as you go along. Sometimes you have to cast aside some ideas. So my approach is always to take the important ideas, spend some time finding out which are the important ingredients, and then give them a really thorough investigation. What are the consequences of some of these ideas? How might they be tested or falsified?

SCEC: You've been using GPS in your more recent research. We're coming to see that GPS is a very important tool for future of earthquake research in terms of possibly understanding a fault's earthquake cycle. Some say the future of earthquake research lies in GPS data. Could you comment on this?

Jackson: GPS offers us a whole new window into the Earth's crust and helps us understand how it deforms. Without geodesy, we have to wait for earthquakes to happen to see faults in motion. Or we could look at the cumulative effects of many, many earthquakes as they've affected the shape of the earth. That's the more geological (and time consuming) perspective. And, in that perspective you get no understanding of the effect of any individual earthquake, or whether there are changes in the rates that faults slip, or changes in the effects of different earthquakes with time.

By using GPS, we get to see the effects of the forces that drive the plate tectonics mechanism and the eventual rupture of the earth. We're getting a different picture in time and also a kind of average over the surface of the earth that we can't get in any other way. So it tells us very important things about stress buildup and release in earthquakes.

SCEC: Let's talk about the work you've accomplished in relation to the Earthquake Center. You have been principal architect of both the *Phase II* ("Seismicity of Southern California — Probable Earthquakes, 1994 - 2024") and *Phase III* (to include earthquake probabilities, ground motions, earthquake scenarios) reports. Can you talk about the focus of each?

Jackson: The primary goal of both of them is to combine our understanding of how, why and how often earthquakes occur, with an understanding of the propagation of seismic waves from those earthquakes, to provide a practical guide to the probability of strong shaking, and even more importantly to understand what the scientific issues are. What are the major unanswered questions that – if they were solved – would allow us to better calculate the probabilities of strong ground shaking?

SCEC: We know that SCEC's mission is to determine when and where future earthquake will occur in southern California, calculate the expected ground motion, and communicate that information to the community at large. But what about actual *prediction*? Do you think there'll ever be a day when we'll be able to say that in a given time frame (say, a few years) it's very likely that a certain fault or fault zone is going to rupture?

Jackson: Not in the foreseeable future. A century from now, anything could happen. I wish I could be around to see it. I'm sure there will be some wonderful discoveries. But earthquakes are quite random and we've done a thorough of looking for tip-offs that might tell us when a fault is approaching critical stress. We've had very little luck finding any reliable precursors, or any signals that would help us predict. So I'm not at all sure that we'll find short-term indicators of future earthquakes.

SCEC: Speaking of the future, what do you, as Science Director, see in the Earthquake Center's next five years?

Jackson: I think there are several dramatic accomplishments in SCEC's immediate future. The most important, I believe, will be to approach effects of earthquakes through calculating theoretical seismograms. We're striving to imagine any kind of earthquake within southern California, and calculate at relatively high frequencies a realistic theoretical seismogram anywhere within southern California. And that's really what is needed to predict strong ground motion from the kinds of earthquakes we can expect in the future.

SCEC: What is your vision for the Earthquake Center beyond the year 2002?

Jackson: Well, there are many different options we could pursue, and this is something that many of us are thinking about right now. One possible option is we continue doing what we're doing, which I think has been very successful. And we're certainly not going to run out of scientific problems. One of the problems we face is that we require earthquakes to test hypotheses. Even though southern California is seismically active, we can't expect that within five or ten years we'll experience the earthquakes that will test our hypotheses. So the temptation is to enlarge the laboratory in which we're making observations. We could expand the studies to either a greater part of the boundary between the Pacific and North American plates. Another possibility is to move to an international effort that would use the whole Pacific Rim and the whole Earth to test hypotheses. ♦

Michael Forrest

SCEC Seminars *continued from Page 5 ...*

Seismicity
• Changes in Distribution of Events and Changes in Stress: the Earthquake Cycle in Fault Models and in Real Catalogs
• A Critical Point Model for Stress Patterns before and after Large Earthquakes
• Coulomb Stress Change - Once You Get It, What Do You Do With It?
• Stress Propagation and Earthquake Probabilities

Second session (convenor, David Jackson) talks were:

• Stress Triggering and Effects of Heterogeneous Coupling in Subduction Zones: Seafloor Events towards the Outer Rise
• Stress Triggering and Effects of Heterogeneous Coupling in Subduction Zones: Upper-Plate Events in Oblique Segments
• Implications of Viscoelastic Strain in the Lower crust and Smoothing/Roughening of Stress in the Upper Crust for Earthquake Sequences
• The Lack of Correlation between Tides and Earthquakes
• Earthquake Stress Interactions: Considering Visco-elasticity, Complex Fault Geometry, Variable Rheology, and Body Forces
• Time-dependent Reorganization of Failure Stresses Following the 1971 San Fernando Earthquake: Implications for the Triggering of the 1994 Northridge, California Earthquake

Although no abstract volume or proceedings exist for this workshop, the SCEC Knowledge Transfer staff will be soliciting speakers for extended abstracts. Ruth Harris plans on publishing proceedings in a special of the Journal of Geophysical Research, which may not be published for a year.

For more information, contact Mark Benthien at *scecinfo@usc.edu*.

SCEC BOREHOLE INSTRUMENTATION INITIATIVE WORKSHOP

On Tuesday, March 25, 1997, SCEC hosted an open workshop to review the existing and planned surface and borehole instrumentation in the Los Angeles area, and discuss the scientific justification for borehole data. Participants discussed possible borehole instrumentation scenarios, as well as alternatives to borehole instrumentation.

As part of its 5 year renewal proposal to NSF and USGS in 1996, SCEC proposed to drill and instrument three boreholes per year from 1997 to 1999. Each borehole would be drilled and cased to a depth of 100 m in rock and be logged for P- and S-wave velocity and density. A three-component force-balanced accelerometer (FBA) with 120 dB dynamic range would be grouted in place at the bottom of each hole, with a second FBA placed at the surface. A six-channel Kinemetrics K2 data acquisition system (which includes the surface FBA) with dial-up capability would digitize the data, store it on site and telemeter the data into the SCSN. This arrangement would allow on scale recording for M 2.5 to be recorded with good signal to noise at distances of at least 40 km and perhaps as far as 70 km. All data would be incorporated into the SCSN and would complement on-going strong motion arrays in southern California.

These proposed borehole installations would help in reducing the uncertainty in predicting ground motion from future earthquakes. During the review process, it was suggested that SCEC hold a workshop to review the scientific objectives and better define the need for borehole instrumentation versus other scenarios, such as surface arrays, before preceding with the installation. This workshop addressed those concerns.

Following an introduction by Dave Jackson, SCEC Science Director, the first session (Review of Existing/Planned Surface and Borehole Data & Instrumentation) included speakers Bob Nigbor (Agbabian Associates) on the ROSRINE project; Dave Boore (USGS) on USGS borehole data; an overview of future plans for CDMG instrumentation; UC campus instrumentation (Ralph Archuleta, UCSB); and TriNet instrumentation (Egill Hauksson, Caltech).

Scientific justification for borehole instrumentation was presented by Tom McEvilly (UCB/LLBL) and Larry Hutchings (LLNL) on [San Francisco] Bay area borehole network; Archuleta on looking at details of the earthquake source; Kim Olsen (UCSB) on theoretical modeling using borehole data; and Jamison Steidl (UCSB) on ground motion prediction and non-linear effects.

Possible borehole scenarios and alternatives were presented by Dan Ponti (USGS); Archuleta and Steidl; and Jim Mori (USGS Pasadena).

SQN Editor's Note: SCEC funded the project, which is to be a joint effort among institutions running the ROSRINE and TriNet initiatives. ROSRINE will coordinate the drilling of the boreholes and TriNet will contribute toward instrumentation. Dr. Jamie Steidl recently updated us on the progress of the coordination: "SCEC plans to case the boreholes after they are drilled, sampled, and logged. SCEC will also assume the cost of instrumentation, installation, surface enclosures, data acquisition, and other related costs. These sites are going to be digital 24-bit real-time TriNet stations that feed directly into Caltech, and anyone will have access to the uphole/downhole data. This coordination will afford savings in terms of the budgeted SCEC drilling costs. We plan to use these savings in a similar fashion on other ROSRINE holes (TBD), once the three SCEC sites for year 1 are completed."

For more information on the Borehole workshop, contact John McRaney at SCEC: mcraney@usc.edu
or
Dr. Jamison H. Steidl, Institute for Crustal Studies, UCSB, email: steidl@quake.crustal.ucsb.edu

See "SCEC Seminars" *on Page 30*

SCEC Seminars *continued from Page 29 ...*

SCIGN Network Design Re-evaluation Workshop to be held May 15-16, 1997

A SCEC workshop will be held May15-16, 1997 at The Scripps Institute of Oceanography, at UC San Diego. Scripps Institution of Oceanography Convenors will be Yehuda Bock (UCSD) and Andrea Donnellan (JPL).

Following the 1994 Northridge earthquake, the SCEC Crustal Deformation Working Group proposed the implementation of a 250-station continuous GPS network in southern California. A first workshop, held in September of 1994, examined the pros and cons of a continuous network and other issues surrounding continuous GPS networks. A second workshop, held in March of 1995, led to a network design. The network design includes three north-south trending profiles with dense station spacing that span the Los Angeles and Ventura basins. Regional scattered stations fill in the rest of southern California. In the current network configuration 105 stations make up the profiles and the remaining 145 stations are disbursed throughout the regional subnetworks.

Approximately $14M has been raised for the network since the March 1995 workshop. Forty stations are currently in operation and the current funds allow for approximately 200 more stations. The approximate locations of the next 100 stations have been selected following the guidelines of the SCIGN network map from the March 1995 workshop.

The SCIGN coordinating board recommends a re-evaluation of the network design at this time in order to ensure that the most science be achieved with the 250 stations. The workshop held on May 15-16 will revisit the network design and associated issues. The workshop will consist of background talks, position papers, and discussion of the network design. To get a copy of the original network map contact Andrea Donnellan at *andrea@cobra.jpl.nasa.gov*. To get a copy of the planned 100 stations contact Ken Hudnut at *hudnut@gps.caltech.edu*. ♦

Jill Andrews

SIMULATION MODELS SOUGHT for INTERNATIONAL STUDY

The Institute for Construction Equipment and Construction Management at the University of Karlsruhe, Germany, is taking part in the Collaborative Research Center (CRC) 461 “Strong Earthquakes – a Challenge for Geosciences and Civil Engineering.” This CRC has been established in July 1996 and is a German contribution to the UN initiative ‘International Decade of Natural Disaster Reduction’ (IDNDR). It aims at strategic research in the field of strong earthquakes with regional focus on Vrancea events in Romania. This CRC works on three main topics:

1. Lithospheric scenario
2. Recent Kinematics and Dynamics
3. Earthquake impacts and engineering measures

We are engaged in the engineering measures. Our main aim is the development of mathematical models for the simulation, as well as the installation of a database with the simulation models for damages existing up to now. We would like to make contact with people engaged in this field of research and we would like to ask some questions:

1. Which models are existing, which input data do they need and which output data do they create?
2. Are these models designed for complete regions or only for particular buildings (do they need detailed information of the structural design or only general information)?
3. Are there any simulation models, which take predamaged structures into consideration? Particularly in the Vrancea region (Romania) many buildings were damaged during the earthquakes in 1977, 1986 and 1990, and have not been rehabilitated in accordance with the rules. It is not possible to base on the general linear supposition, that the structure gets worse with age. Therefore we are looking for simulation models which take predamages into account.
4. Which kind of models are existing for secondary damages after a disaster (fire, industrial accident, floods)?

Please do not hesitate to contact us if you have any questions or if you need further information.

Thorsten Hdrtel
Email: *thaertel@imbdec1.bau-verm.uni-karlsruhe.de*
Universitdt Karlsruhe
Am Fasanengarten
76128 Karlsruhe
Germany
Tel.: 0049 721 608 3885
Fax: 0049 721 695245

Positions Available

IRIS Consortium Education and Outreach Program Coordinator

We are seeking a geoscientist with expertise in seismology and education to coordinate the new IRIS program in Education and Outreach. The program coordinator will represent the geophysical community on educational issues, and interact with the National Science Foundation and professional educational and scientific organizations. The program coordinator will work with the seismological and educational communities to develop and implement IRIS programs designed to enhance seismology and geoscience education in K-12 schools, colleges and universities, and public outreach. In keeping with the National Science Foundation's goal of integrating education with research, the program coordinator will also be responsible for developing mechanisms for adapting IRIS research programs and activities to the educational process at all levels. Applicants should have strong interest in educational reform and curriculum development, excellent interpersonal and communication skills, the ability to work effectively with diverse groups, and broad interest in the geosciences. Background should include a Ph.D. in geoscience or education with experience in seismology. IRIS is a university consortium funded by the National Science Foundation. IRIS represents the seismological interests of 90 research institutions. IRIS is an equal opportunity employer. Candidates should send letter of intent, curriculum vitae, and the names of three references by June 30, 1997 to:

Ms. Susan Strain
IRIS Consortium
1200 New York Avenue, NW, Suite 800
Washington, DC 20005

Postdoctoral Researcher in Seismology, Washington University

Washington University is seeking applicants for a post-doctoral researcher in seismology to work on investigations of the structure of the Earth's core and mantle. Analysis will be done using data from a recent Missouri-to-Massachusetts experiment as well as global digital data. The salary will be commensurate with the experience of the applicant, and funding is for 2 years with extension possible. The nominal start date for this position is July 1, 1997, but flexibility for later starting dates is possible. Applicants should contact Michael Wysession, Assistant Professor of Geophysics, Washington University, St. Louis, MO 63130, email: *michael@wucore.wustl.edu* or phone: 314-935-5625

Geophysical Research Assistant in Crustal Deformation

The Earthquake Hazards Team of the U.S. Geological Survey in Menlo Park, CA, seeks a geophysical research assistant in crustal deformation to help develop an INSAR (interferometric synthetic aperture radar) laboratory; analyze GPS and leveling data; produce GIS maps and analyses; and develop web sites. Candidates need Unix and Mac programming (Fortran, C), GIS (GMT, MapInfo, ArcInfo), graphics (Illustrator), and web (HTML, Java) software experience. Skill in making oral presentations, preparing scientific figures, and writing manuscripts, is critical. MS degree or BA plus experience required. This is a 3.5-yr term position; salary of $32,730. Contact: *http://www.usajobs.opm.gov/c.htm* or 415 744 5627 to apply (enter vacancy FS0537) or Fed. job BBS at 912 757 3100.

Please contact Wayne Thatcher (thatcher@usgs.gov) or Ross Stein (rstein@usgs.gov) for questions, or paper application forms. Application closing date: 20 May.

Senior Research Scientist

New England Research, Inc. (NER), a geophysical research and development company specializing in rock physics, invites applications for a new senior research scientist position. The successful candidate will be expected to develop their own research program which compliments NER's existing emphasis on the use of laboratory measurements to constrain interpretation of field and/or borehole geophysical data. Background in relating micro-mechanical and porescale models to explain and predict macroscopic properties and processes is desirable. Experience working on problems related to the oil and gas industry is preferred, although candidates with backgrounds in geothermal, environmental, and other geotechnical fields will be considered. Candidates should send a brief letter detailing research interests and background, along with a resume and list of publications to: Personnel Director, New England Research, Inc., 76 Olcott Drive, White River Junc., VT, 05001 (or by email to *info@ner.com*).

Research Scientist

New England Research, Inc. (NER), a geophysical research and development company specializing in rock physics, invites applications for a new research scientist position. The successful candidate will be expected to participate in the collection, analysis, and application of laboratory data to address problems concerning interpretation of field and borehole geophysical measurements. A Bachelors or Masters degree in the physical or earth sciences is preferred. Strong computer and laboratory experimental skills are required. Candidates should send a brief letter detailing technical interests and background, along with a resume to: Personnel Director, New England Research, Inc., 76 Olcott Drive, White River Junc., VT, 05001 (or by email to info@ner.com).
New England Research, Inc. is an equal opportunity employer.

Resident Computer Geoscientist

The Department of Geological Sciences at San Diego State University seeks to hire a staff scientist position specializing in the application of computer resources to teaching and research in the geosciences. The Department maintains a state-of-the art computer facility, including Pentium, Macintosh, Sun, and SGI workstations, and has a multi-faceted cooperative program with the petroleum industry and the developers of CogniSeis and GeoQuest (Schlumberger) software packages. A primary responsibility of the successful applicant will be to train students in an assortment of workstation applications, including CogniSeis and GeoQuest packages, relevant to their future employment in the teaching and the geosciences industry, particularly the non-renewable oil, gas, and mineral industries, as well as to develop techniques to link high-end computing to Distance Learning. The successful candidate will also be expected to obtain funding and conduct research on further application of computer resources to the geosciences and the use of computer resources to improve teaching of geosciences in the K-12 through university levels. This position is a full-time, 12-month position. The salary range is $42,036 to $60,288, commensurate with experience. Applicants should have a Ph.D. in either Computer or Geological Sciences and a strong background in both Geological and Computer Sciences,

See "Positions" *on Page 34*

SCEC Research Report

New Grants Expand GPS Network to Monitor Southern California's Earthquake Faults

Ten million dollars in grants from the W.M. Keck Foundation ($5.6 million), the National Aeronautics and Space Administration ($2.4 million), and the National Science Foundation ($2 million) will make Southern California the best-surveyed area on the planet and provide a powerful tool for scientists seeking to understand the region's potential.

The grants were announced this week by the Southern California Earthquake Center (SCEC), headquartered at the University of Southern California. SCEC provides oversight and coordination for the Southern California Integrated GPS Network (SCIGN), which will use the new funds to expand — from the current 45 to 250 sites — an array of ground-based "monuments" that are used to electronically track satellites of the Global Positioning System (GPS). GPS, a constellation of 24 navigation satellites operated by the U.S. Department of Defense, permits points on the Earth's surface to be located with high precision.

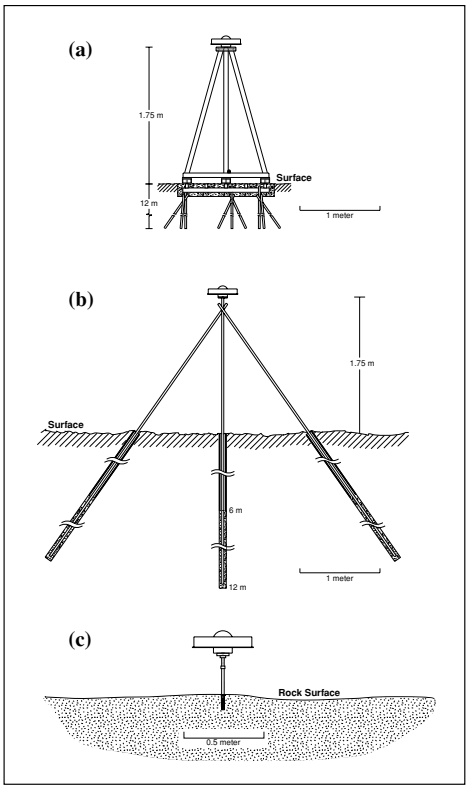
The expanded monument network will enable scientists to follow, in unprecedented detail, movements of the Earth's crust in one of the world's most seismically active and highly populated areas.

"Thanks to the W.M. Keck Foundation, NASA and NSF, the Southern California scientific community can pioneer the use of the most promising new tool in geophysics since the invention of the seismometer," said SCEC director

See "GPS Network" *on Page 33*

Tom Henyey, director of SCEC, with a global positioning system antenna used to precisely measure movement of the Earth's surface. The antenna is located on the grounds of the Health Clinic at the University of Southern California. (Courtesy Eric Mankin, USC News Service.)

GPS Network *continued from Page 32 ...*



Several types of geodetic monuments will be used (right): Most sites will employ braced-rod monuments, drilled to a depth of at least ten meters, shown by (a) and (b); in locations where there are massive rock outcrops, stations may utilize an antenna mounted on a steel shaft drilled into the bedrock (c). (From Figure 11, W. M. Keck Foundation GPS Array for Earthquake Research proposal, September 16, 1996.)

Tom Henyey, who announced the grants at a special meeting of the SCIGN coordinating committee. "Eventual completion of the 250-station array will put the full potential of GPS technology to work in an earthquake-prone region particularly suited to the task," added Dr. Henyey, a professor of earth sciences at USC.

"GPS makes it possible to measure the position of the monuments with extraordinary accuracy," said Mike Watkins of the Jet Propulsion Laboratory. "Although the monuments may be separated by scores of miles, a change in their relative positions of no more than a sixteenth of an inch can be detected by the GPS system."

In seismically active areas such as Southern California, where plate tectonic forces are at work, substantial earth movements of one inch per year occur continuously and are readily measurable by the state-of-the-art GPS technology. "These movements give scientists indications of how fast strain is building up, where it's concentrated, and where earthquakes might occur in the near future," noted SCIGN chairman William Prescott of the U.S. Geological Survey (USGS).

The array, which started with only four sites in 1990, has already detected very small motions of the Earth's crust in Southern California — motions associated with the 1992 Landers (M=7.3) and 1994 (M=6.7) Northridge earthquakes. "The GPS receivers operating during the Landers earthquake were able to detect, for the first time, subtle changes in the regional deformation pattern. Such changes are potentially of great importance for studying the physics of earthquakes and hazards mitigation," said Yehuda Bock, director of the Scripps Orbit and Permanent Array Center at UC San Diego's Scripps Institution of Oceanography.

"Before and after the January 1994 Northridge earthquake, the few GPS monuments then in service revealed important scientific clues about the processes taking place far underground," said Ken Hudnut of USGS in Pasadena. "GPS technology is particularly valuable for studying hidden faults, like the one that caused the Northridge earthquake. Faults located far underground are more difficult to study by other methods."

The current network was funded by earlier grants from NASA and NSF to the Jet Propulsion Laboratory and the Scripps Institution of Oceanography and by USGS. According to SCEC science director David Jackson of UCLA, SCIGN will use the funds to rapidly expand the network of receiver stations. "In addition to providing general coverage for the entire 25,000-square-mile area extending from the Tehachapi Mountains south to the Mexican border, and from the Pacific Ocean to the Colorado River, stations will be concentrated along a tectonically critical corridor extending through the Los Angeles basin. Each station will be monitored daily," Dr. Jackson said.

SCIGN is currently operated by three primary institutions — the Jet Propulsion Laboratory, UC San Diego's Scripps Institution of Oceanography and USGS — with participation by other SCEC institutions and local and state government agencies. The Keck Foundation, NASA and NSF funds also will be used to support data collection, processing and archiving by the three main SCIGN participants. They in turn will make the processed data available to the entire scientific community, where it will be combined with data from other sources to create the most accurate and detailed picture ever of the earthquake hazard in Southern California.

Established in 1991, SCEC is an NSF Science and Technology Center funded by separate grants from NSF and USGS. "The center was conceived with the idea that a better understanding of earthquakes in Southern California will help protect the lives and property of the more than 15 million people living here," Dr. Henyey said.

One of the nation's largest foundations in terms of annual grants, the W.M. Keck Foundation was established in 1954 by the late William M. Keck, founder of the Superior Oil Co. The foundation's primary focus is on universities and colleges throughout the United States, with particular emphasis in the fields of science, engineering and medical research. ♦

Eric Mankin, USC

Positions *continued from Page 31 ...*

including the PC, Macintosh, and Unix platforms, as well as demonstrated teaching and research capability. Experience in CogniSeis and GeoQuest software, as well as a wide range of PC, Macintosh, and Unix software applicable to the geological sciences is desired.

Interested applicants should send a curriculum vitae, undergraduate and graduate transcripts, a letter summarizing teaching and research experience and goals, and three letters of reference to Dr. David Huntley, Department of Geological Sciences, San Diego State University, San Diego, CA, 92182. Recruitment remains open until filled. Application review will begin on Tuesday, April 28, 1997. San Diego State University is an Equal Opportunity employer.

Volunteer Opportunity: SCEC Working Group C

We need a part-time person to help deliver, maintain, and install hydraulic shoring in our trenches. The ideal volunteer is a person with either construction or mechanical experience, and will work with the geologists in Group C. It will be a part-time job, based at the Kresge Laboratory facility at Caltech. The person will be responsible for scheduling and maintaining Group C's hydraulic shores. The individual will check out, deliver, and help the geologists install the shores at the trench site. He / she will help remove the shores at the end of the project, deliver the shores back to Kresge, clean the shores, and make sure they are in good mechanical condition. The part-time job would begin 1998, at the beginning of the 1998 SCEC fiscal year (February). Please contact: Dr. Charles M. Rubin, Associate Professor, Geology, Central Washington University, at:
phone 509 / 963-2827
or
email: *charlier@cwu.edu*

Post-Doc, Seismological Laboratory, Caltech

Applications are being sought for a Seismological Laboratory Postdoctoral Scholar. Candidates in any area of geophysics are encouraged to apply. We are particularly interested in seismologists with broad interests in research programs covering the full spectrum of geophysics. Completion of the Ph.D. is required. The duration of the appointment will normally be for 2 years, contingent upon good progress in the first year. The annual stipend will be $30,000 or higher in the first year, depending on qualifications. Scholars may participate in Caltech's benefit package. A curriculum vitae including a list of publications, the names of three references, and a one page statement of proposed research activities (all in ASCII) should be e-mailed to: gurnis@caltech.edu. Alternatively, applications may be sent to Dr. Michael Gurnis, Seismological Laboratory, 252-21, California Institute of Technology, Pasadena, California 91125, email: *gurnis@caltech.edu*.
See also:
http://www.gps.caltech.edu/positions/positions.page.html

Caltech is an Equal Opportunity / Affirmative Action Employer. Women, minorities, veterans, and disabled persons are encouraged to apply.

Postdoctoral Researcher in seismology, Washington University

Washington University is seeking applicants for a post-doctoral researcher in seismology to work primarily on analysis of data from recent experiments in the Southwest Pacific and the Antarctic. The applicant will be expected to perform a variety of studies using broadband waveforms to constrain the three dimensional structure and earthquake source properties. The salary will be at the beginning post-doctoral level, and funding has been obtained for 2 years, with extension possible if further funding is obtained. The nominal start date for this position is July 1, 1997, but some flexibility for later starting dates is possible. Applicants should contact:
Douglas Wiens, Professor of Geophysics
Washington University
St. Louis, MO 63130
email: *doug@kermadec.wustl.edu*
phone: 314-935-6517

CERI Seismic Network Director

Directs the design, operation, software development, and data analysis of seismograph network at the Center for Earthquake Research and Information. Plans and implements the program upgrade to a totally digital, computer-based, regional seismic network system and its integration with the National Seismic System via satellite data telemetry. Requires Master's degree in Earth Science or Computer Science related field. Three (3) years experience in a scientific computing position or three (3) years experience in a seismic network operations and / or analyst position. Application deadline: April 4, 1997 or until filled. Salary hiring range: $28,872-$33,876. Request application information from the Department of Human Resources, Jones Hall, Campus Box 526714, The University of Memphis, Memphis, TN 38152, (901)678-2601. Equal Opportunity / Affirmative Action Employer. ♦

FIELD TRIP TO THE NORTH ANATOLIAN FAULT

Prof. Aykut Barka, Organizer
Istanbul Technical University,
Geology Department, Ayazaga, Istanbul
Tel: 90 (212) 285 6299
Fax: 90 (212) 285 6210
Email: barka@sariyer.cc.itu.edu.tr

The application for the trip to the North Anatolian fault will end by the end of May 1997. Aykut Barka still has space as of this writing, and may accept 2-3 graduate students with a 30% reduction (1000 USD instead of 1500 USD). The opportunity to view the North Anatolian fault is not offered frequently. This will be the first substantial field trip to the North Anatolian fault.

The field trip to the North Anatolian fault will go from the Erzincan region to the Sea of Marmara (about 1200 km length) between 1-15 August 1997 (15 days total). The trip will cost 1500 USD for each participant. This fee will cover airfare from Istanbul to Erzincan, all food, accommodations and travel in Turkey, including Istanbul.

There will be also one day symposium on recent development on active fault studies. Each participant can send an abstract for this purpose by 15 June 1997. Barka plans to have a maximum of 20 people.

Time permitting, there may be short archeological stops to see the Alacahöyük (Hitites), Safranbolu (18th 19th century Turkish

See "Anatolian Trip" *on Page 35*

Anatolian Trip *continued from Page 34 ...*

houses), Iznik (Roman, Byzantine and Ottoman relics and monuments), Istanbul and Gelibolu (Gallipoli war). The field trip will concentrate on morphological expressions, fault exposures, large earthquake offsets such as 1939, 1943, 1944, trench studies, remains of surface ruptures.

A well documented guide book with colour photographs will be presented to each participant. For application please send US$250 to the account below by 31 May 1997. Acceptance of applications will be on a first come first serve basis.

Aykut Barka
Account #: 3980239/3002481-0
Yap Kredi Bankasi 121-4 (Bank Number)
Yesilkoy Subes, Istanbul, Turkey

THEME SESSION INVITATION: ADVANCES OF THE NEOTECTONICS IN LATIN AMERICA, Geological Society of America Fall Meeting

We are pleased to invite you to participate in the Theme Session on "Advances of the Neotectonics in Latin America" to be held in the Geological Society of America Annual Meeting in Salt Lake City, Utah, from October 20-23, 1997 (Theme Session number T.61). The title of the general meeting is Global Connections, so we want to contribute by making connections between the people working in Latin America and the Caribbean on neotectonic problems. We encourage Latin American scientists to participate, as well as other scientists in the world who have regional data related to: tectonic geomorphology, slip rates, styles of deformation, paleoseismology, GPS interpretation, seismotectonics, and seismic hazards. Other areas of research could be included if they are of interest for the region.

The main objective of this meeting is to summarize the state of the art on neotectonic research in some regions of Latin America and the Caribbean. This Theme Session will be dedicated to the memory of Carlos Schubert for his contributions to the neotectonics in the Caribbean Region. The requirements for the abstract submission can be seen in the *GSA Today*, or can be taken from the Internet at *http://www.geosociety.org*.

Juan-Carlos Moya
Department of Geological Sciences
University of Colorado at Boulder
Boulder CO, 80309-0250
Phone (303) 786-1637
Fax (303) 492-2616
E-mail: *moya@ucsub.colorado.edu*

Carlos H. Costa
Departamento de Geologia
Universidad Nacional de San Luis
Casilla de Correo 3205700
San Luis, Argentina
Phone: 54 652 23917
Fax: 54 652 30224
E-email: *costa@linux0.unsl.edu.ar*

Earthquake Short Course Offered by the Wrigley Institute and SCEC

June 4 and 11, 1997

Thomas Henyey, Director of the Southern California Earthquake Center, and other SCEC researchers will be teaching two one-day courses on earthquakes as part of a Natural Hazards and Insurance Risk short course series, sponsored by the Wrigley Institute for Environmental Studies at USC. The earthquake science course is part of a syllabus that will, over the course of the first two weeks in June, address such topics as global climate systems, climate variability and frequency and severity of storms, analysis of risk for catastrophes, and risk assessment from the perspective of a catastrophe re-insurer. The courses will be taught at the Institute on Catalina Island.

On June 4 and 11, Henyey and others plan to cover the following topics:

1) Seismology 101
2) Understanding the earthquake source
3) Seismic waves and ground shaking
4) Probabilistic seismic hazard analysis and earthquake scenarios.

For more information on the syllabus and on how to register, please contact:

Wrigley Institute for Environmental Studies
University of Southern California
PO Box 5069
Avalon, CA 90704
Phone 310/510-0811 FAX 310/510-1364

or

USC - AHF 232
Los Angeles, CA 90089-0371
Phone 213/740-6780 FAX 213/740-6720

Calendar, May 1997 - January 1998

May

2 Spring Advisory Council Meeting

5 SCEC Fieldtrip led by Jim Dolan on Faults of Los Angeles

13-14 SCEC / CDMG Joint Workshop on Evaluation of and Mitigation Within Co-Seismic Zones of Surface Deformation @ Los Angeles. Hosts: William Bryant, Michael Reichle, Jerry Treiman, Thomas Henyey, and Jill Andrews

15-16 SCEC Science Seminar and GPS Workshop @ San Diego, CA. Host: Yehuda Bock

19 CLA / SEAOSC / SCEC Joint Task Force, Tuck-Under Parking Building Subcommittee (TUPB), 3 pm, USC / SCEC Conference Room; Non-Ductile Concrete Building Subcommittee (NDCB) 4pm. Info: Mark Benthien, 213 / 740-0323.

23 CLA / SEAOSC / SCEC Joint Task Force steering committee meeting, 1:30 pm, USC / SCEC Conference Room. Info: Mark Benthien, 213 / 740-0323.

27-30 AGU Spring Meeting @ Baltimore, MD

29 CLA / SEAOSC / SCEC Joint Task Force, all committees, 3 pm, USC Davidson Conference Center, Figueroa Room. Info: Mark Benthien, 213 / 740-0323.

30 CLA / CDMG / SCEC Vulnerability Workshop report panel summaries and recommendations deadline. Info: Jill Andrews, 213 / 740-3459.

June

4 & 11 Earthquakes and Insurance short course – see announcement, page 35, this newsletter.

12-13 SCEC Board, Steering Committee, and Advisory Council Retreat, Breckenridge, CO. Info: John McRaney, 213 / 740-5842 (invitation only).

18-20 IIPLR Annual Congress, Irvine. Info: 617 / 722-0200

July

13-16 Natural Hazards Research and Applications Information Center Annual Workshop, Denver, CO. Info: 303 / 492-6818

August

20-23 CUREe Northridge Earthquake Research Conference, Los Angeles, CA. Info: 510 / 231-9557

18-28 IASPEI 29th General Assembly, Thessaloniki, Greece. Jill Andrews, co-convenor, Session W-9, "Educating the Public About Earthquake Hazards and Risk." Info: See the Web Home Page for the Assembly: ***www.csd.net/~bergman/iaspei/***

September

22 Field Workshop on Paleoseismology of the San Andreas Fault. Host: Kerry Sieh (to be held during week of September 22).

October

5-7 SCEC Annual Meeting, Costa Mesa, CA

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

24-25 SCEC Workshop, Computational Methodologies for Simulating Earthquakes Workshop, Santa Fe, NM. Hosts: John Rundle (U CO, Boulder) & Bernard Minster (Scripps Institute of Oceanography, UCSD). Info: 303 / 492-5642

November

TBD City of Los Angeles Vulnerability Workshop III

December

8-12 AGU Fall Meeting @ San Francisco, CA

January, 1998

16 San Cayetano Fault Field Trip to be led by Tom Rockwell

SCEC Notes

Charlie Sammis Passes the Baton to James Dolan

Charlie Sammis has been reappointed as chair of the Department of Earth Sciences at USC for the next two years. As the department has a long-term strategic plan under development, Sammis feels he needs to put most of his efforts there in the future. Accordingly, he submitted his resignation as the SCEC board member to the dean here at USC and the dean subsequently appointed James Dolan, Assistant Professor, as the new USC Director, effective May 2, 1997.

John McRaney

Yehuda Bock Appointed Chair of SCIGN

I am pleased to announce that the Board of Directors of the Southern California Earthquake Center has confirmed the appointment of Yehuda Bock as the Chair of the Governing Board of the Southern California Integrated GPS Network. In addition, the SCEC Board has approved new SCIGN Bylaws, which may be found on the World Wide Web at: *http://www.scecdc.scec.org/scign/bylaws.html*

David D. Jackson

SCEC Administrative Assistant Sue Turnbow Retires

Sue Turnbow, administrative assistant here at the SCEC office, has taken an early retirement package from USC and gone off to play golf on a daily basis. She will still assist us in conducting annual meetings and some workshops in the future.

At least for the next couple of months, USC student Becky Robinson will be assisting us in the office in the mornings and Sally Henyey will be in the office in the afternoons. Sue has prepared them for most of the upcoming events, but please be a little patient if they cannot answer your questions right away.

SQN Ed.

NEW SCEC WWW URL

www.scec.org

Earthquake Information Resources On Line

Earth Sciences

SCEC Data Center Pages

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

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

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

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

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

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

Earthquakes in Southern California
http://www.scecdc.scec.org/eqsocal.html

"Finger Quake" ftp (updated frequently)
http://scec.gps.caltech.edu/cgi-bin/finger?quake

So. Calif. Fault Map
http://www.scecdc.scec.org/faultmap.html

Faults of L.A.
http://www.scecdc.scec.org/lafault.html

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

Seismo-surfing the Internet

http://www.geophys.washington.edu/seismosurfing.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

USGS Response to an Urban Earthquake — Northridge '94
http://geohazards.cr.usgs.gov/northridge/

Southern California Seismic Network
http://www-socal.wr.usgs.gov/lisa/NETBULLS/netbull_list.html

The Nevada Seismological Laboratory
http://www.seismo.unr.edu

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

John Louie
email: *louie@seismo.unr.edu*

Paleoseismology

Among the new features of the Forum Palaeosismicum which is part of the Paleoseismology Page of the Paleoseismology Group of the USGS Geologic Hazards Team, is a homepage for ILP Task Group II-5 on "Earthquake Recurrence Through Time" led by Daniela Pantosti and Alan Hull. See: *http://gldage.cr.usgs.gov/paleosei/ILPhome.htm*

A report about last month's paleoseismology training course in Venezula is part of the homepage. I would like to add a list of paleoseismologists and their interests to the Forum. If you would like to be on the list, send me your name, email address, and 2-3 lines listing your areas and / or topics of research interest in paleoseismology. Comments about the Forum are always welcome. See: *http://gldage.cr.usgs.gov/paleosei/PPForMem.htm*

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See "On Line Resources" *on Page 38*

On-Line Resources *continued from Page 37 ...*

Active Tectonics

University of California, Davis - Active Tectonics
http://www-geology.ucdavis.edu/~GEL214/

Currently the pages consist of
o lecture notes ("Contents") of a graduate level course in Active Tectonics, with a heavy focus on crustal deformation and geodesy.
o A series of problem sets ("Problems") for this course
o A page with www links ("Links") of interest to active tectonics students and researchers
o A list of references

GIS Web Sites

One of the best sites to can explore for GIS and environmental applications bibliography is:
http://www.geoplace.com/book

Other sites are:

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

Geodetic Information Web Site

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

New GMT Web Page

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

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

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

Preparedness, Disaster Management

California Governor's Office of Emergency Services
http://www.best.com/~trbu/oes/

KFWB Quake Page (by Jack Popejoy)
http://kfwb.com/eqpage.html

KFWB Webservice Exclusive: Trenching the Cucamonga fault:
http://kfwb.com/cucamong.html

The Los Angeles Sheriff's Department Emergency Operations Bureau Disaster Management
http://www.highways.com/lasd-eob/

John A. Martin & Associates
http://www.johnmartin.com/eqprep.htm

Earthquake Information and Related Sites

EQNET
http://www.eqnet.org/

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

Up-to-the-minute Southern California Earthquake Map
This site takes the earthquake locations broadcast via e-mail from Caltech and makes a map of the last approximately 500 earthquakes. It works for Java-enabled browsers only.
http://www.crustal.ucsb.edu/scec/webquakes/

Probabilistic Seismic Hazard Map, California
http://www.consrv.ca.gov/dmg/shezp/psha0.html

Bay Area Hazard Map
http://www.abag.ca.gov/cgi-bin/pickmapx.pl

Glossary of terms (in progress)
http://www.scecdc.scec.org/glossary.html#BLIN

Seismic Info Sources
http://www.geophys.washington.edu/seismosurfing.html

Seismic Safety Commission
California Mitigation Plan
http://www.seismic.ca.gov/ssccatr.htm

Seismic Safety Commission
Legislation page
http://www.seismic.ca.gov/sscleg.htm

Seismic Safety Commission
Significant Damaging California Earthquakes
http://www.seismic.ca.gov/sscsigeq.htm

♦

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Science Director - David Jackson
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SCEC on the Internet

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

SCECinfo@usc.edu

Internet Discussion Groups

Western States Seismic Policy Council Discussion Group
wsspc-l@nisee.ce.Berkeley.EDU

Paleoseismic ListServe
eq-geo-net@gsjtmws8.gsj.go.jp

Global Volcanism Network
gvn@volcano.si.edu

Research in Quaternary Science
QUATERNARY@morgan.ucs.mun.ca

"Seismological Discussion (SEISMD-L)"
SEISMD-L@BINGVMB.BITNET

Earthquake Discussion List
QUAKE-L@LISTSERV.NODAK.EDU

Conferences, Events

The Second Announcement of the SDEE'97 can now be found at:
http://www.boun.edu.tr/sdee.html
http://www.ceor.princeton.edu/sdee.html

SDEE'97 - EIGHTH INTERNATIONAL CONFERENCE ON SOIL DYNAMICS AND EARTHQUAKE ENGINEERING
July 20-24, 1997
Istanbul, Turkey

Organized by: Bogazici University, Istanbul and Princeton University, Princeton, NJ. Under the Sponsorship of: UNESCO, United Nations Educational, Scientific and Cultural Organization, and IDNDR, United Nations International Decade for Natural Disaster Reduction Secretariat.

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