GARY GUACCI
Chairman - 213-413-3550

STEVE JENSEN
Vice Chairman - 619-931-1916

BOB ZWEIGLER
Treasurer - 818-980-0829

JAMES SHUTTLEWORTH
Secretary - 213-738-2828

MARK OBORNE
Editor - 818-888-3786
C/O Oborne and Associates, Inc.
22715 Dolorosa St.,
Woodland Hills, California 91367

ASSOCIATION ENGINEERING GEOLOGISTS

SOUTHERN CALIFORNIA SECTION newsletter

2550 BEVERLY BOULEVARD, LOS ANGELES, CALIFORNIA 90057

FEBRUARY MEETING

DATE:	Tuesday, February 11, 1985
PLACE:	Stevens Steak House 5332 Stevens Place Commerce (T.G. 53 F2)
COST:	$13.00 (Tip included)
RESERVATIONS:	Kovacs-Byer & Associates, Inc. 818-980-0825 Please make reservations by noon on previous Friday.
TIME:	5:30 Social Hour 6:30 Dinner 7:30 AEG Business 8:00 Speaker 9:00 Section Affairs, if scheduled
SPEAKER:	Charles Dougherty, DeLeuw Cather & Company

<u>Los Angeles Metro Rail Project</u>

Mr. Dougherty grauated from the University of North Carolina with a BA degree in 1964. He began working for DeLeuw Cather in 1967, and has worked on transportation related projects since that time. Having worked on the Washington D.C. Metro Rail system, he brings to Los Angeles much experience in the field of rapid transet system construction. Currently DeLeuw - Cather is working with a group called PDCD who will act as construction management on the Los Angeles Metro Rail project. Mr. Dougherty will be speaking on many aspects of metro rail construction, both above and below ground.

BULLETINS

Examinations for registration as a geologist and geophysicist and for certification as an engineering geologist are expected to be given in Sacramento, Los Angeles, and San Francisco. Examinations will be given: Geology & Geophysicist - May 16, 1986, Engineering Geology - May 17, 1986 (Final Filing Date - February 17, 1986); Geology & Geophysicist - November 14, 1986, Engineering Geologist - November 15, 1986 (Final Filing Date - August 15, 1986).

If you have not yet paid your association dues please be sure and do so. We are up-dating the mailing list and I'm sure you don't want to be left out!

Ed Steiner is our new publications committee chairman and he has just received the publications for sale from Ann Meeker. If you would like to order any publications contact Ed at Geosoils at 1446 East Chestnut Avenue, Santa Ana, CA 92701. There is a 15% off sale going on so act fast!!

The March meeting will be joint with the ASCE and will be held at Steven's Steak House. Last heard, the topic will be concerned with the contradictory requirements of various regulating agencies on aspects of hazordous waste. Tom Mills of Leighton and Associates will be speaking.

Seminar course, Spring Qtr. 1986, Univ. of Calif., Irvine: Quaternary Geology and Geomorphology for Engineering Geologists, instructor: Dr. Roy Shlemon, 3 units, April 13 - June 5, Thurs. night 7:00-10:00 PM, includes two saturday field trips, Cost $150.00, registration contact UCI Extension: (714) 856-5414.

Please note: We're working very hard to try and get the newsletter out sooner each month. You can help by supplying all information to the editor by the second tuesday of the previous month.

SUMMARY OF ANNOUCEMENTS

1. The Assocation mugs are on sale for $8.00, contact Bob Zweigler.

2. Chairmanships are still open for Building Codes and Continuing Education Committees.

3. Don't forget to nominate a young member (age 35 or younger) for the Association's Douglas R. Piteau outstanding Young Member Award. Give nominations to Jim Shuttleworth.

4. If members are interested in updating Engineering Geology in Southern California by helping out or contributing case

history articals, please contact Gary Guacci or Ann Meeker. Ann is calling for abstracts by April 15.

5. A position is still open with the State Building Safety Board. Nominations are requested. The San Francisco section will try and provide a couple of nominations of candidates who possess both certification as an Engineering Geologist and a Civil Engineering Registration. We can support their nominations if we do not produce any candidates of our own. The term is for about four years and the individual should be familiar with building codes, architecture and structural engineering.

6. This year's field trip will be a joint trip with the San Diego Geological Association. It will include a boat trip the first day from San Diego to Ensenada. The second day will be a field excursion by bus as we return to San Diego. Details will be anonounced later.

7. A groundwater contamination and clean-up course will be held at UCLA for professionals and will be taught by members of the local section. Contact Bob Bean (CSULA) for further details. The class will be held April 18 and 19.

8. Marty Stout requests questions for the registration examinations. The deadline is March 15. Marty also indicated to sign up early for the GSA field trips, as spaces are limited.

9. The next Banner Club meeting will be March 4 and the topic will be Antarctica geology.

10. The State Board of Geologists and Geophysicists will be meeting January 23 at 10 AM at the Hyatt Hotel in Los Angeles.

11. The student workshop is being held February 22 at California State University, Los Angeles. Contact David Grover for details. Speakers at the workshop will include AEG members Glen Brown, Dick Proctor, and Joe Cobarrubias. Topics will include salaries, office practices, professional conduct and ethics, grading codes and consultants, local projects and larger construction projects, such as the Metro Rail. Attorney Mike Barmasse will also speak regarding the legal aspects of the profession. Lunch and other refreshments will be provided at no charge for all interested studets, faculty and AEG mebers. Prospective attendees should contact Dave Grover at (818) 889-0844.

12. Dick Brown suggested that the Association send a letter to the State Board of Mining and Geology to encourage the California Division of Mines and Geology to continue to publish the "Index of Geologic Mapping". This particlar

Evaluating Earthquake Hazards in the Los Angeles Region— An Earth-Science Perspective

J. I. Ziony, Editor

U.S. GEOLOGICAL SURVEY PROFESSIONAL PAPER 1360

ABSTRACT

Potentially destructive earthquakes are inevitable in the Los Angeles region of California, but hazards prediction can provide a basis for reducing damage and loss. This volume identifies the principal geologically controlled earthquake hazards of the region (surface faulting, strong shaking, ground failure, and tsunamis), summarizes methods for characterizing their extent and severity, and suggests opportunities for their reduction.

Two systems of active faults generate earthquakes in the Los Angeles region: northwest-trending, chiefly horizontal-slip faults, such as the San Andreas, and west-trending, chiefly vertical-slip faults, such as those of the Transverse Ranges. Faults in these two systems have produced more than 40 damaging earthquakes since 1800. Ninety-five faults have slipped in late Quaternary time (approximately the past 750,000 yr) and are judged capable of generating future moderate to large earthquakes and displacing the ground surface. Average rates of late Quaternary slip or separation along these faults provide an index of their relative activity. The San Andreas and San Jacinto faults have slip rates measured in tens of millimeters per year, but most other faults have rates of about 1 mm/yr or less. Intermediate rates of as much as 6 mm/yr characterize a belt of Transverse Ranges faults that extends from near Santa Barbara to near San Bernardino. The dimensions of late Quaternary faults provide a basis for estimating the maximum sizes of likely future earthquakes in the Los Angeles region: moment magnitude (*M*) 8 for the San Andreas, *M* 7 for the other northwest-trending elements of that fault system, and *M* 7.5 for the Transverse Ranges faults. Geologic and seismologic evidence along these faults, however, suggests that, for planning and designing noncritical facilities, appropriate sizes would be *M* 8 for the San Andreas, *M* 7 for the San Jacinto, *M* 6.5 for other northwest-trending faults, and *M* 6.5 to 7 for the Transverse Ranges faults. The geologic and seismologic record indicates that parts of the San Andreas and San Jacinto faults have generated major earthquakes having recurrence intervals of several tens to a few hundred years. In contrast, the geologic evidence at points along other active faults suggests recurrence intervals measured in many hundreds to several thousands of years. The distribution and character of late Quaternary surface faulting permit estimation of the likely location, style, and amount of future surface displacements.

An extensive body of geologic and geotechnical information is used to evaluate areal differences in future levels of shaking. Bedrock and alluvial deposits are differentiated according to the physical properties that control shaking response; maps of these properties are prepared by analyzing existing geologic and soils maps, the geomorphology of surficial units, and geotechnical data obtained from boreholes. The shear-wave velocities of near-surface geologic units must be estimated for some methods of evaluating shaking potential. Regional-scale maps of highly generalized shear-wave velocity groups, based on the age and texture of exposed geologic units and on a simple two-dimensional model of Quaternary sediment distribution, provide a first approximation of the areal variability in shaking response. More accurate depictions of near-surface shear-wave velocity useful for predicting ground-motion parameters take into account the thickness of the Quaternary deposits, vertical variations in sediment type, and the correlation of shear-wave velocity with standard penetration resistance of different sediments. A map of the upper Santa Ana River basin showing shear-wave velocities to depths equal to one-quarter wavelength of a 1-s shear wave demonstrates the three-dimensional mapping procedure.

Four methods for predicting the distribution and strength of shaking from future earthquakes are presented. These techniques use different measures of strong-motion severity: seismic intensities, peak horizon-

tal acceleration and velocity (or response spectral values), amplification factors relative to ground motion on bedrock, and time-histories of ground motion.

Maps of predicted seismic intensities for the Los Angeles region are useful for emergency-preparedness planning and for estimating losses from future earthquakes. A computer-based technique for predicting earthquake intensities incorporates (1) a numerical model of the earthquake source, (2) a mathematical expression for the rate of attenuation in the crust of the region, (3) an empirical correlation of geologic ground conditions with differences of expected intensity, and (4) a digitized map of geologic ground conditions for the area studied. Comparison of observed intensities from the 1971 San Fernando earthquake with strong-motion records indicates that intensity correlates directly with expected levels of shaking from 0.5 to 3 Hz (periods of approximately 0.3–2 s), frequencies of concern to ordinary structures. Example applications of the predictive method to the Los Angeles region include predicting intensities for a postulated great earthquake on the San Andreas fault; calculating cumulative maximum intensities for a suite of 87 postulated earthquakes representative of the principal potentially active faults; deducing the likely fault sources for the earthquakes of 1812 from candidate predicted intensity maps; and mapping the estimated root-mean-square acceleration for a potential Los Angeles basin earthquake. The technique of predicting intensities can be extended to estimate losses from future earthquakes by incorporating empirical correlations between observed intensities and percentage of damage experienced by various types of structures. A comparison of predicted losses to wood-frame structures for possible earthquakes shows that a moderate-size earthquake in the Los Angeles basin would cause a much higher loss than a great earthquake on the San Andreas fault.

Predictive mapping of peak horizontal acceleration and velocity and of horizontal response spectral values provides an appraisal of areal shaking potential that is useful for engineering design and building codes. The technique relies on equations derived from regression analyses of an extensive set of strong-motion records. These equations link the ground-motion parameters to earthquake magnitude, source distance, and site conditions. The site effect can be expressed in terms of the shear-wave velocities of near-surface geologic materials. Thus, predictive maps of ground-motion values for a single postulated earthquake can be made by applying the predictive equations and taking into account the areal differences in shear-wave velocities. The uncertainty associated with the frequency of occurrence and the size of future earthquakes from multiple potential sources can be evaluated by means of a newly developed approach that uses fault-slip rates to compute the ground motion that will be exceeded at a specified annual probability. Predictive maps for the upper Santa Ana River basin made by using this method show the areal distribution of ground-motion values exceeded at a return period of 500 yr for future large earthquakes on the San Andreas, San Jacinto, and Cucamonga faults.

Areal variations in shaking potential are also estimated by comparing measurements of ground motions from distant underground nuclear explosions recorded at 98 sites in the Los Angeles region. Because local ground response from these low-strain signals correctly predicts ground-motion amplification for higher strain levels caused by nearby large earthquakes, the data provide a way of assigning amplification factors relative to shaking on crystalline bedrock. At periods less than 0.5 s, the most pronounced differences in observed site responses correlate with differences in sediment void ratios, thicknesses of surficial deposits, and depths to basement rocks; resonant effects having large amplifications over narrow frequency bands are observed for sites underlain by Holocene deposits 10 to 20 m thick. At periods greater than 0.5 s, the most important geologic factors are depth to basement rocks and thickness of Quaternary sediments. When recorded motions are compared with what is known about geologic conditions at each site, the principal factors that affect amplification can be grouped, and distinctive types of sites can be identified through cluster analysis. These site types then become the basis for predictive mapping of relative shaking response. To demonstrate the mapping procedure, the areal distribution of expected amplification factors for part of the Los Angeles basin is shown for three period bands (3.3–10, 0.5–3.3, and 0.2–0.5 s); locally, the spectral amplification is predicted to be as much as 6½ times greater than the shaking levels on crystalline bedrock.

Earthquake-resistant design of critical structures commonly requires elaborate estimates of the characteristics of ground motion at a particular site. Time-histories of ground motion from postulated earthquakes are predicted by estimating how each point on a slipping fault will be displaced, determining the ground motions caused by each point, and then summing the ground-motion contributions from all points to obtain the total motion at a given distant site. The method depends on assumptions concerning the detailed character of the expected rupture propagation and the velocity structure of the Earth's crust in the region analyzed. The time-history of ground motion caused by slip of a single point on a fault is called a Green's function. Green's functions can be determined theoretically by solving the wave equation in a model of the crust, or they may be obtained empirically by using recordings of small earthquakes in the desired crustal structure. Economical methods of computing Green's functions by using simplifying assumptions are reviewed.

Secondary geologic effects such as liquefaction within the alluvial basins and landsliding within the upland areas can be expected as a result of strong shaking during future earthquakes. Liquefaction potential is evaluated by preparing two types of maps—one showing the susceptibility of sediment to liquefy with shaking and the other expressing the probabilities that critical levels of shaking needed for liquefaction will be attained. Areas of susceptible sediments are delineated by analyzing the physical properties of the late Quaternary alluvial deposits, grouping these deposits according to their probable content of cohesionless sand or silt, and determining whether they are saturated with ground water at depths of less than about 15 m. Holocene sand and silt, especially if deposited during the past few hundred years, are the most susceptible to liquefaction-related ground failure; these materials are mapped on the basis of soil-profile development, geomorphic expression, and geotechnical properties such as standard penetration resistance. Areas of the Los Angeles region deemed most vulnerable to liquefaction during future earthquakes include the flood plains of the Los Angeles, Santa Ana, and San Gabriel Rivers; parts of the San Fernando Valley and the Oxnard Plain; coastal and harbor areas of Long Beach and Marina Del Rey; and flood-control basins. The opportunity for liquefaction at a site containing susceptible sediments can be estimated by considering the earthquake potential and applying an empirically determined relation between earthquake magnitude and the limiting distances for liquefaction-related ground failure. Regional liquefaction opportunity is mapped by summing, for points on a map, the expected annual rates of occurrence of earthquakes of M 5 or greater from those fault sources that influence each point. Individual sites will experience ground shaking strong enough to cause liquefaction in susceptible sediment on an average of once every 30 to 50 yr.

The extent and severity of future earthquake-induced slope failure can be fully evaluated only when detailed information about the geologic and topographic controls on slope stability is available. Although such information is not yet complete for the Los Angeles region, a twofold approach has been developed to assess the areal limits of earthquake-triggered landslides for postulated earthquakes of specified size. The maximum distances from an earthquake source at which various classes of landslides can occur (given susceptible slopes) are estimated on the basis of worldwide data for historical earthquakes that have triggered landslides. The probability distribution of threshold levels of shaking capable of triggering slope failure can then be mapped by extending the Newmark method of slope-stability analysis; the procedure depends on newly established correlations between earthquake magnitude, critical displacement of a slope, and intensity of shaking for a given earthquake-source distance. The likelihood of slope failures from a postulated earthquake is evaluated for a sample site in the Santa Monica Mountains.

Faults and zones of potential slope instability on the sea floor off the Los Angeles region have been identified and evaluated by means of specialized remote-sensing methods. Acoustic reflection profiles reveal those faults that offset Quaternary sediments of the sea floor and also show potentially unstable slopes on which subaqueous sediment slides, mass flows, and gas-charged sediments occur. A regional analysis of these profiles indicates offshore counterparts to the onshore faults of the San Andreas system and the Transverse Ranges. Many of these offshore faults may generate moderate to large earthquakes and offset the sea floor. Scattered zones of sea-floor sliding as large as 60 km^2 are mapped along the outer edge of the Santa Monica and San Pedro shelves and cover several hundred square kilometers in the central Santa Barbara Basin. Furthermore, potentially unstable gas-charged sediments apparently are widespread in the Santa Monica and San Pedro Basins. Some zones of sea-floor instability could fail during shaking caused by nearby large earthquakes.

Tsunamis are a threat to coastal areas, although the hazard in the Los Angeles region is much less than that in many other regions along the circum-Pacific border. A number of methods for predicting tsunami wave heights and frequency of occurrence from both distant and local sources are summarized. Predictive models for distantly generated tsunamis indicate that wave heights of 2 m are exceeded on the average of once every 500 yr, except locally along Santa Monica and San Pedro Bays and near Ventura, where wave heights of 3 m are exceeded on the average of once every 500 yr. A preliminary appraisal of the potential for locally generated tsunamis suggests that wave runup heights as great as 4 to 6 m could be caused by sea-floor faulting in the Santa Barbara Channel; wave runup heights no greater than 2 to 3 m are estimated for the dominantly strike-slip faults farther south. Earthquake-triggered sea-floor slides having the dimensions observed in the offshore region are unlikely to cause tsunamis.

To demonstrate the various hazard-evaluation methods discussed in this volume, the geologically controlled effects expected from a postulated M 6.5 earthquake along the northern part of the Newport-Inglewood fault zone are evaluated. Predicted effects include:

1. Secondary faulting (normal-oblique slip) at the ground surface along one or more late Quater-

nary faults exposed in the Baldwin and Rosecrans Hills and possible subsurface slip along reverse faults at the northern end of the Dominguez Hills.

2. Shaking intensities of Modified Mercalli intensity VII distributed widely throughout the Los Angeles basin and the San Fernando Valley and scattered areas of intensity VIII as far as 18 km from the main fault.
3. Strong shaking lasting about 10 to 15 s. Peak ground-motion values of about 0.4 g acceleration, 90 to 100 cm/s velocity, 1.2 g pseudoacceleration response, and 160 to 180 cm/s pseudovelocity response near the earthquake source zone. Peak ground-velocity values at the northwestern end of the fault zone will be higher than those at the southeastern end if the subsurface tectonic rupture propagates northwestward from the postulated epicenter.
4. Liquefaction in highly susceptible, water-saturated, cohesionless Holocene alluvial sediments as much as 18 km from the earthquake source zone.
5. Rock or soil falls and slides, the most common earthquake-triggered slope failures, occurring chiefly in upland areas within about 40 km of the earthquake source zone.
6. Minor harmonic waves (seiches) in enclosed small bodies of water.

Earth-science information can be used by planners, engineers, and decisionmakers to solve specific earthquake-related problems in southern California. Examples of the geologic and seismologic information used and the actions taken to reduce the hazard are discussed for the problems of anticipating damage to critical facilities, adopting seismic safety plans, strengthening highway bridges, regulating development in areas of potential surface faulting, and strengthening or removing unsafe masonry buildings. Effective measures for reducing future earthquake losses can result if adequate scientific data and interpretations are available and are thoughtfully applied by engineers, planners, and others responsible for public safety.

1986 DUES STATEMENT

Dues for the Southern California Section of the Association of Engineering Geologists are now payable to the Treasurer, BOB ZWEIGLER. Your dues are used to pay for postage, printing of the newsletter, publication of field trip guidebooks, secretarial services, and section activities. The Section dues are $13.00 per calendar year ($4.00 for student members). Members who have not paid their dues by April will be dropped from the newsletter mailing list. You must be a member of the Association before you can join the Southern California Section, so be sure to pay your dues their also. Please return this entire form with your check payable to "Southern California Section, Association of Engineering Geologists" directly to the trasurer at the address below. If you have an address change, please notify AEG Headquarters in Short Hills, New Jersey. Thank you for sending your 1986 dues promptly.

NAME________________________ Membership status: M AM SM AF

Indicate Preferred Address

(Home___ Business___) ____________________________________

____

____________________________________ Zip Code______

Telephone ___________________

Please send entire form to : BOB ZWEIGLER
Kovacs-Byer and Associates
11430 Ventura Boulevard
Studio City, California 91064

publication has not been published for several years, but is a valuable reference source to all.

13. U.S.G.S. Professional Paper 1360, edited by J. I. Ziony is now available for puchase for $24.00. Contact Lucy Birdsall.

EMPLOYMENT OPPORTUNITIES

Dunhill, a nation wide recruiting firm, is representing an engineering consulting firm that is searching for two people in the southern California area. Position one: # 1 man to manage southern California office. Experienced CEG, five to seven years as a consultant in ground water pollution studies, groundwater development, and hydrocarbon recovery, salary is open depending on experience. Position #2 would be to assist #1 person, background and experience should be similar to position #1. Salary open, all fees paid by client. Call Billy Logue collect at (405) 848-8981.

Woodward-Clyde Consultants are interviewing engineering geologists with the following qualifications: Minimum of a Masters degree, preferably in engineering geology or geological engineering; 8 to 15 yrs. of experience; California certified engineering geologist; and a strong background in rock and soil mechanics and seismic geology. Interested professionals should send resumes to Mr. Tom Freeman, Woodward-Clyde Consultants, 203 North Golden Circle Dr., Santa Ana, CA 92705 (714) 835-6886

Schaefer Dixon Associates (SDA) has purchased the operating assets of Medall, Worswick & Associates, Inc., and has relocated its head-quarters to Santa Ana, with branch offices in San Diego and Los Angeles. SDA is dedicated to high-quality geotechnical engineering and geologic services, and is seeking applications for Senior Geologist, and Senior Geotechnical Engineer. Applicants must have respective California certification (CEG) and registration (RCE), minimum 10 years± varied experience, particularly in Southern California, and must have excellent oral and written skills. Masters degree preferred.

SDA is also seeking experienced Field Soils Technicians with minimum two years experience--local hillside development experience a plus.

- Salary commensurate with qualifications and experience.
- Excellent benefits package.
- E.O.E., M/F

Please send resume to:

Schaefer Dixon Associates, Inc.
2168 South Hathaway Street
Santa Ana, California 92705
Attention: Bob Lynn or Paul Davis
or call (714) 546-6602

James Shuttleworth
P.O. Box 231,
West Covina, California 91739

VAN NUYS, CA 914
PM
7 FEB
1994

USA 22

PROFESSIONAL SERVICES

PIONEER DRILLING

EXPLORATORY DRILLING
AND
IN-SITU TESTING SERVICES

251 TENNESSEE STREET
REDLANDS, CALIFORNIA 92373 (714) 793-6611

P R O F E S S I O N A L S E R V I C E S

Robert Stone & Associates, Inc.

Engineering Geology • Soil Engineering
Material Testing

Michael Scullin, C.E.G. 170
Vice President & Chief Geologist

15414 Cabrito Rd., Unit A (818) 989-5338
Van Nuys, CA 91406-1439 800-222-5913