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Deadline for submittal to the
February newsletter: January 20

THIS MONTH'S MEETING

January 10, 1995

**Thin-skinned vs thick-skinned interpretation of
seismogenic reverse faults**

presented by

Robert S. Yeats

Reservations must be made by **Tuesday, January 3**

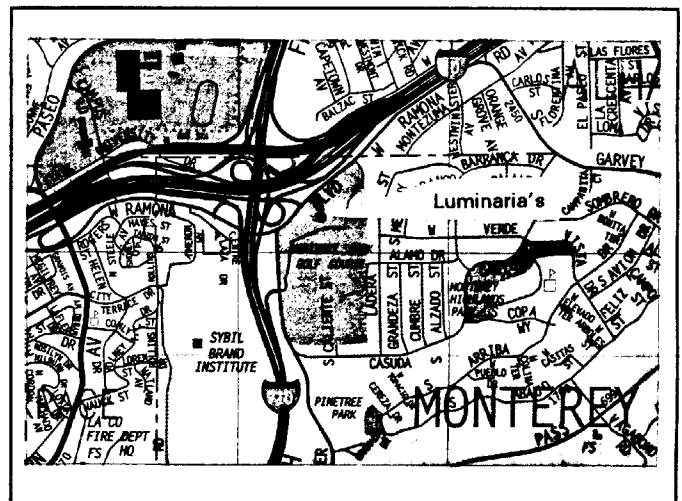
THAT'S TODAY!

by calling GeoSoils at (818) 785-2158

(leave your name and the number of people in your party)

Cost: \$25.00 (full-time students \$15.00)

Map to Meeting



**Luminaria's
Restaurant
3500 Ramona Blvd.
Monterey Park**

**6:00 Social Hour
7:00 Dinner
8:00 Program**

JANUARY PROGRAM

Thin-skinned vs thick-skinned interpretation of seismogenic reverse faults

Robert S. Yeats

*Geosciences, Oregon State University
104 Wilkinson Hall, Corvallis, OR 97331-5506
yeatsr@bcc.orst.edu*

In recent years, a controversy has developed over whether reverse-fault seismic source zones in southern California follow a ramp-and-flat thrust geometry or extend through the brittle crust with a steeper dip. The two alternatives are analogous to a comparison of the thin-skinned Idaho-Wyoming and Sevier thrust belts and the basement-involved reverse faults of the Laramide Rockies of Wyoming to the east. Both structural types comprise major seismic sources.

The best example of a thin-skinned seismic source is the Himalaya of Nepal, northwest India, and adjacent Pakistan. In Pakistan, seismic lines show that active folds near the range front do not involve basement. The Salt Range thrust brings Paleozoic to Pleistocene strata southward over Precambrian basement, with the thrust itself in Eocambrian evaporites. The thrust ramps upward over a pre-existing high angle fault in basement. In India, the M 8 1905 Kangra earthquake (the "mother of all blind-thrust earthquakes") generated highest intensities near the Main Boundary thrust, 75 km north of active anticlines underlain by blind thrusts at the range front. Coseismic leveling changes at the range front are best explained by rupture of the décollement. Interplate instrumental seismicity is highest in a zone 80-100 km north of the range front at, and south of, the inactive Main Central thrust (MCT). Nodal planes are too steep to be explained by displacement above an intact Indian plate. This zone is a thrust ramp, expressed at the surface by high stream gradients near the MCT and uplift rates of the Great Himalaya twice those of the Lesser Himalaya. Himalayan seismic sources of this type exhibit the strongest shaking damage at the epicenter and the greatest amount of tectonic deformation at the range front, 50-100 km to the south. The low dip of the décollement across the Lesser Himalaya results in a large surface-rupture area, large enough to generate earthquakes as large as M8 or larger.

Another thin-skinned source is the April 29, 1991, Racha earthquake (M_s 7) in the Greater Caucasus at 3-10 km depth on a thrust fault dipping 20-30° N. Repeated earthquakes on this structure have uplifted the 1500-m Racha ridge as Greater Caucasus structures were thrust over a basement massif to the south.

Other thin-skinned seismogenic regions are the Subandean Cordillera of eastern Bolivia and the Sulaiman Range of Pakistan. If the décollement is too shallow, as in Papua New Guinea and the Zagros, seismicity develops beneath the thin-skinned belt in reverse faults cutting basement. In these cases, the thin-skinned province directly overlies the thick-skinned province. In California, the Oak Ridge fault flattens into a décollement in Miocene Rincon Shale near

the coast and ramps upward beneath the Ventura Avenue-San Miguelito active anticline. An earthquake on the Oak Ridge fault near the coast would produce strong ground accelerations at rock sites in the Oxnard Plain and surface deformation (but probably not surface faulting) in the anticlines to the north. The Coalinga-Kettleman Hills fold belt, like Racha Ridge, may also be underlain by a low-angle thrust; nodal planes of earthquakes tend to be flatter with increasing depth.

In contrast, seismicity shows that the Red Mountain, Santa Susana, San Fernando, and Northridge faults do not change their dips throughout the seismogenic zone. Convergence rates across the Ventura basin based on GPS agree with geological rates if the Oak Ridge and San Cayetano faults continue into the lower crust as ductile shear zones, and the ductile crust deforms and thickens by pure shear. The Ventura and LA basins are characterized by downward displacement of crust as well as horizontal convergence accommodated across reverse and strike-slip faults. Downward displacement is not explained by two-dimensional kinematic models of low-angle thrusting within the brittle crust, which should require uplift at thrust ramps and at flats behind the ramps. In addition, many and perhaps all of the major seismogenic reverse faults follow pre-existing zones of weakness such as Miocene normal faults.

Surface deformation (uplift and flexural-slip faulting at Northridge) is updip from the epicentral region of greatest shaking, but the offset between maximum ground accelerations and maximum surface deformation is in kilometers, not tens of kilometers as in ramp-and-flat thrust sources.

Most reverse-fault earthquakes of the last 30 years occurred in range-and-basin provinces, a term coined in New Zealand to explain the alternation of ranges and basins bounded by reverse faults in Central Otago, in contrast to the Basin-and-Range Province of the western U.S., where normal faults predominate. In both normal- and reverse-fault provinces, range-front faults continue through the brittle crust, with controversies about whether or not faults flatten in dip below the seismogenic zone. Other range-and-basin provinces and their attendant reverse-fault earthquakes are Nelson-Biller in northwestern South Island, New Zealand (1929 Murchison and 1968 Inangahua earthquakes), Pampean Andes of northwest Argentina (1944 San Juan and 1977 Caucete earthquakes), northern Tianshan of Kyrgyzstan (1992 Susamyrt earthquake), northern Honshu (1896 Riku-u earthquake), and Khorassan, northeastern Iran (1947 and 1968 Ferdows and 1978 Tabas-e Golshan earthquakes). Range-and-basin provinces are characterized by ranges with a low ratio of



length to width (aspect ratio) in comparison with thin-skinned belts. Oak Ridge, Santa Susana Mountains, Santa Monica Mountains, and San Gabriel Mountains have low aspect ratios; in contrast, the central Coast Range and the western Santa Ynez Mountains have higher aspect ratios, more typical of thin-skinned structures. This may also be the case for the eastern Tianshan of Xinjiang Province, China.

Clearly, the thrust-ramp thin-skinned cross sections in southern California presented by John Suppe and his colleagues are kinematically admissible and, indeed, elegant in their construction. For their structural interpretation to result in a paradigm change for southern California, however, it is necessary to document thin-skinned structures by (1) instrumental seismicity, (2) deep seismic profiles, and (3) evidence for ramp-and-flat thrust structures in crystalline basement in deeply-exhumed reverse-fault provinces. None of this has been done. In thin-skinned fold thrust belts, including the Appalachians, Cordillera, and the Himalaya, the flats follow strata of low strength, whereas thin-skinned cross sections in southern California show thrusts that cross at a low angle strata with the same mechanical properties.

Ramp-and-flat thrusts require backlimbs, and the Las Cienegas uplift and the San Gabriel and Topatopa Mountains lack backlimbs.

Fault-bend fold interpretations are strengthened by evidence of growth triangles in which strata roll abruptly through kink bands; dip of strata in a growth triangle tend to be the same from bottom to top. In contrast, the flanks of the Oak Ridge fault and Las Cienegas blind fault (Monocline fault) are characterized by beds that increase in dip with depth, suggesting a relatively steep fault dip and growth by progressive limb rotation rather than kink-bank migration. Growth strata on the flanks of the Las Cienegas structure show a dip of the blind fault of 61-62°.

Postscript. The high dip-slip rate of 3.9-5.9 mm/yr claimed for the Elysian Park thrust beneath the Santa Monica Mountains (SMM) is not supported by geomorphic or subsurface data. Evidence for this slip rate must come from the Santa Monica and Sawtelle plains, north of which the SMM range front is deeply embayed, suggesting that it is tectonically inactive. Active scarps of the Santa Monica fault are found within the plain, not at the SMM range front. At Potrero Canyon, near the coast, this fault offsets the Stage 5e terrace with a slip rate of about 0.5 mm/yr in the last 125 ka, if the fault dips 45° N. Older wave-cut platforms are preserved at altitudes up to 183 m and possibly up to 326 m.

Uplift of the SMM could account for another 0.5 mm/yr on a blind thrust, since the Stage 5e platform gradient is 1.5-6° in comparison with the modern platform gradient of 1-2°, evidence of southward tilting. However, the range profile is asymmetric with a steeper north slope, whereas the south slope should be steeper if the topography is controlled by the blind Elysian park thrust. Data from oil wells south of the SMM range front show that most of the folding and thrusting is Pliocene and early Pleistocene, involving the Repetto and Pico formations, not younger Quaternary deposits. There is an unknown amount of Quaternary strike slip on the Hollywood, Santa Monica, and Malibu Coast faults, however.

Dr. Robert S. Yeats received his BS in Geography at the University of Florida, and his PhD in Geology at the University of Washington. His work experience is as follows:

10 years with Shell Oil Co. in southern California in Ventura, the

Los Angeles basin, and offshore.

Ohio University, 1967-1977. Began research project in seismically active reverse faults after the 1971 San Fernando earthquake.

Oregon State University, 1977-present. Chairman of Geology Department 1977-85. Dr. Yeats and his students have mapped subsurface and surface geology from Santa Barbara to San Fernando and in the northern LA basin, supported mainly by NEHRP and oil companies. Working in active tectonics of the Cascadia subduction zone since 1990. Focus on folding: (1) flexural slip and bending moment faults associated with folding, then (2) surface expression of blind reverse faults. Recent papers on Santa Susana and Red Mountain faults (1987), Oak Ridge fault (1988), East Ventura basin (1994), and Northridge blind thrust (Nature, in press).

Worked in Himalaya of Pakistan and India 1978-present, New Zealand 1983-84, Japan 1992, also shorter excursions to active faults in China and Italy.

Chairman, Task Group on Paleoseismology, Inter-Union Commission on the Lithosphere 1990-present.

Author of a textbook, Geology of Earthquakes, by R.S. Yeats, K.E. Seih, and C.R. Allen to be published in 1995 by Oxford University Press. φ

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CHAIRPERSON'S COLUMN

by Robert A. Larson

About 75 people attended our December meeting at the Quiet Cannon in Montebello. Dr. Tom Henyey from the USC/Southern California Earthquake Center discussed how researchers at the Center are completing a probabilistic seismic hazard model for Southern California. Much of the information they have compiled and analyzed should be available early next year. Dr. Henyey is interested in setting of a workshop for about 30 of our members with the Center's researchers. The workshop would allow interaction between the researchers and the practitioners and will be our chance to inform them of what kind of information would be useful and in what format it should be made available. If you are interested in attending a workshop like this, please let me know. Hopefully, we will be able to expand the program into a short course or two that can have a larger attendance.

The Quiet Cannon wasn't very quiet; our speaker had to compete with loud music again. So we will be having our meetings at a different place. For January we will be at Luminaria's. If you have a strong preference for a meeting place please let me know as soon as possible as I will be setting up the meeting schedule for next year very soon.

For those of you who are interested, you have until January 17, 1995 to file an application for certification as Hydrogeologist with the Board of Registration. As of December 22, 1995 the Board had received 650 requests for the application. Starting with the March exam, applicants will only be able to take one test per exam period. That means you cannot take the RG exam one day and the CEG or CHG exam the next day. You must be a registered geologist before you can take the certification tests.

In order to represent the membership I must know what you think of a variety of potential actions. A poll is included in this newsletter. Please return this poll to me by January 15, 1995. The results will be published in the next newsletter.

You have all received your dues statements by now. Please pay before the New Year so that you will be listed in the Directory. If you have a change of address or phone number, please send the information to our newsletter editor as well as national headquarters.

Next year's annual meeting is in Sacramento and the Sacramento Section is looking for volunteers. If you would like to help, please call James Parsons at (916) 424-4950.

I wish all of you all Happy Holidays!

φ

MEETINGS, FIELD TRIPS, ETC.

JANUARY

- 17-20 The California Office of Emergency Services (OES) is planning a conference titled **Northridge Earthquake One Year Later** to be held in Los Angeles. For information on the conference and for registration materials, contact OES at 818/304-8379
- 26-27 **Advanced Environmental Laws and Regulations**, Short Course, Orlando, FL. Government Institutes, Inc., Suite 200, 4 Research Place, Rockville, MD 20850. Phone 301/921-2345, fax: 301/921-0373.

FEBRUARY

- 8-11 47th EERI Annual Meeting: Interdisciplinary Mitigation, Sheraton Palace Hotel, San Francisco. For information contact EERI, 499 14th Street, Suite 320, Oakland, CA 94612-1934. Sorry, no phone # given.
- 16 The Branner Club, Cal Tech, Mr. John Koivula of the Gemological Institute of America will speak on **Inclusions in Minerals and What They Tell Us**. For reservations call Martine Alter at 818/248-7715.
- 20-21 **Environmental Site Assessments**, Short Course, Orlando, FL. Government Institutes, Inc., Suite 200, 4 Research Place, Rockville, MD 20850. Phone 301/921-2345, fax: 301/921-0373.

FOR THE RECORD

The Los Angeles Times (December 17, 1994) reports that **Henry H. Neel**, author of *The History of the Registration of Geologists in California* reprinted in the November AEG Newsletter, died peacefully in his west Los Angeles home on December 14, 1994, at the age of 81. He was a prominent southern California geologist, a local oil executive, a member of the Jonathan Club, the Wildcaters, and the Los Angeles Petroleum Club. He is survived by his loving wife of 59 years, three sons, six grandchildren, and two great-grandsons. The family wishes contributions sent to either the R.M. Pyles Boys Camp, or Stanford University School of Earth Sciences.

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22	John Vasconcellos, D	49	Diane Martinez, D	76	Susan Davis, D
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25	George House, R	52	Willard Murray, D	79	Denise Ducheny, D
26	Sal Cannella, D	53	Debra Bowen, D	80	Jim Battin, R
27	Bruce McPherson, R	54	Steve Kuykendall, R		

1995 SENATE ROSTER

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4	Maurice Johannessen, R	18	Jack O'Connell, D	31	Bill Leonard, R
5	Pat Johnston, D	19	Cathie Wright, R	32	Rob Hurtt, R
6	Leroy Greene, D	20	Herschel Rosenthal, D	33	John Lewis, R
7	Daniel Boatwright, D	21	Newton Russell, R	34	Ruben Ayala, D
8	Quentin Kopp, I	22	Richard Polanco, D	35	Marian Bergeson, R
9	Nicholas Petris, D	23	Tom Hayden, D	36	Ray Haynes, R
10	Bill Lockyer, D	24	Hilda Solis, D	37	David Kelley, R
11	Tom Campbell, R	25	Teresa Hughes, D	38	William Craven, R
12	Dick Monteith, R	26	Charles Calderon, D	39	Lucy Killea, I
13	Alfred Alquist, D	27	Robert Beverly, R	40	Steve Peace, D
14	Ken Maddy, R				

Addresses are as follows:

Senator or The Honorable _____
State Capitol
Sacramento, CA 95814

MEMBERSHIP POLL
SOUTHERN CALIFORNIA SECTION OF THE AEG

Please complete the following poll and mail it by January 15, 1995 to the address below. You must be a current Member, Associate Member, Student Member, Emeritus Member, or Honorary Member to vote. Return to Robert A. Larson, Chairperson - SCS, 6416 Woodley Ave., #5, Van Nuys, CA 91406.

Member's name _____ Phone number _____

Membership class M AM SM EM HM

1. Do you oppose the elimination (sunsetting) of the California Board of Registration for Geologists and Geophysicists in 1997?
 Yes No
2. Do you support some form of continuing education requirement in order to renew your geologist registration with the California Board of Registration for Geologists and Geophysicists?
 Yes No
3. Do you support some form of requirement to retest registered geologists every few (5?) years in order to maintain their registration with the California Board of Registration for Geologists and Geophysicists?
 Yes No
4. Do you support strong, but fair enforcement actions by the California Board of Registration for Geologists and Geophysicists against registered geologists who violate State law?
 Yes No
5. Are you willing to volunteer to contact legislators about laws and regulations that affect your work as a geologist and our profession?
 Yes No
6. Are you willing to donate money to partially offset the expenses of those members who are willing to volunteer to work with legislators on laws and regulations that affect your work as a geologist and our profession?
 Yes No
7. Are you willing to volunteer to serve on any of the following committees? If Yes, please check any you are interested in.

 Field Trip Short Course Education
 Legislation Registration Membership
 Publications
8. Do you support the USGS and the Bureau of Mines in their fight against being eliminated or having major decreases in funding?
 Yes No

Congress Threatens to Abolish U.S. Geological Survey and U.S. Bureau of Mines

Craig M. Schiffries
American Geological Institute

The U.S. Geological Survey and the U.S. Bureau of Mines are facing one of the most serious challenges in their history. Both agencies have been targeted for complete elimination according to an attachment to the *Contract with America*. The *Contract* contains a package of 10 bills that 224 Republican members of Congress have pledged to introduce in the first 100 days of the new Congress. The attachment identifies \$176 billion in possible spending cuts over five years. Although many programs would be reduced, restructured, or frozen, the USGS and the USBM are among a handful of organizations that would be abolished.

"We are deeply concerned about the *Contract with America* proposal, because it reflects a lack of understanding about the broad range of scientific activities conducted by the U.S. Geological Survey, as well as our active role within all 50 states," says Gordon P. Eaton, director of USGS. "We serve as the archivist of this nation's Earth resources -- monitoring the rivers, for example, and helping to maintain healthy water standards. Our geoscientists help citizens prepare for emergencies such as earthquakes and floods; and we address the challenges of sustainable development of our oil, gas, and minerals resources. In fact, the USGS touches the lives of every American citizen every day."

The geosciences would adsorb a disproportionate share of spending cuts relative to other scientific disciplines, and the U.S. Geological Survey and the U.S. Bureau of Mines would take the most direct hits. Abolishing the USGS ranks as the fifth largest cut among all discretionary programs in the federal budget. Eliminating the USGS represents the largest single reduction for any science and technology program.

Congressional staff members indicate that abolishing the U.S. Geological Survey might be accomplished by transferring some of its functions to other organizations. They suggest that some programs in the water resources division might go to the Environmental Protection Agency. Likewise, certain functions of the national mapping division might move to the Defense Mapping Agency or to the private sector, while some functions of the geologic division might be transferred to universities. But shifting programs from one agency to another would offset some of the proposed savings, and no estimate of the net savings has been made available. It is unlikely that other organizations would pick up these programs at no expense to the nation.

Rep. John R. Kasich (R-Ohio) is a key figure behind the proposal to abolish the USGS and the USBM. Last year, Rep. Kasich cosponsored an amendment that would have eliminated the two agencies, a proposal included in a package of numerous budget cuts. Although his amendment was rejected by the House of Representatives last year, Kasich is in a much stronger position to pass these measures now that he has become chairman of the House Budget Committee and Republicans control both the House and the Senate.

The Clinton Administration has made clear its support of the USGS and the USBM. Secretary of the Interior Bruce Babbitt has said, "The USGS is the nation's premier water and earth-science

information agency, and its role is increasingly important at a time when we are facing many critical decisions on the environment." Last August, Secretary Babbitt stated, "This Administration is firmly committed to maintaining a strong, viable, U.S. Bureau of Mines in the Department of the Interior." In October, when Rhea L. Graham was sworn in as director of the USBM, she said, "I believe that the agency has a vital role to play in helping the nation solve its mineral-related problems -- problems that involve our environmental and economic goals as well as basic human issues such as worker health and safety."

It is ironic that Congress is considering legislation to abolish the USGS and the USBM at a time when the United States is beginning to recognize its increasing vulnerability to earthquakes, floods, droughts, water pollution, volcanic eruptions, global environmental change, contamination from waste disposal, and reliance on unstable sources of foreign oil and minerals.

Geoscience research and information play vital roles in an ever-growing range of societal problems. Federal investments in geoscience research and information continue to pay enormous dividends. Although the rationale for supporting the USGS and the USBM remains strong, Congress and the public are not generally aware of their relevance to a broad range of national goals. Over 100 years ago, the USGS was established without fanfare -- created by an amendment to another bill. Today, the agency stands in danger of being dismantled in much the same way it was created.

Possible Spending Cuts for the Contract with America
(projected savings in billions of dollars over five years)

Proposal	Estimated Savings
Abolish the U.S. Geological Survey	3.261
Abolish U.S. Bureau of Mines	0.872
Abolish National Biological Survey	0.139
Eliminate the Advanced Technology Program	0.819
Downsize Minerals Management Service	0.465
Reduce funding for Energy Technology Development	2.139
Reduce overhead rate for university research	1.620
Freeze funding for NOAA	0.805
Halt purchases of oil for Strategic Petroleum Reserve	0.362
Restructure the Naval petroleum reserves (Elk Hills)	0.143
Restructure Bureau of Reclamation	0.427
De-Emphasize permanence in Superfund clean-ups	1.140
Limit rate of growth of National Science Foundation	0.346


Source: House Budget Committee Republican Staff

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Charles Nestle
AEG Newsletter Editor
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FIRST CLASS POSTAGE

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GEOQUOTE OF THE MONTH

HELP! I've run out of quotes for this section of the newsletter! I DO have a collection of amusing typos and errant statements from consultant's reports, but I would just hate to have to use those here. So send in your suggestions right away.

Ed.

WRITE TO THE NEWSLETTER EDITOR

If you have a suggestion for "Geoquote of the Month", or if you have any news items, short articles (or long if space is available), commentary, suggestions, gripes, complaints, book reviews, software reviews, or whatever, and you would like to share them with your colleagues via the AEG Southern California Section Newsletter, send it to the Newsletter Editor at the address below, or on the internet at ctnestle@aol.com. Longer works are preferred on floppy disk, formatted by any DOS or Windows-based word processor (If you have a MAC, please save your work as an ASCII file or in a DOS format that I can retrieve). Diskettes will be

returned if requested. Please include your phone number in case I have a question.



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