Final Technical Report

United States Geological Survey

National Earthquake Hazards Reduction Program - External Research Grants

Award Number 08HQGR0140

Third Conference on Earthquake Hazards in the Eastern San Francisco Bay Area: Science, Hazard, Engineering and Risk

Conference Dates: October 22nd-26th, 2008

Location: California State University, East Bay

Principal Investigator: Mitchell S. Craig

Department of Earth and Environmental Sciences

California State University, East Bay

Submitted March 2010

Summary

The Third Conference on Earthquake Hazards in the Eastern San Francisco Bay Area was held October 22nd-26th, 2008 at California State University, East Bay. The conference included three days of technical presentations attended by over 200 participants, a public forum, two days of field trips, and a one-day teacher training workshop. Over 100 technical presentations were given, including oral and poster presentations. A printed volume containing the conference program and abstracts of presentations (attached) was provided to attendees. Participants included research scientists, consultants, emergency response personnel, and lifeline agency engineers. The conference provided a rare opportunity for professionals from a wide variety of disciplines to meet and discuss common strategies to address region-specific seismic hazards. The conference provided participants with a comprehensive overview of the vast amount of new research that has been conducted and new methods that have been employed in the study of East Bay earthquake hazards since the last East Bay Earthquake Conference was held in 1992. Topics of presentations included seismic and geodetic monitoring of faults, trench-based fault studies, probabilistic seismic risk analysis, earthquake hazard mapping, and models of earthquake rupture, seismic wave propagation, and ground shaking. Updated estimates of economic losses due to a major earthquake in the East Bay were presented. Engineering studies included examples of seismic design and retrofit of buildings, pipelines, and public transit facilities. The vulnerability of water infrastructure in the Sacramento Delta to seismic shaking was discussed.

A public forum was held one evening of the conference to provide information to the general public in an accessible form. Numerous public agencies staffed information tables and provided information and educational materials on earthquake preparedness. Representatives from news

media, including a local television station, attended a press conference and portions of the technical sessions. The conference was coordinated with numerous other local activities held over a period of several months to raise public awareness of the 140th anniversary of the 1868 earthquake on the Hayward fault, and the high probability of another major earthquake on the fault in the near future.

Field trips were conducted during the weekend following the conference to 1) the northern Hayward fault, 2) the southern Hayward fault, and 3) the stepover between the Hayward and Calaveras faults. A total of 44 people attended field trips.

A one-day teacher training workshop on earthquake hazards held after the conference was attended by 19 teachers from local public schools. The workshop included lectures and demonstrations in the morning, and a field trip of the Hayward fault in the afternoon. The workshop included material on the new California science content standards related to plate tectonics and earthquakes.

The conference was made possible through the generous efforts of many organizations and individuals. Online abstract submissions were managed by the Seismological Society of America. The conference website was provided by the California Geological Survey. Check-in, onsite registration desks and projection equipment were staffed by CSUEB students and staff. Pre-registration and credit card transactions were handled by campus bookstore staff, courtesy of Follett Higher Education Group. Vehicles and drivers for field trips were provided by CSUEB. The Incorporated Research Institutions for Seismology (IRIS) provided materials for the teachers workshop.

The conference schedule, list of sponsors, and abstracts of presentations are included in the Conference Program with Abstracts immediately following this summary. A list of participants in the conference is provided at the end of the abstracts, followed by photographs of conference activities. A flier describing the teacher training workshop and a list of teacher participants are located at the end of the report.

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CONFERENCE PROGRAM WITH ABSTRACTS

THIRD CONFERENCE ON EARTHQUAKE HAZARDS IN THE EASTERN SAN FRANCISCO BAY AREA

SCIENCE, HAZARD, ENGINEERING AND RISK

October 22-24, 2008
140th Anniversary of the 1868 Earthquake
California State University East Bay

Cover photos from the University of California Bancroft Library and the U.S. Library of Congress online archives.

Introduction

The Third Conference on Earthquake Hazards in the Eastern San Francisco Bay Area follows successful conferences held at California State University, East Bay in 1982 and 1992. The purpose of this conference is to synthesize and make public information on the earthquake science, hazard, engineering, and risk in the Eastern San Francisco Bay Area that has been developed since the 1992 conference. The activities and publications take advantage of interest in earthquake hazards and risk generated by the 140th anniversary of the 1868 Hayward fault earthquake (October 21).

Conference Sponsors

Our appreciation to the conference sponsors with special thanks to the U.S. Geological Survey (Tom Brocher and Elizabeth Lemersal) for an important NEHRP grant to support the conference.

California Geological Survey
California State University, East Bay
Earthquake Engineering Research Institute – Northern California Chapter
Seismological Society of America
Structural Engineers Association of Northern California
University of California at Berkeley
URS Corporation
U.S. Geological Survey

Morning and afternoon breaks are made possible in part by contributions from Chevron, Exponent, University of California at Berkeley, and URS Corporation.

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Third Conference on Earthquake Hazards in the Eastern San Francisco Bay Area
Science, Hazard, Engineering, and Risk
CSU East Bay, October 22-26, 2008
Technical Program

Wednesday October 22, 2008

8:00 am – 8:20 am	Welcome
8:20 am – 10:00 am	Seismotectonics of the Eastern San Francisco Bay Area
10:00 am – 10:40 am	Break and Poster Viewing
10:40 am – 11:40 am	Seismotectonics of the Eastern San Francisco Bay Area (*Continued*)
11:40 am – 1:00 pm	Lunch and Poster Viewing
1:00 pm – 3:00 pm	Hayward-Rodgers Creek Fault
3:00 pm – 3:30 pm	Break and Poster Viewing
3:30 pm – 5:30 pm	Hayward-Rodgers Creek Fault (*Continued*)
8:00 am – 5:30 pm	Posters**:** Hayward Fault

Thursday October 23, 2008

8:00 am – 9:50 am	Calaveras Fault
9:50 am – 10:20 am	Break and Poster Viewing
10:20 am – 11:20 am	Calaveras Fault (*Continued*)
11:20 am – 1:00 pm	Lunch and Poster Viewing
1:00 pm – 3:10 pm	Other East Bay Faults
3:10 pm – 3:40 pm	Break and Poster Viewing
3:40 pm – 5:00 pm	Other East Bay Faults (*Continued*)
8:00 am – 5:00 pm	Posters**:** Calaveras fault; Other East Bay Faults and Other Hazards
7:00 pm – 9:00 pm	Public Forum and Free Public Lecture

Friday October 24, 2008

8:00 am – 8:50 am	Sacramento – San Joaquin Delta
8:50 am – 9:50 am	2008 Wenchuan Earthquake
9:50 am – 10:30 am	Break and Poster Viewing
10:30 am – 11:50 am	Strong Ground Motion
11:50 am – 1:00 pm	Lunch and Poster Viewing
1:00 pm – 2:55 pm	Earthquake Engineering and Risk, Disaster Preparedness, and Outreach
2:55 pm – 3:25 pm	Break and Poster Viewing
3:25 pm – 4:55 pm	Earthquake Engineering and Risk, Disaster Preparedness, and Outreach (*Continued*)
8:00 am – 5:00 pm	Posters**:** Seismotectonic Setting; Delta Hazard and Risk; Strong Ground Motions; Earthquake Engineering and Risk, Disaster Preparedness, and Outreach
4:55 pm – 5:00 pm	Closing

Saturday October 25, 2008

8:00 am – 5:00 pm	Field Trips
	Southern Hayward Fault
	Calaveras Fault

Sunday October 26, 2008

8:00 am – 5:00 pm	Field Trips
	Northern Hayward Fault
	Hayward/Calaveras Stepover

Wednesday Morning			
	8:00	Welcome and Opening Remarks	KNUDSEN, K.L., URS Corporation, 1333 Broadway, Suite 800, Oakland, CA, 94612, keith_knudsen@urscorp.com
Seismotectonics of the Eastern San Francisco Bay Area Moderator: K. Knudsen			
1	8:20	Seismic Hazards in the Eastern San Francisco Bay Area, California (*Invited*)	BROCHER, T.M., U.S. Geological Survey, 345 Middlefield Road, MS 977, Menlo Park, CA 94025, brocher@usgs.gov
2	8:45	Space Geodetic Observations of Active Deformation in the Eastern San Francisco Bay Area (*Invited*)	BURGMANN, R., Department of Earth and Planetary Science and Berkeley Seismological Laboratory, University of California, Berkeley, CA 94720-4767, burgmann@seismo.berkeley.edu
3	9:10	East Bay Seismicity, An Overview (*Invited*)	HARDEBECK, J. L., U.S. Geological Survey, Menlo Park, CA, 94205, jhardebeck@usgs.gov.
4	9:35	San Francisco Bay Area Paleoseismology: A Perspective (*Invited*)	SCHWARTZ, D.P., USGS, Menlo Park, CA 94025, dschwartz@usgs.gov
10:00 – 10:40 Break and Poster Viewing			
5	10:40	Earthquake Early Warning for California	HELLWEG, M., ALLEN, R.M., BROWN, H. and NEUHAUSER, D., Berkeley Seismological Laboratory, UC Berkeley, CA 94720, U.S.A., peggy@seismo.berkeley.edu
6	11:00	Probabilistic Seismic Hazard in the San Francisco Bay Area Based on Seismicity Simulation	POLLITZ, F.F., US Geological Survey, 345 Middlefield Rd., MS 977, Menlo Park, CA 94025 United States
7	11:20	A High-Resolution Borehole Fault Monitoring System in the San Francisco Bay Region	JOHNSTON, M.J.S., LANGBEIN, J., MYREN, G.D. AND SILVERMAN, S., U.S. Geological Survey, Menlo Park, CA 94025
11:40 – 1:00 Lunch and Poster Viewing			
Wednesday Afternoon			
Hayward Fault Moderator: J. Hardebeck			
1	1:00	The Hayward Fault: Its Past Large Earthquakes and Ongoing Creep (*Invited*)	LIENKAEMPER, J. J., U.S. Geological Survey, Menlo Park, CA 04025; WILLIAMS, P.W., Dept. Geological Sciences, San Diego State Univ., San Diego, CA 92182; MCFARLAND, F.S., ENSR/AECOM, 300 Lakeside Drive, Ste. 220, Oakland, CA 94621; CASKEY, S.J., Department of Geosciences, San Francisco State University, San Francisco, CA 94132
2	1:25	Hayward Fault Earthquake - Who Will Pay? (*Invited*)	ZOBACK, M.L., GROSSI, P., WILLIAMS, C., SAVY, J., and BOISSONNADE, A., Risk Management Solutions, 7015 Gateway Boulevard, Newark, CA 94560, marylou.zoback@rms.com
3	1:50	The Earthquake of 1868 and the Birth of Seismically-Resistant Architecture and Engineering in San Francisco (*Invited*)	TOBRINER, S., Professor Emeritus, History of Architecture, University of California, Berkeley, 232 Wurster Hall, 94720, tobriner@berkeley.edu.

Hayward Fault (*continued*)			
4	2:15	Ground Motion Simulations of Scenario Earthquake Ruptures of the Hayward Fault (*Invited*)	AAGAARD, B., U.S. Geological Survey, Menlo Park (USGS); GRAVES, R., URS Corporation, Pasadena; LARSEN, S., Lawrence Livermore National Laboratory (LLNL), MA, S., Stanford University, RODGERS, A.; LLNL, BROCHER, T., USGS, GRAYMER, R., USGS; HARRIS, R., USGS; LIEMKAEMPER, J., USGS; PONCE. D., USGS; SCHWARTZ, D.P., USGS; SIMPSON, R., USGS; SPUDICG, P., USGS; DREGER, D., U.C. Berkeley; PETERSSON, A., LLNL; and BOATWRIGHT, J., USGS
5	2:40	Earthquake Stress Drops and Inferred Fault Strength on the Hayward Fault	HARDEBECK, J.L., U.S. Geological Survey, Menlo Park, CA, 94025, jhardebeck@usgs.gov; ARON, A., Brown University, Providence, RI, 02912.
3:00 – 3:30 Break and Poster Viewing			
6	3:30	Rate Constraints for the Northern Hayward Fault at Berkeley: Evaluation of the 335-Meter Strawberry Creek Offset	WILLIAMS, P.L., San Diego State University, San Diego, CA, 92182-1020, plw3@earthlink.net
7	3:50	Earthquake Recurrence on the South Hayward Fault is Most Consistent with a Time-Dependent, Renewal Process	PARSONS, T., U.S. Geological Survey, MS-999, 345 Middlefield Rd., Menlo Park, CA, 94025
8	4:10	Predicted Liquefaction in the Greater Oakland Area and Northern Santa Clara Valley During a Repeat of the 1868 Hayward Fault (M6.7-7.0) Earthquake	HOLZER, T.L., NOCE, T.E., and BENNETT, M.J., U.S. Geological Survey, Menlo Park, CA, 94025, tholzer@usgs.gov
9	4:30	Seismic Upgrade of Pipes Across the Hayward Fault	EIDINGER, J. M., G&E Engineering System Inc., eidinger@GEEngineeringSystems.com
10	4:50	Status and Needs for Seismic Instrumentation of Structures Along the Hayward Fault	CELEBI,M., USGS, Menlo Park, CA. 94025, celebi@usgs.gov
11	5:10	Labor Market Risk of a Magnitude 6.9 Earthquake on the Hayward Fault, East San Francisco Bay Region, California	BAHLS, D., California Employment Development Department, Sacramento, CA, 95814, Donna.Bahls@Edd.ca.gov; HOLDEN, R., U.S. Department of Labor, Bureau of Labor Statistics, San Francisco, CA, 94103, Holden_R@bls.gov; REAL, C., California Geological Survey, Sacramento, CA, 95814,Chuck.Real@Conservation.ca.gov
8:00 – 5:30 Wednesday – Posters			
Hayward Fault			
1		3D Spontaneous Rupture Models of Large Earthquakes on the Hayward Fault, California	BARALL, M., Invisible Software, San Jose CA, mbinv@invisiblesoft.com; HARRIS, R.A., SIMPSON, R.W., U.S. Geological Survey, Menlo Park CA 94025, harris@usgs.gov, simpson@usgs.gov
2		The 'Creepy' Hayward Fault and the 'Piedmont Patch' - Mythology, Problems in Seismicity and Forecast Scenarios	BAUBLITZ, M.T., GeoBlitz,Inc., Applied Geographer/Geo-liaison/Arts&Science Fundraiser, Oakland, CA 94610, blitztravel@sbcglobal.net
3		The Distribution of Modified Mercalli Intensity for the 1868 Hayward Earthquake	BOATWRIGHT, J., and BUNDOCK, H., US Geological Survey, Menlo Park, CA 94025
4		Elastic Rebound Effects to be Expected in the Near Field During the Next Major Earthquake Along the Hayward Fault	BORCHARDT, G., Soil Tectonics, P.O. Box 5335, Berkeley, CA 94705, gborchardt@usa.net

Hayward Fault (*continued*)			
5		Probabilistic Fault Displacement Hazard on the Hayward Fault Near Oakland, California	CHEN, R., WILLS, C.J., BRYANT, W.A., 801 K Street, Sacramento, CA 95814, DAWSON, T., California Geological Survey, 345 Middlefield Road, MS 520, Menlo Park, CA 94025; and PETERSON, M.D., USGS, Denver Federal Center, MS 966, Box 25046, Denver, CO 80225
6		Unnamed Volcanics in the East Bay Hills and Implications on Long-Term Displacement on the Hayward Fault Zone	FAY, R.P., Strayer, L.M., and Allen, J.R., CSU East Bay, Dept. of Earth and Environmental Sciences, 25800 Carlos Bee Boulevard, Hayward, CA., rfay@horizon.csueastbay.edu, luther.strayer@csueastbay.edu, james.allen@csueastbay.edu
7		Balance Between Fault Rate, Locked Area, Magnitude, and Recurrence Interval on the Southern Hayward Fault	GRAYMER, R.W., U.S. Geological Survey, Menlo Park, CA, 94025, rgraymer@usgs.gov
8		Geology of the Hayward Fault Zone Exposed in the Claremont Bypass Tunnel, Berkeley, California	HALL, N. T., thall@geomatrix.com; TRAUBENIK, M. L., mtraubenik@amec.com, AMEC Geomatrix Inc., Oakland, CA 94612; WESLING, J. , john.wesling@conservation.ca.gov, Dept. of Conservation, Sacramento, CA 95814; BROWN, J., EPC Consultants, San Francisco, CA 94104, geojustinb@yahoo.com; CAULFIELD, J. R., Jacobs Associates, San Francisco, CA 94104, caulfield@jacobssf.com; TSZTOO, D. F., davidtsztoo@comcast.net, SHASTID, T.B., tshastid@ebmud.com; East Bay Municipal Utility District, Oakland, CA 94623
9		Airborne Laser Swath Mapping (ALSM)-Based Ground Mapping of the Southern Hayward Fault	MYNATT, I., Stanford University, Stanford, CA 94305, LIENKAEMPER, J., WHITEHILL, C., and PRENTICE, C., USGS, Menlo Park, CA 94025
10		The Borehole Northern Hayward Fault Network (NHFN): Research Applications	NADEAU, R.M., nadeau@seismo.berkeley.edu, HELLWEG, M., peggy@seismo.berkeley.edu, DREGER, D., dreger@seismo.berkeley.edu, U.C. Berkeley Seismological Laboratory, Berkeley, CA 94720.
11		Bay Area Urbanization and Exposure of Critical Facilities and Infrastructure to Hazards Associated with Hayward Fault Earthquakes	PERKINS, J.B., jeannep@abag.ca.gov and MAGARY, K., katem@abag.ca.gov, Association of Bay Area Governments (ABAG), Oakland, CA, 94604
12		Segmentation of the Hayward Fault Based on Geophysical Data	PONCE, D.A., GRAYMER, R.W., JACHENS, R.C., and SIMPSON, R.W., U.S. Geological Survey, 345 Middlefield Rd, Menlo Park, CA, 94025, ponce@usgs.gov
13		Pits, Faults and Halos: Is the Oakland Conglomerate a Hayward Fault Tectonite?	STRAYER, L.M., ALLEN, J.R., WILCOX, J.M., Dept. of Earth and Environmental Sciences, California State University, East Bay, Hayward, 94542, luther.strayer@csueastbay.edu
14		Geology and Displacement Characteristics of the Southern Hayward Fault Zone at Bay Division Pipelines 3 & 4 Crossing, Fremont, California	WRIGHT, R.H., bwright@amec.com; HALL, N.T., thall@geomatrix.com; TRAUBENIK, M.L., mtraubenik@amec.com, AMEC Geomatrix Inc., Oakland, CA 94612; WESLING, J., Department of Conservation, Sacramento, CA 95814, john.wesling@concervation.ca.gov.

Thursday Morning			
Calaveras Fault Moderator: D. Schwartz			
1	8:00	Update on Understanding of the Calaveras Fault: Recent Research, Engineering Applications, and Data Gaps (*Invited*)	KELSON, K., William Lettis & Associates, Inc., Walnut Creek, CA 94596 United States, kelson@lettis.com
2	8:25	Seismicity on the Central and Southern Calaveras Fault and Earthquake Forecasts (*Invited*)	OPPENHEIMER, D., BAKUN, W., United States Geological Survey, Menlo Park, CA 94025, oppen@usgs.gov, bakun@usgs.gov; UHRHAMMER, R., Seismological Laboratory, University of California, Berkeley, CA 94720, bob@seismo.berkeley.edu; BOATWRIGHT, J. and SIMPSON, R., United States Geological Survey, Menlo Park, CA 94025, boat@usgs.gov, simpson@usgs.gov
4	8:50	Implications of Geodetically-inferred Coseismic and Postseismic Slip in the 31 October 2007 M 5.4 Alum Rock Earthquake for Fault Characteristics and Earthquake Hazard	MURRAY-MORALEDA, J. R., SIMPSON, R. W., U. S. Geological Survey, Menlo Park, CA 94025, jrmurray@usgs.gov, simpson@usgs.gov
5	9:10	Seismic Imaging of the Mission Fault in Fremont, Alameda County, California	RYMER, M.J., CATCHINGS, R.D., GOLDMAN, M.R., SICKLER, R.R., CRILEY, C.J., KASS, J.B., U.S. Geological Survey, Menlo Park, CA 94025, GANDHOK, G., and FOGWELL, T.W., Weiss Associates, Emeryville, CA 94608
6	9:30	Geologic Interpretation of Northern Calaveras Fault Location and Displacement Analysis at the Alameda Siphon No. 2 and Proposed Alameda Siphon No. 4, Sunol Valley, California	SUNDERMANN, S.T., William Lettis & Associates, Golden, CO 80401, sundermann@lettis.com; KELSON, K.I., William Lettis & Associates, Walnut Creek, CA 94596, kelson@lettis.com
9:50 – 10:20 Morning Break			
7	10:20	Probabilistic Fault Displacement Hazard Analysis for the Southern Hayward and Northern Calaveras Faults	THOMPSON, S.C., KELSON, K.I., O'CONNELL, D.R.H., William Lettis & Associates, Walnut Creek, CA, United States, thompson@lettis.com
8	10:40	Fault Crossing Design of Large Diameter Pipeline Crossing Calaveras Fault	NISAR, A., MMI Engineering, Oakland, CA; KELSON, K., William Lettis and Associates, Walnut Creek, CA
9	11:00	Fault Propagation through Coyote Earth-Rock Dam Due to Creep on the Calaveras Fault, Santa Clara County, California	NELSON, J.L., VOLPE, R.L., TEPEL, R.E. (Retired), and BAKER, F.B., Santa Clara Valley Water District, San Jose, CA, 95118
11:20 – 1:00 Lunch and Poster Viewing			
Other East Bay Faults Moderator: M. Craig			
1	1:00	Transpressional Tectonics of the Eastern San Francisco Bay Region, California, and Implications for Seismic Hazard Assessment (*Invited*)	UNRUH, J.R., William Lettis & Associates, Inc., Walnut Creek, CA, unruh@lettis.com
2	1:25	Seismic Improvement Program of the East Bay Municipal Utility District Water System (*Invited*)	LEE, D.D., East Bay Municipal Utility District, Oakland, CA, dlee@ebmud.com
3	1:50	Surface Deformation along the Hayward-Rodgers Creek-Maacama Fault System Measured by PS-InSAR	FUNNING, G.J., University of California, Riverside, CA 92521, BURGMANN, R., University of California, Berkeley, CA 94720, FERRETTI, A., NOVALI, F., GIANNICO, C., and FUMAGALLI, A., Tele-Rilevamento Europa, Milan 20147, Italy

Other East Bay Faults (*continued*)			
4	2:10	The Green Valley Fault: Geologic Record of Four Large Earthquakes in the Past Millennium	LIENKAEMPER, J.J., SICKLER, R.R., BROWN, J., USGS MS 977, 345 Middlefield Rd, Menlo Park, CA 94025, BALDWIN, J.N., TURNER, R., Jr., Lettis Assocs., 1700 Botelho Ave., Ste. 262, Walnut Creek, CA 94956, and GUILDERSON, T. P., CAMS, Lawrence Livermore National Lab., Livermore, CA 94551
5	2:30	Context of the Hayward Fault in the Formation and Evolution of the San Andreas Plate Boundary	FURLONG, K.P., Dept. Geosciences, Penn State University, University Park, PA 16802, kevin@geodyn.psu.edu
6	2:50	Ductile Deformation in Lieu of Coseismic Ground Fault Rupture along the Concord Fault	BORCHARDT, G., Soil Tectonics, P.O. Box 5335, Berkeley, CA 94705, gborchardt@usa.net, SNYDER, D.L., Snyder & Wilson Engineering, Inc., 16022 Arminta, Suite 1, Van Nuys, CA 91406; snydersma@aol.com
3:10 – 3:40 Break and Poster Viewing			
7	3:40	Seismic Imaging Evidence for Near-Surface Faulting West of the Hayward Fault along the Northern Projection of the Silver Creek Fault	CATCHINGS, R. D., RYMER, M. J., GOLDMAN, M. R., U.S. Geological Survey, Menlo Park, California, GANDHOK, G., Weiss Associates, Emeryville, CA 94608
8	4:00	Ground Penetrating Radar Surveying of Active Faults in the East San Francisco Bay Area	CRAIG, M.S., mitchell.craig@csueastbay.edu, KIMBALL, M.A., California State University East Bay, Hayward, CA, 94542, and LIENKAEMPER, J.J., U. S. Geological Survey, Menlo Park CA, 94025
9	4:20	Retrofit Design of BART Structures for Fault Movements	MATHUR, R., Parsons, San Francisco, CA, 94105, Ravindra.P.Mathur@Parsons.com; JOHNSON, T., Bay Area Rapid Transit District, Oakland, CA, 94612, Tjohnso@bart.gov
10	4:40	Assessing and Mitigating the Seismic Hazards of the Concord Fault for a Redevelopment Residential Complex: A Case Study	DRUMM, P., Earth Focus Geological Services, Inc., Fremont, CA, 94536, patrick@earthfocusgeology.com
8:00 – 5:00 Thursday – Posters			
Calaveras Fault			
1		Pre-Earthquake Electromagnetic Signals Associated with the Oct 30, 2007, Alum Rock M5.4 Earthquake	BLEIER, T.E., DUNSON,C., QuakeFinder, Palo Alto, CA 94306 tbleier@quakefinder.com, cdunson@quakefinder.com
2		Source of Electromagnetic and other Non-Seismic Pre-Earthquake Signals	FREUND, F.T., NASA Ames Research Center, Earth Science Div., Moffett Field, CA 94035; friedemann.t.freund@nasa.gov, BOSE, M., University of California Riverside, Dept. of Physics, Riverside, CA 92507; KULAHCI, I., Carl Sagan Center, SETI Institute, 515 N Whisman Rd., Mountain View, CA 94043; CYR. G., San Jose State University, Dept. of Physics, San Jose, CA 95192-0106; WINNICK, M., Vassar College, Dept. of Physics and Astronomy, Pougheepsie, NY 12604; XIE, S. and TEICHGRAEBER, C., University of California Berkeley, Dept. of Physics, Berkeley, CA 94720; KING, J., University of Lancaster, Dept. of Physics, Lancaster, LA1 4YQ, UK; TAKEUCHI. A., Tokai Univ. Earthquake Prediction Research Center, Shizuoka 424-8610, Japan.

Calaveras Fault (*continued*)			
3		A New Look at Calaveras Fault Zonation Using Double Difference Relocated Earthquakes	SIMPSON, R., OPPENHEIMER, D., BAKUN, W., GRAYMER, R., U.S. Geological Survey, Menlo Park, CA 94025, simpson@usgs.gov, oppen@usgs.gov, bakun@usgs.gov, rgraymer@usgs.gov; WALDHAUSER, F. and SCHAFF, D., Lamont-Doherty Earth Observatory of Columbia University, Palisades, NY 10964, felixw@ldeo.columbia.edu, dschaff@ldeo.columbia.edu
4		Earthquake Instability Model for Faulting on the Southern Hayward and Central Calaveras Faults	STUART, W.D., stuart@usgs.gov, SIMPSON, R.W., simpson@usgs.gov, US Geological Survey, Menlo Park CA 94025, BARALL, M., mbinv@invisiblesoft.com., Invisible Software.
5		A Study of Strong Ground Motions in the San Francisco Bay Area from the M5.4 Alum Rock, California Earthquake	TSAI,Y.B., YXT1@pge.com; ABRAHAMSON,N.A., NAA2@pge.com, and McLAREN,M.K., MKM2@pge.com, Pacific Gas and Electric Company, San Francisco, CA 94105
6		Absence of Late Neogene Offset on the Northern Calaveras Fault	WALKER, J. P., Kleinfelder, 7133 Koll Center Parkway, Suite 100, Pleasanton, CA 94566, jpwalker@kleinfelder.com; GRAYMER, R. W., U.S. Geological Survey, 345 Middlefield Rd. MS 975, Menlo Park, CA 94502, rgraymer@usgs.gov
7		The Mount Lewis Fault Zone: An Emerging Player in the Hayward-Calaveras Fault System	WATT, J.T., PONCE, D.A., SIMPSON, R.W., GRAYMER, R.W., JACHENS, R.C., WENTWORTH, C.M., U.S. Geological Survey, Menlo Park, CA, 94025
Other East Bay Faults and Other Hazards			
8		Landslide Mapping on Sonoma Mountain, Sonoma County, California: Earthquakes, Weak Rock, and Suburban Development	RUBIN, R.S., Geomatrix Consultants, 2101 Webster Street, 12th Floor, Oakland, CA, 94612, ron.rubin@amec.com; ALLEN, J.R., CSU East Bay, Dept. of Earth and Environmental Sciences, Hayward, CA., james.allen@csueastbay.edu
9		Using Seismic Refraction to Identify and Characterize Near-Surface Expression of Active Faults in the Eastern San Francisco Bay Area, California	KIMBALL, M.A., CRAIG M.S., California State University East Bay, Hayward, CA 94540; LIENKAEMPER J.J., U.S. Geological Survey, Menlo Park, CA, 94025
10		Weakening of Serpentinite Sheared Against Quartzofeldspathic Rocks and its Possible Implications for Creep on the Hayward and Calaveras Faults	MOORE, D.E., LOCKNER, D.A., and PONCE, D.A, U.S. Geological Survey, Menlo Park, CA 94025
11		Dependence of Frictional Strength on Compositional Variations of Artificial Gouge Derived from Hayward Fault Rocks	MORROW, C.A., Moore, D.E., and Lockner, D.A., U.S. Geological Survey, Menlo Park, CA 94025, cmorrow@usgs.gov, dmoore@usgs.gov, dlockner@usgs.gov
12		Mitigation of Fault Crossing Hazard for Large Diameter Pipelines Crossing Concord Fault	NISAR, A., MMI Engineering, Oakland, CA; HITCHCOCK, C., William Lettis & Associates, Walnut Creek, CA
13		Berkeley Hills Landslide-induced Property Line Movement under Both Static and Earthquake Conditions	KROPP, A., Alan Kropp and Associates, Berkeley, California 94704, akropp@akropp.com
14		California Geological Survey Zones of Required Investigation for Earthquake-induced Landslides - Livermore Valley, California	PEREZ, F.G., WIEGERS, M.O., HAYDON, W.D., California Geological Survey, Sacramento, CA 95814, (Ante.Perez, Mark.O.Wiegers, Wayne.Haydon)@conservation.ca.gov

Other East Bay Faults and Other Hazards (*continued*)			
15		Seasonal Acceleration and Structure of Slow Moving Landslides in the Berkeley Hills	QUIGLEY, K.C. and BURGMANN, R., Department of Earth and Planetary Science University of California Berkeley, Berkeley, CA;. GIANNICO, C. and NOVALI, F. Tele-Rilevamento Europa, Milano, Italy
16		California Geological Survey Zones of Required Investigation for Liquefaction, Livermore Valley, CA	ROSINSKI, A.M., California Geological Survey, Menlo Park, CA

Friday Morning			
Sacramento-San Joaquin Delta Moderator: T. Brocher			
1	8:00	Quantifying the Earthquake Threat in the Sacramento-San Joaquin Delta, California; How Bad Can It Get (*Invited*)	WONG, I. and THOMAS, P., Seismic Hazards Group, URS Corporation, Oakland, CA, ivan_wong@urscorp.com; UNRUH, J., William Lettis & Associates, Walnut Creek, CA; HANSON, K. and YOUNGS, R., Geomatrix Consultants Inc., Oakland, CA
2	8:25	Delta Risk Management Strategy: Risk Analysis for the Sacramento-San Joaquin and Suisun Marsh Levee System (*Invited*)	McCANN, M.W., Jr., Jack R. Benjamin & Associates, Inc., Menlo Park, CA
2008 Wenchuan Earthquake			
1	8:50	Damage Survey of the 2008 Sichuan Earthquake and Application to California and Eastern San Francisco Bay Area	MIYAMOTO, K., and GILANI, A., Miyamoto International, Sacramento CA
2	9:10	Reconnansance Observations and Lessons Learned from the M8.0 Wenchuan Earthquake, China	LEE, D.D., East Bay Municipal Utility District, Oakland, CA, dlee@ebmud.com
3	9:30	Landslides and Quake Lakes from the M7.9 China Earthquake; Are Californians in the Same Boat?	STENNER, H., Exponent Failure Analysis Associates (FaAA), Oakland, CA, hstenner@exponent.com; HAMILTON, D., Exponent FaAA, Irvine, CA, dhamilton@exponent.com; CYDZIK, K., Exponent FaAA, Irvine, CA, kcydzik@exponent.com; CATTAROSSI, A., Med Ingegneria, Padova, Italy, andrea.cattarossi@medingegneria.it; MATHIESON, E., Exponent FaAA, Oakland, CA, emathieson@exponent.com
9:50 – 10:30 Break and Poster Viewing			
Strong Ground Motion			
1	10:30	Issues at the Seismic Hazard/Seismic Design Interface in the San Francisco Bay Region	WONG, I. and THOMAS, P., Seismic Hazards Group, URS Corporation, Oakland, CA 94612, ivan_wong@urscorp.com
2	10:50	An Investigation of the Impact of Variability in Source Modeling and Seismicity Features of Hayward-Rodgers Creek-Calaveras Fault System on Near Source Ground Motions	ROWSHANDEL, B. and WILLS, C.J., California Geological Survey, Sacramento, CA, 95814
3	11:10	Impact of NGA Models on Ground Motions and Retrofit Decisions for BART Facilities	ABRAHAMSON, N., Pacific Gas & Electric Company, San Francisco, CA and JOHNSON, T., Bay Area Rapid Transit District, Oakland, CA
4	11:30	Caltrans Seismic Hazard Characterization: New Procedures On-Line	SHANTZ, T. and MERRIAM, M., California Department of Transportation, Sacramento, CA
11:50 – 1:00 Lunch and Poster Viewing			
Earthquake Engineering and Risk, Disaster Preparedness, and Outreach Moderator: D. Cushing			
1	1:00	Building Evaluation and Design: How Engineering Standards Can Better Support Community Efforts to Reduce Earthquake Risk (*Invited*)	BONOWITZ, D., David Bonowitz, S.E., San Francisco, CA 94117
2	1:25	Pacific Gas and Electric GIS-Based Earthquake Planning and Emergency Response (*Invited*)	NISHENKO, S.P., FERRE, K., FIELD, L., FUJISAKI, E., LEE, C.H., MCLAREN, M., AND VISRAM, K., Pacific Gas and Electric Company, San Francisco, CA 64105

Earthquake Engineering and Risk, Disaster Preparedness, and Outreach (*continued*)			
3	1:50	Long-Term Disaster Recovery Planning Essential for Local Governments (*Invited*)	PERKINS, J.B., Consultant, Association of Bay Area Governments (ABAG), Oakland, CA, 94604, jeannep@abag.ca.gov.
4	2:15	An Overview of the AB 300 Report, Seismic Safety Inventory of California Public Schools	ROJAHN, C., HEINTZ, J.A., Applied Technology Council, Redwood City, CA, and BELLET, D., Division of the State Architect, Sacramento, CA
5	2:35	Managing Earthquake Risks of Buildings at Pacific Gas and Electric Company	FERRE, K.S., PG&E, San Francisco, CA, 94105
2:55 – 3:25 Break and Poster Viewing			
6	3:25	New Construction on Existing Landslides in Urban Areas Regulated by the California Seismic Hazard Mapping Act	KROPP, A., and MAGNUSEN, W., Alan Kropp and Associates, Berkeley, California 94704, akropp@akropp.com
7	3:45	Effects of Topography and Geology on Shaking Damage to Wood Frame Residential Structures During the 2003 San Simeon Earthquake, Western San Luis Obispo County, California	MCCRINK, T.P., MANSON, M.W., WILLS, C.J. and REAL, C.R., California Geological Survey, Sacramento, CA, 95814
8	4:05	Probability-Based Seismic Assessment of Buildings, Considering Post-Earthquake Safety	MAFFEI, J. and TELLEEN, K., Rutherford & Chekene Consulting Engineers, San Francisco, California
9	4:15	Assessment and Repair of Earthquake Damaged Woodframe Buildings	OSTERAAS, J.D., Exponent Failure Analysis Associates, Menlo Park, CA 94025, osteraas@exponent.com
10	4:35	Seismic Hazard Mitigation and Response at CSU East Bay	ISHIDA, C., California State University East Bay, Hayward, CA, 94542, craig.ishida@csueastbay.edu
4:55 – 5:00 Closing			KNUDSEN, K.L., URS Corporation, 1333 Broadway, suite 800, Oakland, CA, 94612, keith_knudsen@urscorp.com
Posters – All Day			
Seismotectonics of the Eastern San Francisco Bay Area			
1		Should the San Andreas Fault System have been Named the Hayward-Calaveras Fault System?	BURNHAM, K., Independent Research, Oakland, CA, 94620-1087, katb@stanfordalumni.org
2		Characterizing Seismicity in the San Francisco East Bay	HELLWEG, M., UHRHAMMER, R., DREGER, D., TAGGART, J; CHUNG, A; and MCKENZIE, M.R., Berkeley Seismological Laboratory, UC Berkeley, Berkeley, CA 94563, peggy@seismo.berkeley.edu, WALDHAUSER, F., and SCHAFF, D., Lamont Doherty Earth Observatory, Columbia University, Palisades, NY 10964
3		Bay Area Regional Deformation Network Capabilities in East San Francisco Bay	HOULI, N. and ROMANOWICZ, B., Berkeley Seismological Laboratory, University of California, 205 McCone Hall, 94720-4760, Berkeley, CA
4		Stratigraphic Evidence for a Middle Miocene Onset of Right Lateral Strike Slip in the East Bay	WALKER, J.P., Kleinfelder, Pleasanton, CA,94566, jpwalker@kleinfelder.com
Sacramento-San Joaquin Delta			
5		Earthquake Site Response in the Sacramento/San Joaquin Delta	FLETCHER, J.B., BOATWRIGHT, J., and SELL, R., U.S. Geological Survey, Menlo Park, CA 94025
6		Sacramento-San Joaquin Delta Region-Proposed Contemporary Tectonic Model	HAMILTON, D.H., Consulting Geologist, 2 Bassett Lane, Atherton, California, 94027

Strong Ground Motions			
7		Empirical Prediction of Cumulative Absolute Velocity (Cav)	CAMPBELL, K.W., ABS Consulting (EQECAT), Beaverton, OR, kcampbell@eqecat.com; BOZORGNIA, Y., PEER, University of California, Berkeley, CA, yousef@berkeley.edu
8		Site Response in the San Francisco Bay Area, California	BERGEN, K.J., FLETCHER, J.B., BOATWRIGHT, J., LANGENHEIM, V., NOCE, T., DETWEILER, S., SELL, R., and MOONEY, W.D., U.S. Geological Survey, Menlo Park, CA 94025
9		Local Magnitude Amplitude Tomography of California	FORD, S.R. and UHRHAMMER, R.A., Berkeley Seismological Laboratory, Berkeley, CA
10		Seismic Hazard Mapping of California Incorporating Spatial Variability of Site Conditions	KALKAN E., WILLS J.C., AND BRANUM D., California Geological Survey, Sacramento, CA
11		Seismic Soil-Structure Interaction Analysis of Tall Structures in Time Domain	SUBRAMANIAN C., A.C. College of Engineering and Technology, Karaikudi, Tamil Nadu, India 630004 cgsmanian@yahoo.co.in; KARPAGAM (ALIAS) NACHAMMAI M., University of Wollongong, NSW, Australia 2500 karpagam_civil@yahoo.co.in
12		Moderate Earthquake Ground Motion Validation in the San Francisco Bay	KIM, A., DREGER, D., Berkeley Seismological Laboratory, Berkeley, CA, 94720, and LARSEN, S., Lawrence Livermore National Laboratory, Livermore, CA, 94551
13		Exploring Spatial Coherence Between Earthquake Source Parameters	SONG, S., PITARKA, A., SOMERVILLE, P., URS Corporation, Pasadena, CA, 91101-2560, seok_goo_song@urscorp.com
Earthquake Engineering and Risk, Disaster Preparedness, and Outreach			
14		Seismic Performance of Friction Pendulum Bearings in Liquid Storage Tanks	ACEVEDO-CABRERA, A., analuzac@berkeley.edu, MAHIN, S., mahin@ce.berkeley.edu, CALUGARU,V, University of California Berkeley, Berkeley, CA, 94720, calugaru@berkeley.edu
15		Zonation, Regulation, and Mitigation of Seismic Hazards in Santa Clara County, California	BAKER, J.B., Santa Clara County Planning Office, San Jose, California, 95110
16		Persistent Microzones Suggest 1906 Intensity Patterns in and near San Jose, California, for a Major Earthquake on the Southern Hayward Fault	SHOSTAK, N.C., San Jose State University, San Jose, California 95192, nshostak@geosun.sjsu.edu, BOATWRIGHT, J., and BUNDOCK, H., U.S. Geological Survey, MS 977, 345 Middlefield Road, Menlo Park, California 94025

GROUND MOTION SIMULATIONS OF SCENARIO EARTHQUAKE RUPTURES OF THE HAYWARD FAULT

AAGAARD, Brad, U.S. Geological Survey, Menlo Park; GRAVES, Robert, URS Corporation, Pasadena; LARSEN, Shawn, Lawrence Livermore National Laboratory; MA, Shuo, Stanford University; RODGERS, Arthur, Lawrence Livermore National Laboratory; BROCHER, Thomas, GRAYMER, Russell, HARRIS, Ruth, LIENKAEMPER, James, PONCE, David, SCHWARTZ, David, SIMPSON, Robert, and SPUDICH, Paul, U.S. Geological Survey, Menlo Park; DREGER, Doug, University of California at Berkeley; PETERSSON, Anders, Lawrence Livermore National Laboratory; and BOATWRIGHT, John, U.S. Geological Survey, Menlo Park

Abstract:
We compute ground motions in the San Francisco Bay area for a suite of 35 magnitude 6.7-7.2 scenario earthquake ruptures involving the Hayward fault. The suite of scenarios encompasses variability in rupture length, hypocenter, distribution of slip, rupture speed, and rise time. The five rupture lengths include the Hayward fault and portions thereof, as well as combined rupture of the Hayward and Rodgers Creek faults and the Hayward and Calaveras faults. For most rupture lengths, we consider three hypocenters, yielding north-to-south rupture, bilateral rupture, and south-to-north rupture. We also consider multiple random realizations of the slip distribution, accounting for creeping patches (Funning et al., 2007) either through simple assumptions about how creep reduces coseismic slip or a slip-predictable approach. The kinematic rupture models include local variations in rupture speed and use a ray-tracing algorithm to propagate the rupture front. Although we are not attempting to simulate the 1868 Hayward fault earthquake in detail, a few of the scenarios are designed to have source parameters that might be similar to this event. This collaborative effort involves four modeling groups, using different wave propagation codes and domains of various sizes and resolutions, computing long-period ($T > 1$-2 s) or broadband ($T > 0.1$ s) synthetic ground motions for overlapping subsets of the suite of scenarios. The simulations incorporate the 3-D geologic structure as described by the USGS 3-D Geologic Model (Jachens et al., 2006; Watt et al., 2007) and USGS Bay Area Velocity Model (Brocher et al., 2007). The simulations illustrate the dramatic increase in intensity of shaking for a magnitude 7.0 bilateral rupture of the entire Hayward fault compared with a magnitude 6.8 bilateral rupture of the southern two-thirds of the fault; the area subjected to shaking stronger than MMI VII increases from about 10% to more than 40% of the San Francisco Bay urban area. For a given rupture length, the synthetic ground motions exhibit the strongest sensitivity to the distribution of slip and proximity to sedimentary basins. The hypocenter also exerts a strong influence on the amplitude of the shaking due to rupture directivity. The synthetic waveforms exhibit a weaker sensitivity to the rupture speed and are relatively insensitive to the rise time.

Presentation Type:
Oral

Presenting Author:
Aagaard, Brad

IMPACT OF NGA MODELS ON GROUND MOTIONS AND RETROFIT DECISIONS FOR BART FACILITIES

ABRAHAMSON, Norman, Pacific Gas & Electric Company, San Francisco, CA and
JOHNSON, Tracy, Bay Area Rapid Transit District, Oakland, CA

Abstract:
The Bay Area Rapid Transit (BART) District is undertaking a comprehensive program to seismically retrofit its system. For the initial seismic hazard studies, BART developed DBE and LDBE spectra based on 1997 vintage ground-motion models. The DBE spectrum is defined as the maximum of either the 500-year return period uniform hazard spectrum or the median plus half-sigma deterministic spectrum. The LDBE spectrum is defined as the median deterministic spectrum. For simplicity, the BART facilities were grouped into zones and a single rock spectrum was used for all sites in the zone. The site response was modeled using NEHRP site factors.

The BART seismic hazard studies were updated using the NGA ground-motion models in place of the 1997 standard models. In addition, the site-specific locations and site-specific VS30 values were considered rather than using zones and NEHRP site factors. This combination of factors had varying effects on the ground motions. For example, the impacts at the Hayward station are as follows: At short periods ($T<0.1$ sec), most of the reduction is due to the site-specific calculation; at intermediate periods ($0.2<T<0.5$ sec) the reduction is about equal from the site-specific calculation and from use of the NGA models; at longer periods ($0.5<T<2$ sec), the reduction is due to use of the NGA models; and at long periods ($T> 2$ sec) there is no reduction.

The NGA-based spectra were used for retrofit designs of some sections of the BART aerial guideways, the West Oakland, Rockridge, and Daly City stations, and at 13 aerial stations on the Fremont, Pittsburgh-Bay Point, and Richmond lines. The NGA-based spectra were also used to analyze several underground stations and ultimately contributed to the elimination of the need for retrofits at the Glen Park, 12th Street, and 19th Street stations.

Presentation Type:
Oral

Presenting Author:
Abrahamson, Norman

SEISMIC PERFORMANCE OF FRICTION PENDULUM BEARINGS IN LIQUID STORAGE TANKS

ACEVEDO-CABRERA, A., University of California, Berkeley, CA, 94720, USA, analuzac@berkeley.edu; MAHIN, S., University of California, Berkeley, CA, 94720, USA, mahin@ce.berkeley.edu; and CALUGARU, V., University of California, Berkeley, CA, 94720, USA, calugaru@berkeley.edu

Abstract:
Most of the catastrophic effects of earthquakes are a result of buildings collapsing due to inadequate consideration of seismic safety conditions. Seismic safety can be improved in a variety of ways, but the method that most effectively protects the contents of a structure is by utilizing seismic isolators: elastomeric bearings and/or sliding systems. This research focuses on sliding systems, specifically friction pendulum bearings (FPB). Special attention is placed on the seismic performance of liquid storage tanks with FPB. Other studies have shown that FPB reduce the base shear and overturning moment on liquid storage tanks by up to 80%. In this experiment, the performance of FPB under primarily single-directional excitation, but also bidirectional and tridirectional excitation, in liquid storage tanks will be evaluated. This will be done by postprocessing of the experiment's camera recordings, load cells, strain gauges, and twin-wire probes to measure the sloshing of water inside the tank. This experiment will test the tank on top of an earthquake shake table both with and without the FPB in order to obtain comparable results and determine the isolators' effectiveness. It is expected that FPB will reduce the base shear, overturning moment, and sloshing of the water inside the tank.

Presentation Type:
Poster

Presenting Author:
Acevedo-Cabrera, Ana Luz

LABOR MARKET RISK OF A MAGNITUDE 6.9 EARTHQUAKE ON THE HAYWARD FAULT, EAST SAN FRANCISCO BAY REGION, CALIFORNIA

BAHLS, Donna, California Employment Development Department, Sacramento, CA 95814, donna.bahls@edd.ca.gov; HOLDEN, Richard, U.S. Department of Labor, Bureau of Labor Statistics, San Francisco, CA 94103, holden_r@bls.gov; REAL, Charles, California Geological Survey, Sacramento, CA, 95814, chuck.real@conservation.ca.gov

Abstract:
This presentation describes the exposure of the San Francisco Bay area labor market to a large earthquake in the East Bay region based on a M6.9 earthquake scenario on the Hayward Fault. To assess potential employment and business losses, data from the Quarterly Census of Employment and Wages (QCEW) were overlaid on a Modified Mercalli Intensity map from the ShakeMap archives of the U.S. Geological Survey. The employment data included the major proximate eastern San Francisco Bay area counties, but particular emphasis was placed on Alameda County, which encompasses the most populated areas around the Hayward Fault, ranging from Fremont in the south to Berkeley in the north. Alameda County is therefore the most exposed county in the region to earthquakes on this fault. Using the tabulating tools in geographical information systems we estimate that total exposures in the ten-county San Francisco Bay area in MMI VII (moderate damage) and VIII and greater (moderate to heavy damage) zones, combined, could include 87,000 employers, 1.5 million jobs, and quarterly wages approaching $25 billion. We estimate that approximately 90% of the businesses, employees, and payrolls are located in the most intense shaking zones on the map. Analysis indicates that more than half of the businesses, employees, and payrolls are in the zones characterized as having violent shaking and heavy damage. There are more than 600,000 employees in the most intense shaking zones earning $8.2 billion in quarterly payrolls. In short, interruption to business from a M6.9 Hayward earthquake could affect nearly all businesses and employees in Alameda County.

Presentation Type:
Oral

Presenting Author:
HOLDEN, RICHARD

ZONATION, REGULATION, AND MITIGATION OF SEISMIC HAZARDS IN SANTA CLARA COUNTY, CALIFORNIA

BAKER, James B., Santa Clara County Planning Office, San Jose, CA 95110

Abstract:
In 1974, Santa Clara County established Relative Seismic Stability Zones (RSSZs) and began requiring geologic reports prior to approving development of parcels located within high-hazard zones. The state's Alquist-Priolo Preliminary Special Studies Zones (changed to Earthquake Fault Zones in 1994) were included in the county's map. In addition, some faults not zoned by the state were zoned by the county. Other RSSZs for potential landsliding and liquefaction were delineated in the State's Special Report 107.
In 1978, the County's RSSZs were delineated on maps showing property lines and adopted by the County Board of Supervisors.
Beginning in 1999, computer-based mapping was used to delineate Geologic Hazard Zones (GHZs) that included the earthquake-induced landslide-prone and liquefaction-prone areas delineated on State Seismic Hazard Zones (SHZs) Maps.
In 2002, the County Board adopted the computer-based GHZs and a new Geologic Hazards Ordinance. At that time, only four quadrangles were covered by state SHZs in the county. The County Ordinance directs the Planning Office to "automatically" update the county zones when the State Geologist releases additional SHZ maps, however. As of 2008, 13 official state SHZs maps have been incorporated into the county's GHZs via computer-based GIS. Geologic reports required by the county must be signed by a consulting California Certified Engineering Geologist and comply with state guidelines. Reports about properties located within state SHZs must comply with the state's guidelines described in SP117 as well as the SCEC's recommended procedures. The county's Engineering Geologist reviews all reports for technical compliance. In some cases, supplemental reports are required. In most cases, a Plan Review Letter and Construction Observations Letter from the consulting geologist are required to ensure conformance with the approved recommendations. Statistics and examples will be presented.

Presentation Type:
Poster

Presenting Author:
Baker, James

3D SPONTANEOUS RUPTURE MODELS OF LARGE EARTHQUAKES ON THE HAYWARD FAULT, CALIFORNIA

BARALL, M., Invisible Software, San Jose CA, mbinv@invisiblesoft.com; HARRIS, R. A., and SIMPSON, R. W., U.S. Geological Survey, Menlo Park CA 94025, harris@usgs.gov, simpson@usgs.gov

Abstract:
We use 3D spontaneous rupture computer simulations to understand the behavior of past and future large earthquakes on the Hayward and central Calaveras faults. The Hayward Fault has a geologic history of producing many large earthquakes (Lienkaemper and Williams, 2007), with its most recent large event a M6.8 earthquake in 1868. Future large earthquakes on the Hayward Fault are not only possible but probable (WGCEP, 2008). Our numerical simulation efforts use information about the complex 3D fault geometry of the Hayward and Calaveras faults and information about the geology and physical properties of the rocks that surround the faults (Graymer et al., 2005). We use initial stress on the Hayward and Calaveras faults inferred from geodetic observations (Schmidt et al., 2005), seismological studies (Hardebeck and Aron, 2008), and rate-and-state simulations of the interseismic interval (Stuart et al., 2008). In addition, friction properties on the fault surface are inferred from laboratory measurements of adjacent rock types (Morrow et al., 2008). We incorporate these details into forward 3D computer simulations of dynamic rupture propagation, using the FaultMod finite-element code (Barall, 2008). To validate the model we use the SCEC/USGS 3D spontaneous rupture benchmarks (Harris et al., 2008) and kinematic simulations of the M5.4 2007 Alum Rock earthquake. Initial tests suggest that, coseismically, variable rock properties along the fault may be more important than fault geometry for rupture evolution. Our goal is to constrain estimates of lateral and depth extent of future large Hayward earthquakes and the resulting strong ground motion. We believe these 3D computer simulations are the first that include physical properties assigned to the rock bodies adjacent to the faults, realistic fault geometry, and many of the complex details of coseismic faulting behavior in a simulation of spontaneous earthquake rupture propagation.

Presentation Type:
Poster

Presenting Author:
Barall, Michael

THE "CREEPY" HAYWARD FAULT AND THE "PIEDMONT PATCH": MYTHOLOGY, PROBLEMS IN SEISMICITY, AND FORECAST SCENARIOS

BAUBLITZ, M. T., Applied Geographer/Geo-liaison/Arts&Science Fundraiser, GeoBlitz, Inc., Oakland,CA 94610 USA, blitztravel@sbcglobal.net

Abstract:
Piedmont, California, once a city of the most millionaires in the U.S., was thought to be a safe haven from earthquakes in the aftermath of the 1906 San Francisco quake. The main attractions had been the mineral springs and the Piedmont resort. After the springs were capped in the mid-1970s, seismicity in the area has steadily increased, and in recent years several M>4 earthquakes have occurred, mostly centered in Piedmont and the Berkeley hills. They have been widely felt in the Bay Area, typically as sharp jolts with little aftershocks. Questions about the Hayward Fault in the Piedmont area are concerned with the rate of creep and possible locked segments building up stress on the northern Hayward Fault.
A bend in the fault here may be a big cause for concern. Could umderground water also be a factor in future seismic activity on this part of the Hayward Fault? A possible scenario of a M>5 event here may be the precursor for an even greater quake on the northern extension of the Hayward Fault, with serious impacts on the communities of Piedmont, Oakland, Berkeley, and the North Bay (to the Rodgers Creek Fault).
The USGS has helped educate the local residents of the Piedmont area that while they may feel safe in the hills, the next "big one" in this area may be closer than we all think. Courtesy of the City of Piedmont, a 30-minute video will be presented which addresses all these concerns.

Presentation Type:
Poster

Presenting Author:
Baublitz, Michael

SITE RESPONSE IN THE SAN FRANCISCO BAY AREA, CALIFORNIA

BERGEN, K. J., FLETCHER, J. B., BOATWRIGHT, J., LANGENHEIM, V., NOCE, T., DETWEILER, S., SELL, R., and MOONEY, W. D. U.S. Geological Survey, Menlo Park, CA 94025 USA

Abstract:
It is well known that near-surface geology can greatly affect seismic-wave amplification. The determination of site response characteristics is therefore an important component of estimating seismic hazard for the San Francisco Bay area. For example, Santa Rosa, California sustained unexpectedly high damage from the 1906 San Francisco earthquake (M7.8) and the 1969 Santa Rosa earthquake sequence (M5.6 and M5.7). In the nearby city of Napa, ground motion was also unexpectedly high during the 2000 Yountville earthquake (M5.2). This history of unexpectedly strong ground motions, in combination with large metropolitan populations in Santa Rosa (>150,000 inhabitants) and Napa (>75,000 inhabitants) and their proximity to Holocene active faults such as the Rodgers Creek-Healdsburg fault system, West Napa Fault, and Green Valley Fault, make estimation of site response in these regions particularly important. We estimate site response at several stations in this region by inverting seismograms of local events (r < 100 km) from the past five years for source, site, and propagation characteristics. We inverted spectra of 33 earthquakes for P waves and 25 earthquakes for S waves, covering a range of hypocentral distances and azimuths. Seismic cone penetration testing (SCPT) was done at three stations each in Santa Rosa and Napa to determine near-surface S-wave velocities and to constrain absolute site amplification. High site response is estimated from the inversion in the cities of Santa Rosa and Napa, in agreement with slower near-surface S-wave velocities from SCPT. Response is estimated to be lower at adjacent sites outside of the valleys. Having knowledge of site response characteristics will enable better spectral analysis of small and moderate-sized earthquakes as well as better future models of wave-propagation characteristics in the region.

Presentation Type:
Poster

Presenting Author:
Detweiler, Shane

PRE-EARTHQUAKE ELECTROMAGNETIC SIGNALS ASSOCIATED WITH THE 30 OCTOBER 2007, ALUM ROCK M5.4 EARTHQUAKE

BLEIER, T. E. and DUNSON,C, QuakeFinder, Palo Alto, CA 94306, tbleier@quakefinder.com, cdunson@quakefinder.com

Abstract:
QuakeFinder, a small R&D company in Palo Alto, California has built a network of ultralow-frequency (ULF) magnetometers and air conductivity sensors which were deployed at 55 sites near major fault lines in California (http://www.quakefinder.com/). The purpose of this network (CalMagNet) is to search for short-term (days to weeks) precursor signals based on the physics of pre-earthquake processes. One of these sites (Site 609 in East Milpitas) was 2 km from the epicenter of the 30 October 2007 Alum Rock M5.4 earthquake (20:29 local time), and it detected an unusual pattern of large magnetic pulses 1-2 weeks prior to the quake, as well as a large increase in air conductivity 22 hours prior to the quake. The data from this event are being compared with signatures observed over the past year at this and similar more distant "reference" sites to determine if there are any unique features. Their root cause is not known with certainty, but they are consistent with a theory proposed by Friedemann Freund (SETI Institute and NASA AMES) in which pre-earthquake rock stress changes in the deep underground appear to activate extensive electronic charge carriers during the build-up of stress, presumably weeks before the event. These same types of charge carriers, along with similar currents measured through the rock samples in laboratory experiments, may be responsible for the magnetic field changes, air conductivity changes, and infrared signatures that have been observed by researchers in the U.S. and in other countries. The M5.4 Alum Rock event, and the corresponding electromagnetic data observed, may be the first step in a partial validation of this seismo-electromagnetic theory.

Presentation Type:
Poster

Presenting Author:
BLEIER, THOMAS

THE DISTRIBUTION OF MODIFIED MERCALLLI INTENSITY FOR THE 1868 HAYWARD EARTHQUAKE

BOATWRIGHT, John and BUNDOCK, Howard, U.S. Geological Survey, Menlo Park, CA 94025

Abstract:
The 21 October 1868 Hayward earthquake was the most damaging earthquake to occur in California in the half-century following the 1848 annexation. The earthquake strongly damaged downtown San Francisco and cracked brick buildings as far away as Santa Rosa and Gilroy. We have re-evaluated Modified Mercali Intensities (MMI) at 124 sites with damage or felt reports compiled by Toppozada et al. (1981), and added 26 new sites based on other newspaper reports and historical narratives. The highest intensities (MMI 8–9 to 9) are clustered near the middle of the fault rupture, in Hayward, San Leandro, and San Lorenzo. The intensities are lower (MMI 7–8) at the ends of the fault rupture, in Berkeley and Warm Springs. There are significant lengths of fault rupture, both southeast and northwest of Hayward, which had no damage reports. We have taken particular care to interpolate intensities in these areas because of their dense modern population. The intensities obtained at regional distances are slightly stronger to the northwest toward Petaluma (MMI 7) and Martinez (MMI 7) than to the southeast toward Calaveras Valley (MMI 6–7) and Gilroy (MMI 6–7), but the rupture appears nearly bilateral. The relatively low intensities in Oakland and Berkeley (MMI 7–8) suggest that the shallow locked zone near Piedmont, which Simpson et al. (2001) infer from the distribution of surface fault creep, did not rupture in the earthquake. Given the large proportion of aseismic slip on the Hayward Fault, both observed geologically at the surface and inferred geodetically at depth, we propose that the rupture process of the 1868 earthquake was a series of disjoint asperity ruptures with variable rupture directions, which produced a substantial amount of dynamically forced slip on the aseismic zones.

Presentation Type:
Poster

Presenting Author:
Boatwright, John

BUILDING EVALUATION AND DESIGN: HOW ENGINEERING STANDARDS CAN BETTER SUPPORT COMMUNITY EFFORTS TO REDUCE EARTHQUAKE RISK

BONOWITZ, David, David Bonowitz, S.E., San Francisco, CA 94117, USA

Abstract:
In the past ten years, technical guidelines for earthquake design, evaluation, and retrofit of buildings have proliferated as never before. While they are invaluable to engineers working on specific projects, they do little to reduce earthquake risk, largely because they are not written to help the people who actually decide whether and how to do that. The next generation of technical documents, therefore, needs to translate and extend the contributions of engineering guidelines to account for the decision-making processes used by legislators, emergency planners, lenders, developers, and insurers.
This presentation will draw lessons from current Bay Area projects to illustrate where improvements might be made to engineering codes and standards, for example, by:
- More rational and explicit linkage to occupancy, as opposed to structure type.
- Emphasis on continuity and recovery of operations, with attention to nonstructural systems.
- Tailoring to the different needs of voluntary, mandated, and triggered retrofits.
- Coordination with planning for response, recovery, and capital budgeting.

Presentation Type:
Oral

Presenting Author:
Bonowitz, David

ELASTIC REBOUND EFFECTS TO BE EXPECTED IN THE NEAR FIELD DURING THE NEXT MAJOR EARTHQUAKE ALONG THE HAYWARD FAULT

BORCHARDT, Glenn, Soil Tectonics, P.O. Box 5335, Berkeley, CA 94705, gborchardt@usa.net

Abstract:
Two kinds of ground deformation are to be expected during the next major earthquake on the Hayward fault: (1) coseismic ground fault rupture directly on traces of the fault and (2) elastic rebound producing permanent ground displacement in the near field. The first affects only structures straddling the fault and has been adequately addressed through fault zoning and mitigation. The second kind of deformation and its potentially damaging effects is not well understood. It will produce permanent NW and SE displacements for an unknown distance (3–5 km?) from the fault. With an aseismic slip rate of about 5 mm/yr and a geologic slip rate of about 9 mm/yr, we expect the elastic rebound at the surface of the ground to be equivalent to about 4 mm/yr since the last event. This could produce ground surface offsets up to 56 cm along the southern segment, which ruptured in the M6.9 event of 1868, and 93 to 147 cm along the northern segment, which has not ruptured for 232 to 368 years. Elastic rebound will send the NE side of the fault to the SE and the SW side of the fault to the NW by about half of these measurements. The effect will occur in a second or two and will diminish with distance from the fault. As seen in 1868, structures SW of the fault and not fastened to their foundations will be left behind by a maximum of 28 to 74 cm. Structures SW of the fault and inadequately fastened to their foundations may resist the initial motion, only to be thrown toward the NW, with accelerations dependent on the height and flexibility of the structure and nearness to the fault. Also, as shown in the Northridge and Sichuan earthquakes, structures having their strong axes parallel to the direction of elastic rebound will suffer less damage than those constructed perpendicular to it. As always, cyclic shaking will produce additional damage superimposed on these permanent ground displacements, obscuring their true nature. The answer: Retrofit or provide data for the next earthquake.

Presentation Type:
Poster

Presenting Author:
Borchardt, Glenn

DUCTILE DEFORMATION IN LIEU OF COSEISMIC GROUND FAULT RUPTURE ALONG THE CONCORD FAULT

BORCHARDT, Glenn, Soil Tectonics, P.O. Box 5335, Berkeley, CA 94705, gborchardt@usa.net; and SNYDER, David L., Snyder & Wilson Engineering, Inc., 16022 Arminta, Ste. 1, Van Nuys, CA 91406, snydersma@aol.com

Abstract:
To date, paleoseismic investigations along the Concord Fault have not uncovered evidence of coseismic ground fault rupture even though the fault has an aseismic slip rate of about 3 mm/yr. The largest historic earthquake on the Concord Fault was the M5.4 event of 1955. Current planning is for a ground-rupturing event with a magnitude as high as M6.7, although there is no paleoseismic evidence that the fault is capable of such a large event. The most intensively studied site along the fault is in the central segment at Galindo Creek, where sediments dated to 6.4 ka were draped across a mostly buried 3-m high southwest-facing scarp. Soils and paleosols formed on the subsided side of the fault were the result of overbank deposition that protected the plastically formed scarp from erosion. Specifically, there were no sheared soils, offset soils, or colluvial wedges that would indicate coseismic rupture. All features could be explained solely as the result of slow plastic deformation due to aseismic slip. The horizontal slip rate since 6.4 ka is 3.2+0.4 mm/yr, about the same as the horizontal aseismic slip rate. The vertical creep rate has not been measured, but our work predicts that it would be 0.47 mm/yr at the Galindo Creek site. We conclude that if major earthquakes occur along the Concord Fault, they do not involve ground fault surface rupture. Further studies are needed to evaluate this hypothesis, particularly in light of the presence of a significant number of high-rise buildings subject to rebound in the near field. The question arises: To what degree are near-field effects dependent on coseismic ground fault rupture?

Presentation Type:
Oral

Presenting Author:
Borchardt, Glenn

SEISMIC HAZARDS IN THE EASTERN SAN FRANCISCO BAY, CALIFORNIA

BROCHER, T. M., U.S. Geological Survey, 345 Middlefield Road, MS 977, Menlo Park, CA 94025, brocher@usgs.gov

Abstract:
Faults in the greater San Francisco Bay Area accommodate about 39 mm/yr of relative motion between the Pacific and North American plates. East Bay faults accommodate nearly half of the relative motion, 15 to 19 mm/yr, and current understanding is that the probability of a magnitude 6.7 or greater earthquake in the East Bay is higher than along the San Francisco peninsula and Marin coast. The Rodgers Creek-Hayward Fault system, alone, has a 30-year probability of such an earthquake of 31%, accounting for about half of the total Bay Area probability. The Calaveras, Greenville, Concord-Green Valley, and Mount Diablo faults also contribute to the hazard in the East Bay, and to the Sacramento-San Joaquin delta, but their slip rates and recurrence histories are currently less well characterized than those of the Hayward Fault.
Bay Area geography will play an important role in the damage produced by future East Bay earthquakes. The location of the bay shore forces much of the East Bay population to live close to the Hayward Fault. Other East Bay urban centers are located over sedimentary basins, such as the Livermore Basin, where ground motions will be amplified and prolonged. A Hayward Fault earthquake will produce significant liquefaction in the landfill areas along the bayshore. In addition, extensive landsliding is likely to be generated in the East Bay hills.
The East Bay was sparsely populated when the 1868 Hayward earthquake struck: The total population of Alameda County, where ground motions were highest, was only 24,000. Now the East Bay population is 100 times larger. Recent estimates of loss due to a Hayward Fault earthquake are $120 to $165 billion due to strong shaking alone, comparable to losses experienced in Hurricane Katrina. Unlike the Katrina-related losses, only 5 to 15% of the future Hayward earthquake-related losses will be insured.

Presentation Type:
Oral

Presenting Author:
Brocher, Tom

SPACE GEODETIC OBSERVATIONS OF ACTIVE DEFORMATION IN THE EASTERN SAN FRANCISCO BAY AREA

BURGMANN, R, Department of Earth and Planetary Science and Berkeley Seismological Laboratory, University of California, Berkeley, CA 94720-4767, USA, burgmann@seismo.berkeley.edu

Abstract:
Active crustal deformation in the San Francisco Bay Area includes contributions from elastic strain build-up across major faults and aseismic fault creep relieving a small portion of the plate tectonic fault slip budget. In addition to deformation associated with regional plate-normal convergence, shortening accommodated by thrust faulting occurs in areas of restraining strike-slip fault geometries. Increasingly precise and dense measurements of surface motions using GPS and InSAR satellite data provide valuable information on the distribution and rates of surface deformation. In the eastern Bay Area, the Hayward, Calaveras, and Concord faults are known to be source areas of moderate to large earthquakes but also exhibit significant aseismic fault creep. Modeling of space geodetic data collected along the Hayward Fault over a greater than 10-year period allows for the determination of the distribution of currently locked asperities and creeping portions of the fault zone. Inversions of these data reveal a locked zone at depth which has built up a slip deficit since the 1868 Hayward Fault rupture that is large enough to produce a M=7 earthquake. The inferred slip rates along the creeping portions of the Hayward Fault are significantly less than the long-term slip rate, and thus a substantial slip deficit is accumulating there as well. It is likely, however, that the creeping portions of the East Bay faults will catch up most of their slip deficit by accelerated postseismic creep following large ruptures of the currently locked asperities. Using a combination of GPS-measured horizontal velocities and InSAR range-change rates, we can also resolve vertical motions in the region, which provides valuable constraints on deformation rates in areas dominated by active contraction and thrust faulting. I will provide an overview of work done in collaboration with a large number of students, postdocs, and collaborators over recent years.

Presentation Type:
Oral

Presenting Author:
Burgmann, Roland

SHOULD THE SAN ANDREAS FAULT SYSTEM HAVE BEEN NAMED THE HAYWARD-CALAVERAS FAULT SYSTEM?

BURNHAM, K., Independent Research, Oakland, CA, 94620-1087, USA, katb@stanfordalumni.org

Abstract:
Sequential paleogeographic reconstructions from 30 Ma to ~3 Ma juxtapose ~70 previously published pairs of correlative features.
Eight pairs of correlatives reported by four sets of researchers (Dibblee, 1966; Cummings, 1968; Wakabayashi and Hengesh, 1995; McLaughlin et al., 1996) indicate only ~30 km lateral offset across the section of the San Andreas Fault between its intersections with the Calaveras and San Gregorio faults. The Cretaceous-Pleistocene ages of these correlatives indicate dextral offset of this section of the San Andreas Fault was not initiated until less than 3-4 Ma (McLaughlin et al., 1996).
The 315 km offset of the San Andreas Fault at Pinnacles and Neenach volcanics is partitioned between ~30 km offset of the San Andreas Fault north of the Calaveras Fault intersection, and ~285 km offset of the San Andreas-Calaveras-Hayward-Rodgers Creek-Maacama fault. Offset distance of the Calaveras Fault leg of this partition is verified by paleogeographic juxtaposition (~70-21.3 Ma) (Burnham, 2006 & in press) of Wakabayashi's (1999) Skaggs Springs Schist near Healdsburg and Pacheco Pass. Dextral offset of the San Andreas-Calaveras-Hayward-Rodgers Creek-Maacama fault commenced after ~21.3 Ma and had slipped at least 77 km before 11 Ma.
The ~205 km offset of the northernmost San Andreas Fault at the Delgada fan and the Wilson Grove Fm. is partitioned between ~180 km offset of the San Gregorio-northern San Andreas fault and ~30 km offset of the San Andreas Fault south of the San Gregorio Fault intersection. Dextral offset of the San Gregorio-northern San Andreas fault began after ~19 Ma and had slipped at least 70 km before 5.3 Ma.
The San Andreas Fault is not a single entity, but a temporary assemblage of disparate fault segments bounding different tectonic blocks and having vastly differing ages and offset distances. The Hayward-Calaveras fault is older and has greater dextral offset than the San Francisco peninsula segment of the San Andreas Fault.

Presentation Type:
Poster

Presenting Author:
Burnham, Kathleen

EMPIRICAL PREDICTION OF CUMULATIVE ABSOLUTE VELOCITY (CAV)

CAMPBELL, Kenneth W., ABS Consulting (EQECAT), Beaverton, OR, USA, kcampbell@eqecat.com; and BOZORGNIA, Yousef, PEER, University of California, Berkeley, CA, USA, yousef@berkeley.edu

Abstract:
Cumulative absolute velocity (CAV) is defined as the integral of the absolute value of the acceleration time series. As such, it inherently includes the cumulative effects of duration in its definition. This has led several investigators to propose that CAV can be used as a parameter for characterizing the damage potential of vibratory ground motion. For example, CAV has been shown to correlate with the onset of damage in nuclear power plants, where it has been accepted by the U.S. Nuclear Regulatory Commission (NRC) as a better ground-motion index than peak ground acceleration (PGA) or response spectral acceleration for determining whether a power plant should be shut down after an earthquake. It has also been shown to provide a better ground-motion index for determining excess pore pressure generation in potentially liquefiable soils than other ground-motion parameters, including PGA and Arias intensity. Most recently, it has been shown to be a better parameter than earthquake magnitude for screening out nondamaging ground motions in a probabilistic seismic hazard analysis (PSHA). In this paper, we develop a ground-motion prediction equation (GMPE) for CAV based on the functional form and database used to develop similar relationships for peak ground motion parameters and response spectral acceleration in the Next Generation Attenuation (NGA) project. The relationship for CAV shows that, besides having a strong dependence on magnitude and distance, it also exhibits a statistically significant dependence on fault mechanism, hanging-wall effects, shear-wave velocity, and sediment depth, similar to the other strong-motion parameters investigated in the NGA project. The standard deviation of the natural logarithm of CAV, however, is found to be substantially smaller than that found for these other ground-motion parameters, including peak ground velocity (PGV), suggesting that CAV is more stable and less dependent on the occurrence of random peaks in the time series.

Presentation Type:
Poster

Presenting Author:
Campbell, Kenneth

SEISMIC IMAGING EVIDENCE FOR NEAR-SURFACE FAULTING WEST OF THE HAYWARD FAULT ALONG THE NORTHERN PROJECTION OF THE SILVER CREEK FAULT

CATCHINGS, R. D., RYMER, M. J., GOLDMAN, M. R., U.S. Geological Survey, Menlo Park, California, USA; and GANDHOK, G., Weiss Associates, Emeryville, CA 94608, USA

Abstract:
High-resolution seismic-reflection and seismic-refraction images of the East Bay Plain show near-surface vertical offsets of strata and underlying bedrock, suggesting near-surface faulting beneath highly populated areas of the East Bay. We acquired an approximately 2-km-long high-resolution seismic reflection and refraction profile along Alameda Creek, beginning approximately 1 km east of the Coyote Hills. The Alameda Creek seismic images show vertical offsets of near-surface strata and the underlying bedrock beneath areas with little surface topography. The apparently near-surface faults along Alameda Creek are located along the northward projection of the Silver Creek Fault, as inferred by vertical offsets in the groundwater table (CDWR, 1967). Farther north in San Lorenzo, we acquired an approximately 8-km-long seismic profile from San Francisco Bay to the Hayward Fault. In the area along the northward projection of the Silver Creek Fault, the San Lorenzo seismic images also show vertical offsets of near-surface strata and underlying bedrock, suggesting that the Silver Creek Fault extends northward to at least San Lorenzo. On a regional seismic profile from the Pacific Ocean to the Livermore Valley, the Silver Creek Fault approximately marks the boundary between high velocities beneath the bay and lower velocities to the east, suggesting that the Silver Creek Fault may represent a major structural boundary within the San Francisco Bay area. Although the vast majority of seismic events recorded in the area can be attributed to slip on the Hayward Fault, the Northern California catalog shows that some events occur beneath the just identified trace of the Silver Creek Fault. Collectively, the available data indicate that the Silver Creek Fault may be more than 80 km long and may be currently or recently active. Because of its proximity to high-population centers of the East Bay, more careful examination of this fault is warranted.

Presentation Type:
Oral

Presenting Author:
Catchings, Rufus

STATUS OF AND NEEDS FOR SEISMIC INSTRUMENTATION OF STRUCTURES ALONG THE HAYWARD FAULT

CELEBI, M., U.S. Geological Survey, Menlo Park, CA 94025, celebi@usgs.gov

Abstract:
The inventory of structures in heavily built urban communities of the San Francisco Bay area (within and in close proximity to) that will experience strong ground motions from a rupture of the Hayward Fault includes a variety type of recent and older structures built with a variety of materials. Those who remember the effects of the 1989 Loma Prieta earthquake on structures in the area also remember the collapse of one segment of the upper deck of the San Francisco Bay Bridge, which halted transportation for approximately five weeks. Therefore, it is imperative that owners of these structures as well as governmental organizations acquire shaking response data from instrumented (or yet to be instrumented) structures during the forecasted events. Within California, such data are acquired mainly by the California Geological Survey and U.S. Geological Survey. A small number of private owners contribute to this effort.
The inventory of existing instrumented structures is much less than 0.1% of the total and as such cannot statistically be considered sufficient. For example, some existing important regular or lifeline structures are not instrumented (e.g., BART Transbay Tunnel, many segments of elevated BART structures in the proximity of the Hayward Fault, San Francisco Bay Bridge, Hetch-Hetchy pipeline system crossing the Hayward Fault), even though attempts and proposals have been developed to do so in the past. It is of course undeniable how and why such data from such structures can be useful both for immediate response and future response points of view.
Thus, this paper presents a critical assessment of the status quo and the future needs for instrumentation of structures in the greater San Francisco Bay area that includes the Hayward Fault. There are many new attempts and successes in instrumentation of structures in the referenced regions, but more needs to be done.

Presentation Type:
Oral

Presenting Author:
Celebi, Mehmet

PROBABILISTIC FAULT DISPLACEMENT HAZARD ON THE HAYWARD FAULT NEAR OAKLAND, CALIFORNIA

CHEN, R., WILLS, C. J., BRYANT, W. A., California Geological Survey, 801 K Street, Sacramento, CA 95814, USA; DOWSON, T., California Geological Survey, 345 Middlefield Road, MS 520, Menlo Park, CA 94025 USA; and PETERSON, M. D., USGS, Denver Federal Center, MS 966, Box 25046, Denver, CO 80225, USA

Abstract:
Probabilistic seismic hazard analysis (PSHA) is a standard practice to characterize hazards from complex ground motions produced by large earthquakes. Probabilistic methods have been applied recently to estimate surface fault displacement hazards for lifelines, where it is not possible to avoid the surface fault rupture hazard. This study tests the application of probabilistic fault displacement hazard analysis (PFDHA) for strike-slip faults based on regressions that depend on the accuracy of fault mapping and the complexity of mapped fault traces. Displacement hazards with 10% probability of exceedance in 50 years are calculated along the central portion of the Hayward Fault. Results are presented as hazard maps superimposed on the Alquist-Priolo Earthquake Fault Zone Map. The hazard maps show a zone of potential surface displacement in the vicinity of the mapped fault. In general, the magnitude of displacement decreases as distance from the mapped fault trace increases. The extent of the zone of displacement and the rate of displacement attenuation, however, show strong dependence on fault complexity and mapping quality. In the study area, Interstate Highway 580 follows the Hayward Fault and crosses it three times. Hazard distribution along the highway and the integrated displacement hazard curve show that the highway is subject to significant displacement hazard. PFDHA relies on regression analyses of available fault displacement data, just as PSHA depends on ground motion data. Displacement data are scarce compared to ground motion data. Rupture depth and subsurface rock and soil conditions are not accounted for although they may affect hazard. Nevertheless, a probabilistic approach is consistent with PSHA and may be developed into a valuable tool for evaluating the surface fault rupture hazard to lifelines.

Presentation Type:
Poster

Presenting Author:
Chen, Rui

GROUND-PENETRATING RADAR SURVEYING OF ACTIVE FAULTS IN THE EAST SAN FRANCISCO BAY AREA

CRAIG, Mitchell S., KIMBALL, Mindy A., California State University East Bay, Hayward, CA 94542, mitchell.craig@csueastbay.edu; and LIENKAEMPER, James J., U.S. Geological Survey, Menlo Park, CA 94025.

Abstract:
Ground-penetrating radar (GPR) surveys of the active Green Valley and Hayward faults revealed details of near-surface stratigraphy consistent with observations from trenches, pits, and auger holes. At the Green Valley Fault near Mason Road, a grid of fault-parallel GPR profiles was recorded in search of offset buried stream channels to provide a constraint on fault slip rate. Profiles were 90 m long, spaced 5 m apart. Maximum depth penetration was about 4 m for the 50 MHz GPR and 2 m for the 100 MHz GPR. Though the surveys did not provide sufficient resolution and penetration to determine slip rate, they did provide images of near-surface stratigraphy consistent with independent observations. Core from an auger hole and sediment samples collected from a pit wall showed interfaces with textural contrasts likely responsible for observed GPR reflections. Sediments were dominated by fine silt, with occasional sandy layers up to a few tens of centimeters thick. One GPR profile was collocated with a 12-m-long trench crossing the fault. The trench revealed relatively subtle variations in lithology that were expressed in the GPR profile as discontinuous and undulatory reflectors. GPR profiles were also recorded across the southern Hayward Fault at Tule Pond and 700 m to the SE at Fremont Central Park, typically providing 2–3 m of penetration. Two Tule Pond profiles were 110 m and 125 m long, parallel and adjacent to paleoseismic trenches. Near-surface layers showed distinct lateral variations in thickness. Two 100-m-long Central Park profiles imaged the Hayward Fault and indicated vertical separation downward to the east, in agreement with observations from trenches.

Presentation Type:
Oral

Presenting Author:
Craig, Mitchell

ASSESSING AND MITIGATING THE SEISMIC HAZARDS OF THE CONCORD FAULT FOR A REDEVELOPMENT RESIDENTIAL COMPLEX: A CASE STUDY

DRUMM, Patrick L., Earth Focus Geological Services, Inc., Fremont, CA 94536, USA, patrick@earthfocusgeology.com

Abstract:
The active, mostly right-slip Concord Fault passes through downtown Concord, Contra Costa County, offsetting streets and curbs, deflecting drainages, producing low scarps, and forming at least one sag pond. The project site is within the Alquist-Priolo Earthquake Fault Zone for the Concord Fault just south of the downtown area and consists of an early 1970s mobile home community approximately 10 acres in size slated for redevelopment with upscale condominiums. Review of published geologic maps and previous fault evaluation studies, analysis of historic aerial photographs, and site mapping of apparent fault-creep-related distress to cultural features targeted promising exploratory fault trench locations within the site. Fault trenches were geologically logged to expose the main trace of the Concord Fault zone. The fault consisted of an approximately 10-foot-wide, northwest-striking, steeply northeast-dipping shear zone separating sandstone on the east from colluvium over alluvium and bedrock on the west, which is contradictory to published geologic maps. Half of the transverse section of a significant fluvial channel was exposed east of the fault in one of the trenches, and dated at older than 10,000 years based on soil pedogenic development of overlying soils. The channel was incised into sandstone and tilted approximately 10 degrees from horizontal toward the east, apparently due to uplift along the east side of the Concord Fault at this location. The existing mobile home residences that sit astride the fault zone and any future mobile homes placed on the site are specifically exempt from the setback criteria outlined in Alquist-Priolo Act. A horizontal setback of 50 feet was established along both sides of the explored fault zone for this study and would apply if the site were developed for condominiums as originally proposed.

Presentation Type:
Oral

Presenting Author:
Drumm, Patrick

SEISMIC UPGRADE OF PIPES ACROSS THE HAYWARD FAULT

EIDINGER, J. M., G&E Engineering Systems, Inc., eidinger@geEngineeringSystems.com

Abstract:
This paper provides the status of all water pipelines crossing the Hayward Fault, and a few other utilities such as sewers, water and transit tunnels, and high-voltage power transmission lines. These utilities are owned by EBMUD (water), City of Hayward Water Department, Alameda County Water District, San Francisco Public Utilities Commission, Castro Valley Sanitary District, Bay Area Rapid Transit District, and Pacific Gas and Electric.
For the period between 1990 and 2008, costs for seismic retrofit of existing pipes an tunnels across the Hayward Fault have been about $74,000,000. The utilities currently have design efforts and future planned construction efforts over the next decade that will amount to an additional $69,000,000 (in 2008 dollars). These costs exclude other seismic retrofits due to ground shaking, landslide or liquefaction hazards, or the installation of new pipes for redundancy (more than $1 billion for the period 1990 through 2020).
If the implementation goes forward as planned, then by the year 2020, the majority of the seismically upgraded pipes will survive a Hayward M 6.7 to 7.2 event; the utilities will be in a better position than they were in 1990 to respond to residual damage for nonretrofitted pipes. Even after the year 2020 and the expenditure of some $140,000,000 for fault offset upgrades, more than 200 pipes (most of them 12-inch diameter or smaller) will still suffer damage when exposed to 3 to 5 feet of fault offset. The solution to these remaining nonretrofitted pipes is a combination of long-term replacement (100+ years) using seismic design requirements for new pipes, or good postearthquake response capability to repair the pipes rapidly.

Presentation Type:
Oral

Presenting Author:
Eidinger, John

UNNAMED VOLCANICS IN THE EAST BAY HILLS AND IMPLICATIONS FOR LONG-TERM DISPLACEMENT ON THE HAYWARD FAULT ZONE

FAY, R. P., STRAYER, L. M., and ALLEN, J. R., CSU East Bay, Dept. of Earth and Environmental Sciences, 25800 Carlos Bee Boulevard, Hayward, CA, rfay@horizon.csueastbay.edu, luther.strayer@csueastbay.edu, james.allen@csueastbay.edu

Abstract:
Volcanics of unknown age are interbedded with fluvial units previously mapped as the Orinda Formation of the Contra Costa Group (CCG) and crop out near the Dry Creek Park area of Union City, California. Volcanic units in the Coast Range serve as the key basis to refine long-term displacement rates along active faults by means of correlating these offset rocks using their ages. Unlike the dated Sonoma, Tolay, Berkeley Hills, Mt. Burdell, Northbrae, and Quien Sabe volcanic units and their offset correlatives, the unknown age of the volcanics at Dry Creek Park is important in order to determine their implications for long-term displacement models along the Hayward Fault. We propose to conduct a detailed petrographic analysis of these rocks, attain radiometric dates for these undated volcanics, and map the geology in the Dry Creek area. Our goal is to integrate these findings into existing long-term displacement models.

The Dry Creek Volcanics (DCV) mostly outcrop in the McConnell Syncline (although an isolated tuff appears to be related to the DCV in the Agua Caliente area of Fremont) and within the CCG and represent the youngest rocks within the syncline, which is bounded to the west by the Hayward Fault and to the east by the Mission Peak and Chabot faults. The DCV and the CCG are underlain by the San Pablo Group and Monterey Group, and are in fault contact with the Great Valley Sequence. The faulted, north-plunging, overturned toward the east McConnell syncline contains a 3–5 m thick, green welded tuff within the CCG on the west limb and porphyritic cpx-bearing basalt within the eastern limb.

The DCV share many common features (and maybe age?) with other Tertiary Coast Range units such as the Tolay, Burdell, and Berkeley Hills volcanics. If any of these units are correlative to the DCV, then existing piercing points based only on these units will need to be reevaluated.

Presentation Type:
Poster

Presenting Author:
Fay, Ryan

MANAGING EARTHQUAKE RISKS OF BUILDINGS AT PACIFIC GAS AND ELECTRIC COMPANY

FERRE, K. S., PG&E, San Francisco, CA 94105

Abstract:
Predicting the performance of buildings in earthquakes is a great challenge for structural engineers. At Pacific Gas and Electric Company this is especially true, because the company owns and leases more than 3,000 buildings in its service territory. The buildings encompass all ages, materials, and structural types. Many of the buildings require an enhanced performance objective to assure continued operations after an earthquake for a quick and safe response and restoration of gas and electric service to its customers. The risk management steps of PG&E buildings consider the probability of a significant event, the likelihood of damage, and the consequences of the damage. Buildings are prioritized according to risk, and those buildings with unacceptable earthquake risks are improved to meet the appropriate performance objectives. Several different methods are used to assess the performance of existing buildings and to develop creative retrofit strategies.

Presentation Type:
Oral

Presenting Author:
Ferre, Kent

EARTHQUAKE SITE RESPONSE IN THE SACRAMENTO-SAN JOAQUIN DELTA

FLETCHER, J. B., BOATWRIGHT, J., and SELL, R., U.S. Geological Survey, Menlo Park, CA 94025, USA

Abstract:
Approximately 1,700 km of levees were built to reclaim wetlands for agricultural and urban development in the inland delta of the Sacramento and San Joaquin rivers. These levees (nominal height of 5 m and base of 20 m) are prone to failure from strong motion excited by major local and regional earthquakes. In this study we investigated the response of several representative sites in the delta to seismic shaking. We deployed broadband, continuously recording digital seismographs at three sites in the delta during 2006–2007. Seismometers were deployed at both the crests and bases of the levees at each site. We used both BYR (a new site at Byron Hot Springs) and BDM (of the Berkeley seismic net BDSN) as reference sites. Site response was estimated by determining ratios of spectra of S waves from regional earthquakes recorded at each site with respect to a reference site. Four Bay Area earthquakes, with magnitudes from 3.7 to 5.6, were recorded during this time. The site responses showed considerable variation. Large resonances were observed at Bethel Island crest (ratios greater than 10 at about 3 Hz) using BDM as a reference site. Peak amplifications were smaller and at lower frequencies at the Holland Marina sites. We also determined site response using spectral ratios of microtremor (horizontal to vertical motion) to gain insight into the influence of the choice of reference station. Averaged spectral ratios of microtremor showed many of the same features as those of body waves, such as a strong resonance at about 3 Hz with amplitude of about 6 at the crest site at Bethel Island. The similarity of the response curves from the two methods suggests that the results are not dependent on a particular set of earthquakes or reference sites, but instead represent actual amplifications. The site response analyses indicate that large amplifications can be expected on the levees from strong local and regional earthquakes and may significantly increase the risk of seismic failure.

Presentation Type:
Poster

Presenting Author:
Fletcher, Jon

LOCAL MAGNITUDE AMPLITUDE TOMOGRAPHY OF CALIFORNIA

FORD, Sean R. and UHRHAMMER, Robert A., Berkeley Seismological Laboratory, Berkeley, CA, USA

Abstract:
We find lateral variation in attenuation structure for California by inverting thousands of amplitudes used to calculate local magnitudes for the California Integrated Seismic Network (CISN). The site terms are fixed from previous work, so only the source and path terms are calculated via an iterative least-squares inversion. The source terms are compared with calculated seismic moments. The path terms yield 2D attenuation structure of Northern California fault regions. Lateral variations in attenuation are related to intensities and therefore play an important role in seismic hazard analysis.

Presentation Type:
Poster

Presenting Author:
Ford, Sean

SOURCE OF ELECTROMAGNETIC AND OTHER NONSEISMIC PRE-EARTHQUAKE SIGNALS

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Abstract:
The fear of earthquakes (EQ) is to a large extent based on our collective inability to interpret the diverse and often subtle signals, which the Earth sends out prior to major seismic events:
(i) low-frequency electromagnetic (EM) emissions,
(ii) ionization of the air at the air-ground interface,
(iii) perturbations in the ionosphere at an altitude of 100-300 km,
(iv) infrared (IR) emissions from the epicentral region seen in nighttime satellite images, and
(v) others.

The discovery that electronic charge carriers — positive holes and electrons — can be activated by stress in crustal rocks opens a window of opportunity to study these nonseismic pre-EQ signals from a novel, solid-state physics perspective. Normally the charge carriers lie dormant. When stress is applied, they wake up, turning the stressed rock volume into a battery, from which electric currents can flow out deep within the crust. When these currents fluctuate, they generate EM signals. How they flow depends on many variables. Under certain conditions, which are most likely met only late in the EQ preparation process, the "battery circuit" can close. At this time large currents can flow out, leading to strong EM emissions, predominantly of low frequency. When the positive holes arrive at the Earth's surface, they cause a variety of secondary effects including ionization of the air at the ground-air interface, perturbations in the ionosphere, and distinct IR emissions. This work is being tested through field observations. Recent results obtained by CalMagNet sensors (http://www.quakefinder.com/) prior to the M5.4 30 October 2007 Alum Rock earthquake in the San Francisco East Bay are consistent with these laboratory findings.

Presentation Type:
Poster

Presenting Author:
Freund, Friedemann

SURFACE DEFORMATION ALONG THE HAYWARD-RODGERS CREEK-MAACAMA FAULT SYSTEM MEASURED BY PS-INSAR

FUNNING, Gareth J., University of California, Riverside, CA 92521, USA; BURGMANN, Roland, University of California, Berkeley, CA 94720, USA; FERRETTI, Alessandro, NOVALI, Fabrizio, GIANNICO, Chiara, and FUMAGALLI, Alfio, Tele-Rilevamento Europa, Milan 20147, Italy

Abstract:
The Hayward-Rodgers Creek-Maacama fault system accommodates approximately a quarter of the total Pacific-Sierra Nevada/Great Valley relative motion. Although the system is not a continuous structure, with significant step-overs between the Hayward and Rodgers Creek faults in San Pablo Bay, and the Rodgers Creek and Maacama faults between Santa Rosa and Healdsburg, the faults show similar behaviors, with a mixture of locking and brittle aseismic creep.

We illustrate these behaviors here using a spatially dense set of surface deformation observations from the Bay Area and further north, taken from three parallel descending satellite tracks of the European ERS radar satellites between 1992 and 2003. We process the radar data using the PS-InSAR method, giving us in particular coverage of the southern Maacama Fault zone for the first time. In addition, we have complementary ascending track PS-InSAR data from the RADARSAT satellite and the BAVU regional GPS velocity compilation.

In the area where data are densest, along the central Hayward Fault, we image a zone of zero creep extending from south Oakland to Union City at depths of 6–12 km, which we believe to be a locked asperity and which is consistent with the extent of the damage zone due to the 1868 Hayward earthquake. The southern Rodgers Creek Fault shows no clear creep features, consistent with existing studies suggesting that it remains an unruptured seismic hazard. Further north, however, we find a cross-fault velocity step across the same fault in Santa Rosa, which is consistent with creep at up to 6 mm/yr, although other interpretations are plausible (such as fault-bounded hydrology). Finally, we find the first InSAR evidence for creep on the Maacama Fault at Ukiah, at a rate broadly consistent with that inferred from offsets of surface features.

Presentation Type:
Oral

Presenting Author:
Funning, Gareth

CONTEXT OF THE HAYWARD FAULT IN THE FORMATION AND EVOLUTION OF THE SAN ANDREAS PLATE BOUNDARY

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Abstract:
Although the general process by which the San Andreas Plate boundary (SAPB) forms in response to the fundamental plate tectonic change as the Mendocino Triple Junction migrates along the western margin of North America is well known, the details of the processes by which the specific major faults, which comprise the plate boundary, form is less well understood. Although the San Andreas Fault is typically invoked as the main plate boundary structure, it is clear in Northern California that other major faults play an equal or greater role. In particular, the fault corridor running from nascent to mature of the Maacama-Rodgers Creek-Hayward-Calaveras-San Andreas represents the primary locus of plate boundary deformation on a lithospheric scale. The Hayward Fault sits in a key transitional position along the corridor as it represents the first fully mature segment of the plate boundary along its evolutionary corridor. The mechanical and kinematic behavior of the Hayward Fault, particularly in comparison with the less mature segments to the north, provide insight into both the processes of plate boundary development and the physical fault zone characteristics that are imprinted on the fault during its evolution. For example, characteristic behavior observed on the Hayward Fault, such as substantial fault creep, which also occurs along segments of the Maacama Fault, appears to be an early acquired attribute of the system. Such fault creep behavior is enabled by localized shear beneath the fault, implying that a localized SAPB system, on a lithospheric scale, is well established along the corridor after just a few million years of post-MTJ tectonics. Improved understanding of the links between the Hayward Fault and the deeper structures of the SAPB provide not only important information on the mechanics of that fault segment, but also allow us to place the entire San Francisco Bay area system of faults into a mechanical context, allowing improved assessments of fault interactions.

Presentation Type:
Oral

Presenting Author:
Furlong, Kevin P

BALANCE BETWEEN FAULT RATE, LOCKED AREA, MAGNITUDE, AND RECURRENCE INTERVAL ON THE SOUTHERN HAYWARD FAULT

GRAYMER, R. W., U.S. Geological Survey, Menlo Park, CA, 94025, USA, rgraymer@usgs.gov

Abstract:
The long-term slip rate for the Southern Hayward is generally accepted at 9 ± 2 mm/yr (WGCEP, 2003). Recent geodetic inversions (d'Allesio and others, 2005), however, show that a fault rate between 6.5 ± 1.4 (preferred) and 7.6 ± 1.4 mm/yr better fits GPS data. The idea of a lower fault rate is supported by the observation that accepted fault rates across the East Bay area (total 17 ± 5 mm/yr) exceed those accepted for related faults in the North Bay (14 ± 5 mm/yr) and South Bay (total 15 ± 3 mm/yr) areas.
I tested the possibility of a lower fault rate using the moment-magnitude and moment-area-displacement relations, recently calculated recurrence intervals (131 ± 72 and 160 ± 103 years; Lienkaemper et al., this meeting), repetition of the 1868 M6.8 earthquake or the lower M6.67 WGCEP 2003 mean, an average creep rate of 4.5 mm/yr (to calculate moment released by creep), and two "realistic" models of locked areas. Using locked areas based on creep data (Funning et al., 2006) and no aseismic afterslip (afterslip would increase the total slip for each event and hence increase the fault rate) yields a *minimum* fault rate between 7.5–8.5 mm/yr for a M6.8 quake, 5.9–6.6 mm/yr for a M6.67 quake. Using locked areas based on microseismicity (Waldhauser and Ellsworth, 2002) yields a *minimum* fault rate between 7.6–8.6 mm/yr for a M6.8 quake, 6.0–6.7 mm/yr for a M6.67 quake.
If the 1868 quake represents the average Southern Hayward Fault quake, the geodetic slip rate is less than the long-term slip rate, and disparities in related slip rates between the North, East, and South Bay areas cannot be reconciled by a lower slip rate on the Southern Hayward Fault. If the lower M6.67 estimate better represents the average, then the lower slip rate is allowed (although not proven). A lower slip rate on the Southern Hayward Fault would have ramifications for understanding slip rate on the Northern Hayward, Rodgers Creek, and Maacama faults.

Presentation Type:
Poster

Presenting Author:
Graymer, Russell

GEOLOGY OF THE HAYWARD FAULT ZONE EXPOSED IN THE CLAREMONT BYPASS TUNNEL, BERKELEY, CALIFORNIA

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Abstract:
In 2007, the East Bay Municipal Utility District completed a seismic upgrade of its 18,065-ft-long Claremont Water Tunnel, which crosses the Hayward Fault zone (HFZ). To mitigate tunnel blockage resulting from both aseismic creep and coseismic fault rupture during an Mw 7.0 design earthquake, a 1,571-ft-long bypass tunnel was built through the fault. Centered on the main trace, an 85-ft-long, 6-ft-diameter, and 3-in-thick steel carrier pipe, designed to provide 130 mgd of postearthquake flow, lies within a 16.5-ft-wide reinforced concrete vault. Construction of the NE-trending bypass tunnel provided a rare glimpse of a major active fault 130 feet below ground surface.
The regional-scale HFZ is at least 910 feet wide between east and west boundary faults. Within lies the zone of maximum primary displacement and several subsidiary faults. The main active (creeping) trace is 7–12 ft wide, strikes on average N35°W, dips 40°–68° NE, and is marked by a 0.5–1.0 ft seam of black clay gouge (CH) with slickenlines that plunge 1-4° NW. This trace separates on the SW an 80-ft-wide fault-bounded slice of wood-bearing Quaternary terrestrial sediment deposited in the Lake Temescal right step-over from pervasively sheared serpentinite with meta-basalt inclusions on the NE. Consisting of both alluvium and colluvium, the sediments unconformably overlie a NE-sloping erosional surface developed across tectonically mixed Franciscan mélange and silica-carbonate rock.
About 545 ft NE of the main active trace, the bypass tunnel intersects the east boundary fault of the HFZ, which strikes N34°W, dips ~85°NE, and has poorly developed vertical slickenlines. A 16+-ft-wide clayey gouge zone with tectonically rounded clasts of serpentinite, greywacke, and green chert separates serpentinite and related rocks on the west from sandstone/shale turbidites of the Great Valley Sequence on the east. This fault is likely a remnant of the subduction zone that deformed the Franciscan Assemblage during the Mesozoic.
About 365 ft SW of the main active trace, the bypass tunnel crosses a likely west boundary of the HFZ, which is a NW-trending, near-vertical fault marked by a 0.7-in-thick sandy gouge zone within Franciscan Assemblage mélange. The USGS identified this fault 50 years ago from aligned geomorphic features of probable tectonic origin.

Presentation Type:
Poster

Presenting Author:
Hall, N. Timothy

SACRAMENTO-SAN JOAQUIN DELTA REGION: PROPOSED CONTEMPORARY TECTONIC MODEL

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Abstract:
The Sacramento-San Joaquin delta (S-SJD) is an enigmatic region in that it lacks the obvious tectonic geomorphology displayed in the adjacent Coast Ranges. Late Quaternary terrain features of probable tectonic origin present within and bordering the S-SJD region include the Montezuma Hills (MH), Los Medanos Hills (LMH), local uplifts along the Kirby Hill (KH) fault trend, the Midland (M) and West Tracy (WT) faults, and the Concord-Green Valley (C-GV) fault trend. Other isolated, structurally controlled hills located between the KH and C-GV fault trends are at least of post Plio-Pleistocene age. Additionally the S-SJD region has been the site of local and nearby damaging earthquakes and continuing microseismic activity. We here propose a structural and tectonic model that could explain the geologic features and seismicity mentioned above. This model draws on data and interpretations developed during the past 35 years by numerous researchers. Our tectonic model involves a detachment fault near or at the base of the Great Valley sequence between the C-GV and M faults, with an upper plate being driven south up a ramp over a concealed tectonic wedge presumed to consist of Franciscan rock. The detachment upper plate is split longitudinally by high-angle faulting along the KH trend, which may extend southward beneath the LMH to merge into the G-MC-C trend along the south margin of the LMH wedge-ramp upwarp. The western part of the upper plate is undergoing N-S shortening by internal folding while the eastern part, between the KH and M faults and including the overlying MH, is simply being translated and tilted up to the south as part of the eastern LMH wedge ramp uplift. The driving mechanism for the detachment and wedge ramp uplift may be local N-S compression resulting from long term closing of the inside bend formed by a local change from ~N32W to ~N20W in the fault-controlled orientation of the adjacent eastern Coast Ranges.

Presentation Type:
Poster

Presenting Author:
Hamilton, Douglas

EARTHQUAKE STRESS DROPS AND INFERRED FAULT STRENGTH ON THE HAYWARD FAULT

HARDEBECK, J. L., U.S. Geological Survey, Menlo Park, CA 94025, USA, jhardebeck@usgs.gov; and ARON, A., Brown University, Providence, RI 02912, USA.

Abstract:
The Hayward Fault and other faults of the East Bay provide an opportunity to study variations in earthquake stress drop with depth, faulting regime, creeping versus locked behavior, and the strength of the wall rocks on either side of the fault. We use the displacement spectra from borehole seismic recordings of 529 M1.0–4.2 earthquakes in the East Bay to estimate stress drop using an empirical Green's function method (Shearer et al., 2006). The median stress drop is 8.7 MPa, and 50% of stress drops are between 3.2 MPa and 25 MPa. Several lines of evidence indicate that stress drop is controlled by the applied shear stress, even though the median stress drop values are significantly less than the theoretical shear stress assuming strong faults (Byerlee's law) and hydrostatic pore pressure. There is a trend of increasing stress drop with depth, with median stress drop of about 5 MPa for 1–7 km depth, about 10 MPa for 7–13 km depth, and about 50 MPa deeper than 13 km. Higher stress drops are observed for a deep cluster of thrust-faulting earthquakes near Livermore than for a deep cluster of strike-slip events on the Calaveras Fault. The changes in stress drops with depth and faulting regime imply that stress drop is related to the applied shear stress. We compare the spatial distribution of stress drops on the Hayward Fault to models of creeping versus locked behavior of the fault and find that high stress drops are concentrated around the major locked patch near Oakland. This also suggests a connection between stress drop and applied shear stress, because the locked patch might be expected to experience higher shear stress as a result of either the difference in cumulative slip or the presence of higher-strength material. Comparison of stress drops with the wall-rock geology at depth does not show a correlation between stress drop and rock strength, suggesting that the fault strength is not directly related to the strength of the wall rock.

Presentation Type:
Oral

Presenting Author:
Hardebeck, Jeanne

EAST BAY SEISMICITY: AN OVERVIEW

HARDEBECK, J. L., U.S. Geological Survey, Menlo Park, CA 94205, USA, jhardebeck@usgs.gov

Abstract:
More than 20,000 small East Bay earthquakes have been recorded by the Northern California Seismic Network since the 1960s. These earthquakes provide valuable insight into the geometry and sense of motion of East Bay faults at seismogenic depths. Recent work using 3D seismic velocity models, waveform cross-correlation, and relative relocation techniques has brought these seismicity patterns into sharper focus. High-precision relocations of seismicity on the Hayward Fault reveal a narrow fault zone with subhorizontal streaks of seismicity and aseismic patches on the fault surface. Similar aseismic patches on the Central Calaveras Fault appear to be locked zones that fail in M5 earthquakes. In contrast, the seismicity of the Northern Calaveras Fault and the Mt. Lewis aftershocks exhibit vertical planar features orthogonal to the fault plane. Repeating microearthquakes have been identified on the Hayward and Calaveras faults and are being used to monitor fault creep rates at depth. Seismicity reveals that the Hayward Fault at depth is near vertical to steeply east-dipping. Most Hayward Fault earthquakes have focal mechanisms consistent with pure strike-slip motion on a vertical fault. South of San Leandro, the seismicity at depth diverges from the surface trace to follow the Mission Trend, which merges smoothly with the seismicity of the Central Calaveras Fault. Shallow seismicity locations suggest an east-dipping connection between the Mission Trend seismicity at depth and the surface trace of the Hayward Fault. This implies that the southernmost Hayward Fault is nonplanar, dipping shallowly in the upper 4 km and transitioning to the steeper dip of the Mission Trend at depth. In this model, the Hayward Fault merges smoothly at seismogenic depths with the Central Calaveras Fault. Scenarios considering a large earthquake spanning both the Hayward and Central Calaveras faults should therefore be considered.

Presentation Type:
Oral

Presenting Author:
Hardebeck, Jeanne

EARTHQUAKE EARLY WARNING FOR CALIFORNIA

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Abstract:
Earthquake early warning is the rapid detection of P waves emanating from an earthquake underway, assessment of the ground shaking hazard, and warning those in regions likely to experience damaging ground shaking. ElarmS (http://www.ElarmS.org/), a method for earthquake early warning that uses streaming data from regional seismic networks, can potentially provide seconds to tens of seconds of warning.
UC Berkeley (UCB) is currently participating in a statewide effort to test earthquake early warning algorithms by the California Integrated Seismic Network (CISN). This collaborative effort by UCB, Caltech, the Southern California Earthquake Center, and the U.S. Geological Survey is testing three algorithms, including ElarmS, for accuracy and timeliness.
ElarmS was implemented on the real-time system in early October 2007 and successfully detected the 30 October 2007 M 5.4 earthquake near San Jose, the largest earthquake in the San Francisco Bay region since the 1989 Loma Prieta earthquake. Using 3 or 4 sec of data, ElarmS estimated the event's magnitude to within 0.5 magnitude units and predicted the distribution of ground shaking to within one unit on the Modified Mercalli Intensity scale. The ElarmS computers had determined this hazard before the shaking was felt in San Francisco. There is currently no warning mechanism so no warning was issued. Work by the CISN early warning group suggests that such an analysis could be made so quickly that a warning could be ready at least 10 seconds before the peak ground shaking arrived in San Francisco and Oakland.
Real-time testing continues as more of the seismic stations across California are incorporated into the ElarmS processing system. Currently all stations that could be used for early warning in Northern California (about 160), along with a few in Southern California (15 stations), have been incorporated. In the next few months all Southern California stations will be added, bringing the total number of stations to more than 300.

Presentation Type:
Oral

Presenting Author:
Hellweg, Margaret

CHARACTERIZING SEISMICITY IN THE SAN FRANCISCO EAST BAY

HELLWEG, M., UHRHAMMER, R., DREGER, D., TAGGART, J, CHUNG, A, MCKENZIE, M. R., Berkeley Seismological Laboratory, University of California, Berkeley, CA 94563, USA, peggy@seismo.berkeley.edu; WALDHAUSER, F., and SCHAFF, D., Lamont Doherty Earth Observatory, Columbia University, Palisades, NY 10964, USA

Abstract:
Instrument-based earthquake reporting in the San Francisco Bay Area extends back to the beginning of the 20th century, but the best and most complete data are available for the past thirty years. From the interval spanning the early 1980s to the present, we show earthquake locations in the East Bay from the catalog of the Northern California Seismic Network and compare them with double-difference locations. The double-difference locations highlight more precisely where the faults run at depth, where small earthquakes occur along them, and where events repeat. For events which occurred since 1993, with magnitudes greater than 3.5, we show moment tensor solutions. We have also been reviewing about 700 historical (1930–1966) Bay Area events that were recorded by seismographs run by UC Berkeley. Reviewing P- and S-arrival times and amplitude readings, we relocate them and redetermine their magnitudes. This compilation of East Bay seismicity highlights the known hazards in the area.

Presentation Type:
Poster

Presenting Author:
Hellweg, Margaret

PREDICTED LIQUEFACTION IN THE GREATER OAKLAND AREA AND NORTHERN SANTA CLARA VALLEY DURING A REPEAT OF THE 1868 HAYWARD FAULT (M6.7–7.0) EARTHQUAKE

HOLZER, T. L., NOCE, T. E., and BENNETT, M. J., U.S. Geological Survey, Menlo Park, CA, 94025, tholzer@usgs.gov

Abstract:
The probability of surface manifestations of liquefaction was predicted for two areas along the margin of San Francisco Bay, California — the greater Oakland area and the northern Santa Clara Valley — for a repeat of the 1868 Hayward Fault (**M**6.7–7.0) earthquake. Liquefaction will be significantly more widespread in the greater Oakland area than in the northern Santa Clara Valley owing to the 57 km^2 of susceptible sandy artificial fill emplaced after 1868 along the greater Oakland area shoreline to build military bases, port facilities, and bayfront communities such as Alameda and Bay Farm Island. Probabilities of liquefaction in the area underlain by artificial sandy fill range from 0.2 to ~0.5 for a **M**7.0 event, and decrease to 0.1 to ~0.4 for a **M**6.7 event. In the greater Oakland area, liquefaction probabilities in general are significantly less than 0.05 in the Holocene alluvial fan deposits. In the northern Santa Clara Valley, for a **M**7.0 earthquake and an assumed water-table depth of 1.5 m — the historical shallowest water level — in the central part of the valley, liquefaction probabilities range from 0.1 to 0.2 along Coyote and Guadalupe Creeks, but are less than 0.05 elsewhere. For a **M**6.7 earthquake, probabilities remain greater than 0.1 along Coyote Creek but decrease along Guadalupe Creek to less than 0.1. The higher probabilities are in areas underlain by young Holocene levee deposits where liquefaction and lateral spreading occurred during large earthquakes in 1868 and 1906. Liquefaction probabilities were predicted with the method for probabilistic liquefaction hazard mapping by Holzer (2008, ASCE Geotechnical Special Paper 181). Each liquefaction scenario map was produced with *ArcGIS® ModelBuilder*. Peak ground acceleration was estimated with the new Boore and Atkinson NGA attenuation relation (2008, *Earthquake Spectra* **24**:1, 99–138). V_{S30} was used to account for local site amplification.

Presentation Type:
Oral

Presenting Author:
Holzer, Thomas

BAY AREA REGIONAL DEFORMATION NETWORK CAPABILITIES IN EAST SAN FRANCISCO BAY

HOULIÉ, Nicolas and ROMANOWICZ, Barbara, Berkeley Seismological Laboratory, University of California, 205 McCone Hall, Berkeley, CA 94720-4760, USA

Abstract:
The San Francisco Bay area is one of the most tectonically deformed areas in the world. This deformation is the result of relative motion of the Pacific and North American plates. A large part of the strain (75%) is accommodated along structures lying in a 50-km-wide land stripe. At least two major seismic events (Mw>6.5) are expected along the San Andreas (SAF) and Hayward faults (HAY) within the next decades.
The BARD network is a permanent GPS network composed of 40 GPS sites, installed since 1994 in Northern California (Romanowicz et al., 1994). Originally started as a collaborative effort of different Bay Area institutions, since the establishment of the Plate Boundary Observatory, it is now focused on real-time data acquisition from stations operated by UC Berkeley, with plans for expansion in collaboration with USGS/Menlo Park. The BARD network is streaming data to the Berkeley Seismological Laboratory in real-time (sampling rates of 1s and 15s, depending on the site). All sites are transmitting data using Frame Relay technology, which makes them safer in case of earthquake occurrence. Data are archived at the Northern California Earthquake Data Center (NCEDC, http://www.ncedc.org/) and are freely available (Neuhauser et al., 2001). The BARD network is currently able to provide high-accuracy (error<1mm/yr) velocities in Northern California.
With seven sites located less than 15 km from the Hayward Fault, the BARD network is thus well suited to constrain the slip amplitude along the Hayward Fault as well as its northern end location in north San Francisco Bay.

Presentation Type:
Poster

Presenting Author:
Houlie, Nicolas

SEISMIC HAZARD MITIGATION AND RESPONSE AT CSU EAST BAY

ISHIDA, Craig W., California State University East Bay, Hayward, CA 94542, USA, craig.ishida@csueastbay.edu

Abstract:
Situated adjacent to the Hayward Fault, the CSU East Bay Hayward campus has two buildings rated as the highest seismic risk within the CSU system. These buildings will be either razed or modified to reduce their seismic risk. New buildings are not only constructed according to the latest seismic codes and recommendations but also are supplied with specialized equipment, such as evacuation chairs.
The Emergency Management Program at CSU East Bay has vastly expanded its seismic hazard mitigation and response responsibilities over the past 15 years. The seismic anchoring program not only includes gas cylinders as required by OSHA but extends to shelf restraints, computer straps, bolted bookcases, and anchored file cabinets. The university provides daily back-up and off-site storage of its critical e-mail and network files.In addition to the designated emergency responders in the University Police, Facilities Management, and Environmental Health and Safety, Building Safety Assistants (BSA) comprise the core of the response program. A voluntary group whose primary role is to provide guidance during evacuations of buildings, BSAs may receive additional training in use of fire extinguishers, evacuation chairs, NIMS/SEMS (incident command), CPR, first aid, and Campus Community Emergency Response Team (C-CERT).

Presentation Type:
Oral

Presenting Author:
Ishida, Craig

A HIGH-RESOLUTION BOREHOLE FAULT MONITORING SYSTEM IN THE SAN FRANCISCO BAY REGION

JOHNSTON, M. J. S., LANGBEIN, J., MYREN, G. D., and SILVERMAN, S., U.S. Geological Survey, Menlo Park, CA 94025, USA

Abstract:
Identification of strain, displacement, and slip at high resolution on faults in the Bay Area before, during, and following the next damaging earthquake remains a necessary step and a critical challenge for the earthquake hazard reduction program. To achieve this, a low-noise real-time fault monitoring system has been installed throughout the region with a particular focus on the Hayward Fault. Instruments used include dilational strainmeters, tensor strainmeters, fluid pressure monitors, creepmeters, tiltmeters, continuous GPS displacement monitors, and seismic velocity and acceleration transducers. Most instruments are installed in boreholes at depths up to 200 m. At these depths, measurement precision is about 20 dB below that of surface instruments and short-term crustal strain changes less than one part per billion can easily be identified. A total of 14 strainmeters, 8 tiltmeters, 5 creepmeters, 5 pore pressure instruments, 5 continuous GPS, 11 borehole seismic instruments, and a number of supporting instruments have been installed through the bay area. Data are transmitted by digital satellite telemetry to the USGS and high sample rate telemetry to either the USGS or UC Berkeley for analysis, display, and archiving. Results include clear observations of (1) strain load changes from local seismic and aseismic slip events with ML>3. M=5+ events, such as the M5.5 Alum Rock earthquake of 31 October 2007, are recorded on the entire network; (2) dynamic loading and unloading of the different fault systems by teleseismic events; (3) slow earthquakes with substantial moment release equivalent of at least M5; and (4) limits on the depth of surface fault slip (creep) events. No indications of deep accelerating fault slip, indicative of the onset of fault failure, have yet been observed.

Presentation Type:
Oral

Presenting Author:
Johnston, Malcolm

SEISMIC HAZARD MAPPING OF CALIFORNIA INCORPORATING SPATIAL VARIABILITY OF SITE CONDITIONS

KALKAN, Erol, WILLS, J. Chris, and BRANUM David, California Geological Survey, Sacramento, CA, United States

Abstract:
The U.S. Geological Survey has released a new version of the probabilistic National Seismic Hazard Maps. These maps plot the peak ground acceleration (PGA) and spectral ordinates at 0.2 sec and 1.0 sec with 2% and 10% probabilities of being exceeded in 50 years, corresponding to return periods of about 2,475 and 475 years, respectively. These acceleration levels were computed for uniform “firm rock” site conditions, i.e., 760 m/sec average shear-wave velocity in the upper 30 m. These maps do not show the potential spatial variability of ground motion estimates associated with different site conditions. In order to show the potential seismic shaking hazards, including the effects of site conditions, we have combined the USGS National Seismic Hazard Map model with the map of California showing geologic units that can be defined by their shear-wave velocity (Wills and Clahan, 2006). Wills and Clahan (2006) described a set of 17 generalized geologic units. For this new seismic shaking hazard map, these units were regrouped and defined by seven different shear-wave velocities. At each shear-wave velocity value, a probabilistic seismic hazard map was generated for the entire state. By combining seismic hazard maps based on the seven different shear-wave velocity values, a suite of seismic hazard maps was computed for California for PGA, 0.2 sec and 1.0 sec spectral ordinates at 2% and 10% probabilities of being exceeded in 50 years. These improved maps explicitly reflect the site effects and their spatial variability on ground motion estimates.

Presentation Type:
Poster

Presenting Author:
Kalkan, Erol K

UPDATE ON UNDERSTANDING OF THE CALAVERAS FAULT: RECENT RESEARCH, ENGINEERING APPLICATIONS, AND DATA GAPS

KELSON, Keith, William Lettis & Associates, Inc., Walnut Creek, CA 94596 USA, kelson@lettis.com

Abstract:
The 150-km-long Calaveras Fault is a major seismic source in the eastern San Francisco Bay area and accommodates about 40% of regional dextral strain at the latitude of San Jose. While current seismic source characterizations enable construction of viable hazard models, substantial uncertainties remain. Active efforts are improving fault characterization and hazard estimation: Research on interactions between the Calaveras and Hayward faults is addressing the likelihood of multisegment ruptures; detailed LiDAR- and photo-based geomorphic mapping is defining patterns of Holocene deformation and targeting key paleoseismic sites; exploratory trenching is refining surface-rupture histories; analyses of seismicity are elucidating repeatability of small and moderate events; and large-scale crustal deformation analyses are defining regional strain fields. Consulting analyses focused on better hazard characterization are using this research to refine seismic source characteristics for ground-motion estimation, improve estimates of coseismic rupture amounts for lifeline design and retrofit, and develop earthquake-resistant engineering designs. Several critical questions remain for defining ground-motion and fault-rupture hazards posed by the fault:
(a) How does the intersection of the Calaveras and Hayward faults affect fault segmentation models and large-earthquake rupture scenarios? Is a Central Calaveras-Southern Hayward multisegment rupture plausible?
(b) What are probabilities for large, surface-rupturing earthquakes on the Central or Southern Calaveras faults? Zero?
(c) Do range-front reverse faults rupture independently of the Central Calaveras Fault?
(d) What is the timing of the most recent surface rupture on the Northern Calaveras Fault?
(e) Does slip on the Northern Calaveras Fault transfer to the Concord Fault, the Contra Costa Shear Zone/West Napa Fault, or somewhere else?
(f) What are reasonable cross-fault distributions of coseismic slip at the ground surface?

Presentation Type:
Oral

Presenting Author:
Kelson, Keith

MODERATE EARTHQUAKE GROUND MOTION VALIDATION IN THE SAN FRANCISCO BAY AREA

KIM, A., DREGER, D., Berkeley Seismological Laboratory, Berkeley, CA, 94720; and LARSEN, S., Lawrence Livermore National Laboratory, Livermore, CA, 94551

Abstract:
We performed 3D ground motion simulations for 10 recent moderate earthquakes in the San Francisco Bay area to evaluate two versions of the USGS 3D velocity model. Comparisons were made in terms of modeling phase arrival timing, peak ground motion amplitudes, and general seismic waveforms. One model, version 5.1.0, was released in 2005 (Brocher et al., 2005; Jachens et al., 2006). The other model, version 8.3.0, was released in May 2008 (Brocher, 2008). This later model reduced both P- and S-wave velocities to correct the earlier phase arrival timing mismatch reported by Rodgers et al.(2007). The comparison of peak ground velocity (PGV) for both models reveals that both 3D models predict the observed PGV well over the four orders of magnitude. On the other hand, model 8.3.0 predicts the arrival time better, but discrepancies remain in estimated amplitudes, which are remedied by including attenuation in the calculation. In our presentation we will compare observed and simulated peak ground velocity maps and waveforms for both point-source and finite-source models for the moderate earthquakes.

References
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Rodgers A., N., A. Petersson, S. Nilsson, B. Sjögreen, and K. McCandless (2008), Broadband Waveform Modeling of Moderate Earthquakes in the San Francisco Bay Area and Preliminary Assessment of the USGS 3D Seismic Velocity Model, Bull. Seism. Soc. Am., 98 no. 2, 969-988.

Presentation Type:
Poster

Presenting Author:
Kim, Ahyi

USING SEISMIC REFRACTION TO IDENTIFY AND CHARACTERIZE NEAR-SURFACE EXPRESSION OF ACTIVE FAULTS IN THE EASTERN SAN FRANCISCO BAY AREA, CALIFORNIA

KIMBALL, M. A., CRAIG, M. S., California State University East Bay, Hayward, CA 94540; and LIENKAEMPER, J. J., U.S. Geological Survey, Menlo Park, CA 94025

Abstract:
We recorded seismic refraction lines on the Green Valley and Hayward faults, two active right-lateral strike-slip faults in the San Andreas Fault system. The Green Valley Fault site is near Mason Road, 2.8 km NW of the junction of Highways 80 and 680. The Hayward Fault site is at Tyson's Lagoon in Fremont, 200 m SE of the Fremont BART station. When used together with ground-penetrating radar, cone penetrometer tests, borehole logs, and trenching, the seismic refraction data proved useful in verifying the fault locations and in facilitating the location of future work at the sites. More specifically, at the Green Valley Fault site, refraction travel-time curves clearly show lateral discontinuities beneath a fairly homogeneous surface layer. Corresponding velocity contours in refraction profiles parallel to the fault are 2–5 m deeper to the west, indicating a minor vertical component of slip, or at the very least a geomorphic expression of offset topography. At Tyson's Lagoon (also called Tule Pond) along the Hayward Fault, the refraction models indicate a stark velocity contrast that is likely the contact between Holocene alluvium and Pleistocene gravel deposits. Two travel-time curves indicate the presence of a lateral discontinuity at depth that may correspond to a suspected cross-fault within the sag pond. At both sites the lateral discontinuities noted in travel-time curves correspond to similar features observed in tomographic inversion models. Results from the seismic refraction surveys presented here bridge a critical gap between relatively shallow trench-based studies and studies based on deeper, but laterally discontinuous, boreholes. While the refraction method has lower resolution than trench or borehole mehods, and is unable to resolve velocity reversals, it does provide an effective and inexpensive tool for near-surface characterization of faults in Holocene and Pleistocene sediments, and for the placement of boreholes or trenches for more detailed studies.

Presentation Type:
Poster

Presenting Author:
Craig, Mitchell

NEW CONSTRUCTION ON EXISTING LANDSLIDES IN URBAN AREAS REGULATED BY THE CALIFORNIA SEISMIC HAZARD MAPPING ACT

KROPP, Alan and MAGNUSEN, Wayne, Alan Kropp and Associates, Berkeley, CA 94704, USA, akropp@akropp.com

Abstract:
The 1990 California Seismic Hazards Map Act (SHMA) delineated a significant portion of the East Bay hillsides to be potentially susceptible to earthquake-induced landslides. The revised *Guidelines for Evaluating and Mitigating Seismic Hazards in California* (Special Publication 117) provide a framework for "Hazard Accommodation" and states "engineering techniques based on performance can be used to accommodate the stress" caused by seismically induced landslides. Broad areas shown as potentially susceptible to earthquake-induced landsliding on the SHMA maps are located in the Berkeley Hills. Several large landslide complexes have been identified by a variety of investigators and have been shown to be undergoing slow downhill creep under current nonseismic conditions. Therefore, depending on the magnitude and distance of a future earthquake, as well as the groundwater conditions present at the time, it is anticipated that significant earthquake-induced landslide displacement may occur during a large Bay Area earthquake.
A number of measured displacements of creeping landslides were compiled from California, New Zealand, and Japan for movement before, during, and after significant earthquakes. General estimates of seismically induced movements were also developed using current analytical techniques for the Berkeley Hills sites. Applying the case history information and calculated magnitudes, it is anticipated that earthquake-induced landslides of several inches to many feet could occur in the Berkeley Hills landslide complexes.
Carefully engineered mat foundations for new and existing structures have been constructed at more than 30 locations in the Berkeley Hills area. A review of the performance of these foundations, some of which have moved several feet, has been very good. It is the author's conclusion that acceptable performance of these foundations would likely occur during significant Bay Area seismic events and that this approach is in compliance with the provisions of the SHMA.

Presentation Type:
Oral

Presenting Author:
Kropp, Alan

BERKELEY HILLS LANDSLIDE-INDUCED PROPERTY LINE MOVEMENT UNDER BOTH STATIC AND EARTHQUAKE CONDITIONS

KROPP, Alan, Alan Kropp and Associates, Berkeley, CA 94704, USA, akropp@akropp.com

Abstract:
A number of slowly creeping landslide complexes are located in the Berkeley Hills; inclinometer and InSAR measurements indicate that the rate of movement generally varies from zero to nearly two inches per year. Land survey readings have recorded 10–15 feet of downhill movement since some of the streets and lots were created nearly 100 years ago. The landslides are often moving as relatively coherent blocks, and constructed works within a landslide are generally moving intact with the block. The most severe damage tends to occur at landslide boundaries or at edges of discreet sections within the overall complex. Various amounts of damage occur within the landslide boundaries with occasional zones of virtually no distress; this makes many property owners unaware of the situation until there is a property line survey and obvious discrepancies are seen between existing facilities and surveyed lines. Numerous lawsuits related to this situation have arisen and the author has served as an expert witness on four such litigation matters. Recently, a legal precedent may have been set when a judge ruled in favor of one neighbor seeking an adjustment of a property line and associated easement. Another remedy may be to pass laws like those governing ground displacement from earthquakes. Permanent adjustments to property lines resulting from seismic displacements were made by the Alaskan legislature in 1966 for Anchorage following the 1964 earthquake (the Earthslip Relief Act) and by the California legislature for Sylmar following the 1971 earthquake (the Cullen Earthquake Act). A bill currently pending in the California legislature (AB2479) seeks authority for a companion law to the Cullen Earthquake Act that would address gradual earth movement. Following a large earthquake impacting the Berkeley Hills, it is anticipated that elements of both the Cullen Earthquake Act and the new legislation addressing gradual movement (if passed) will be needed to adjust property lines equitably.

Presentation Type:
Poster

Presenting Author:
Kropp, Alan

SEISMIC IMPROVEMENT PROGRAM OF THE EAST BAY MUNICIPAL UTILITY DISTRICT WATER SYSTEM

LEE, David D., East Bay Municipal Utility District, Oakland, CA, USA, dlee@ebmud.com

Abstract:
The East Bay Municipal Utility District (EBMUD) has recently completed a 10-year, $200 million Seismic Improvement Program. This presentation will describe the development of the improvement strategy, public outreach and education, implementation of the improvement program, and, most importantly, the lessons learned from the experience of the Seismic Improvement Program.
The East Bay Municipal Utility District serves 1.3 million water customers living in a 325 square mile area on the east side of San Francisco Bay. The district undertook an in-depth review of the vulnerability of its water system in 1991 after the Loma Prieta earthquake. The studies took a comprehensive look at the overall system reliability. It developed service goals, predicted system performance under major earthquakes, and developed a $200 million improvement program to meet various performance levels. The implementation of the program was recently completed. In any undertaking of this magnitude of seismic improvement program, lessons are learned which will make future programs more successful. This presentation will also discuss the key lessons learned.

Presentation Type:
Oral

Presenting Author:
Lee, David

RECONNAISSANCE OBSERVATIONS AND LESSONS LEARNED FROM THE 8.0M WENCHUAN EARTHQUAKE, CHINA

LEE, David D., East Bay Municipal Utility District, Oakland, CA, USA, dlee@ebmud.com

Abstract:
The M8.0 Wenchuan earthquake occurred on 12 May 2008, at 2:28 p.m. local time. The magnitude of this earthquake makes it one of the largest earthquakes in the world in recent decades. The earthquake caused more than 69,000 deaths, 19,000 missing, and 374,000 injuries. More than 5 million buildings collapsed, 21 million buildings were damaged, and more than 5 million people were left homeless. The total economic loss is estimated to be $86 billion.
The ASCE (American Society of Civil Engineers) Technical Council of Lifeline Earthquake Engineering (TCLEE) dispatched a reconnaissance team to the disaster area on 12 July 2008 to investigate the earthquake damage. This presentation will describe the observations of the team members and lessons learned in the subject areas of geology, buildings, water, transportation, power, communications and industrial facilities. The presentation will also describe the emergency response by the Chinese government and military.

Presentation Type:
Oral

Presenting Author:
Lee, David

THE GREEN VALLEY FAULT: GEOLOGIC RECORD OF FOUR LARGE EARTHQUAKES IN THE PAST MILLENNIUM

LIENKAEMPER, J. J., SICKLER, R .R., BROWN, J., USGS MS 977, 345 Middlefield Rd., Menlo Park, CA 94025; BALDWIN, J. N., TURNER, R., Jr., Lettis and Assocs., 1700 Botelho Ave., Ste. 262, Walnut Creek, CA 94956; and GUILDERSON, T. P., CAMS, Lawrence Livermore National Lab., Livermore, CA 94551

Abstract:
We have documented a geologic record of at least four surface-rupturing earthquakes on the Green Valley Fault (GVF) at the Mason Road trench site near Fairfield, California since AD 1024 ± 97 yr (1 sd, standard deviation). The GVF creeps 3-4 mm/yr (McFarland et al., 2007), making recognition of evidence for past surface ruptures challenging, but we identified four stratigraphic horizons disrupted by upward-flowering shears and in-filled fissures, features that likely would not have formed from creep alone. The age of the most recent earthquake (MRE), critical to seismic hazard evaluation, is not well constrained here (AD 1623 ± 112 yr; 1 sd), but it is at the Lopes Ranch site located 10 km south of Mason Road, at AD 1705 ± 70 yr (1 sd). Dating more radiocarbon samples from below the MRE horizon at Mason Road may further reduce this age uncertainty. Using the latest version of the program Oxcal (Bronk-Ramsey, 2007) to model the timing of the four-event earthquake sequence from our radiocarbon data yields a mean recurrence interval (RI) of 200 ±148 yr (1 sd). Previously, no geologic data existed to estimate the RI for the GVF, so the Working Group on California Earthquake Probabilities (2003) used a generic geophysical model of the fault to estimate a mean RI of 210 yr (112-665 yr, 95 percentile), similar to our geologically based estimate of 200 yr (1-518 yr, 95 percentile).

Presentation Type:
Oral

Presenting Author:
Lienkaemper, James

THE HAYWARD FAULT: ITS PAST LARGE EARTHQUAKES AND ONGOING CREEP

LIENKAEMPER, J. J., U.S. Geological Survey, Menlo Park, CA 04025; WILLIAMS, P. W., Dept. Geological Sciences, San Diego State Univ., San Diego, CA 92182; McFARLAND, F. S., ENSR/AECOM, 300 Lakeside Drive, Ste. 220, Oakland, CA 94621; and CASKEY, S. J., Department of Geosciences, San Francisco State University, San Francisco, CA 94132

Abstract:
Without knowledge of the M6.8 earthquake in 1868, we might have been ignorant of the serious hazard the Hayward fault poses for the San Francisco Bay Area. However, geologists recently have found evidence of multiple prehistoric or paleo- earthquakes on this fault. We excavated trenches across the fault in places where many layers of sediment can be radiocarbon dated, such as Tule Pond in Fremont. Fault ruptures, the cause of earthquakes like the 1868 event, disrupt these layers. Dating disrupted layers buried by younger undisturbed layers provides timing for paleoearthquakes. We estimate paleoearthquake ages using radiocarbon and other dating methods using a chronologic modeling program (Oxcal) that incorporates uncertainty in converting radiocarbon ages to calendar ages and stratigraphic ordering constraints. The estimated mean recurrence interval for large southern Hayward fault earthquakes is 160+/-103 years (+/-1sd, one standard deviation) since AD 110 (+/-49 years), using the ages of the 12 most recent earthquakes, but for the past 5 earthquakes it is 131+/-72 years (1sd). Within the uncertainties, these estimates are not statistically distinct.

The fault has also been creeping steadily since 1868 (except for brief interruptions caused by the 1906 and 1989 earthquakes), along most of its length at 0.18 inch/year (3-6 mm/yr) and near its south end at 0.35 inch/year (9 mm/yr). This creep is slow enough, that it went undetected until the early 1960s. However by then, critical structures including U.C. Memorial Stadium, five elementary schools and a hospital had been built right across its active traces. This steady creep relieves some crustal strain that would otherwise release in large earthquakes. Various geophysical models suggest that enough sizable patches of the fault remain fully locked, at depths ranging from as shallow as 1.5 miles down to 8 miles (3 -12 km), that sufficient strain has accumulated on these locked patches to produce a large earthquake.

Presentation Type:
Oral

Presenting Author:
Lienkaemper, James

PROBABILITY-BASED SEISMIC ASSESSMENT OF BUILDINGS, CONSIDERING POSTEARTHQUAKE SAFETY

MAFFEI, Joe and TELLEEN, Karl, Rutherford & Chekene Consulting Engineers, San Francisco, CA, USA

Abstract:
Advanced Seismic Assessment Guidelines, developed by researchers at Stanford University and tested by the authors, offer improvement over previous methods for seismic evaluation of buildings where postearthquake safety is a concern. The authors have used this method to perform seismic assessments for several buildings in PG&E's utility network, including electrical substations near the Hayward Fault in Oakland and Berkeley, as well as facilities in San Francisco and Vacaville. This probability-based method allows engineers to quantify expected structural performance with respect to PG&E's specific performance goals. Performance levels quantified in the *Guidelines* range from “No Damage” to “Collapse” and include intermediate performance levels based on the postearthquake occupancy classifications “Green Tag,” “Yellow Tag,” and “Red Tag.” Other features of the *Guidelines* include an emphasis on correctly identifying the governing mechanism of nonlinear behavior, practical methods for addressing the effects of strength degradation and residual drift, and a probability-based approach that incorporates uncertainty.

Presentation Type:
Oral

Presenting Author:
Telleen, Karl

RETROFIT DESIGN OF BART STRUCTURES FOR FAULT MOVEMENTS

MATHUR, R., Parsons, San Francisco, CA, 94105, USA, Ravindra.P.Mathur@Parsons.com; and JOHNSON, T., Bay Area Rapid Transit District, Oakland, CA, 94612, USA, Tjohnso@bart.gov

Abstract:
The Bay Area Rapid Transit (BART) District is undertaking a comprehensive program to seismically retrofit its system. The Bay Point-Concord Line aerial guideway is part of this $1.3 billion program. This section of BART is crossed by the potentially active Contra Costa Shear Zone (CCSZ) at Pleasant Hill Road in Lafayette and at the I-680 Overpass in Walnut Creek and by the active Concord Fault at Systron Drive in the city of Concord. A report by William Lettis & Associates[1] presented the expected amounts and distributions of fault offsets for these three locations. These offsets were used to develop retrofit designs.
Cumulative expected fault offsets were developed for earthquakes having a return period of 475 years (10% probability of occurrence in 50 years) from scenario earthquakes for the 50%, 84% and 97.5% cumulative probability levels. Displacements corresponding to 84% cumulative probability levels were chosen for evaluating the structures and the decision was made to base the retrofit designs on the combined effects of the expected fault displacements and the design acceleration response spectrum analyses. The latter analyses considered the design basis earthquake with the intent of providing a life safety performance level.
This paper discusses the retrofit designs for three structures that consider the combined effects of fault movements and response spectrum analyses.

1. Expected Fault Displacements along the BART Concord-Bay Point line, Alameda and Contra Costa Counties, CA, William Lettis & Assoc., Inc, Feb. 2006

Presentation Type:
Oral

Presenting Author:
Mathur, Ravi

DELTA RISK MANAGEMENT STRATEGY RISK ANALYSIS FOR THE SACRAMENTO-SAN JOAQUIN AND SUISUN MARSH LEVEE SYSTEM

McCANN, Jr., M. W., Jack R. Benjamin & Associates, Inc., Menlo Park, CA, mccann@jbaslc.best.vwh.net

Abstract:
In the event of a major earthquake in the Bay Area, particularly one occurring in the East Bay, there may be a significant impact to levees in the Sacramento-San Joaquin delta. The Delta Risk Management Strategy (DRMS) project carried out by the California Department of Water Resources has evaluated the impact that earthquakes may have on delta levees and the potential life safety, economic and environmental impact levee failures may have in the delta and the state. When levees failures occur as the result of an earthquake, the DRMS models the hydrodynamics of salt water intrusion into the delta as islands flood and the timing and cost of levee repair operations (e.g., repair of breached levees, protecting the exposed levee interiors to wind waves, repair of damaged but nonbreached levees). The consequences of island flooding include the potential for fatalities and injury, damage to delta infrastructure (residences, businesses, pipelines, roadways, rail lines, etc.), and disruption of SWP and CVP water exports due to salinity intrusion, which impacts the state's economy and has in-delta environmental consequences. In addition to earthquakes, the DRMS study also evaluates the risk due to floods, wind waves, and normal or sunny-day events on delta levees.
The DRMS is being carried in part in response to Assembly Bill (AB) 1200, which also requires an assessment of risks over the next 200 years. An estimation of risks in the future is particularly challenging, given the limited information that is available. The analysis includes the increasing potential for a major seismic event, the effects of climate change (e.g., sea level rise and impacts on flooding), the increasing exposure of people and property in the delta to the effects of island flooding, and the growing exposure of the state to the effects of water export disruptions.

Presentation Type:
Oral

Presenting Author:
McCann, Martin

EFFECTS OF TOPOGRAPHY AND GEOLOGY ON SHAKING DAMAGE TO WOOD-FRAME RESIDENTIAL STRUCTURES DURING THE 2003 SAN SIMEON EARTHQUAKE, WESTERN SAN LUIS OBISPO COUNTY, CALIFORNIA

McCRINK, Timothy P., MANSON, Michael W., WILLS, Christopher J., and REAL, Charles R., California Geological Survey, Sacramento, CA, 95814, USA

Abstract:
The California Geological Survey, sponsored by the California Earthquake Authority, recently completed a study of earthquake shaking damage to residential wood-frame buildings caused by the 2003 M6.5 San Simeon earthquake. This study used shaking damage value estimates from insurance claims for 297 structures in western San Luis Obispo County. A background data set of 5,099 insured properties was also used. Structural features recorded for each claim include the year built, square footage, number of stories, foundation type, garage location, and floor plan configuration. Digital elevation models and GIS software were used to classify terrain into distinct landforms at each claim and policy site. A geologic map was compiled over the study area and the geology underlying each building was recorded. All known occurrences of ground failure were removed.
There are both increased occurrences and higher damage costs to houses constructed on hilltops when compared to those on sloping ground. Damage is related to underlying geology. The highest number of occurrences is on Paso Robles Formation, and these are the result of site response, not topographic amplification. Highest damage cost is on Tertiary and Cretaceous rocks on hilltops and is thought to be related to hilltop shape, though site response effects cannot be completely ruled out. Erosion patterns that result in higher slope curvature at hilltops are an indication of higher damage levels. Structural vulnerabilities also are significant. Damage to old structures is significantly higher on hilltops than sloping ground, suggesting topographic amplification is exploiting this vulnerability. The increased shaking amplitude on hilltops overwhelms any advantages imparted by other favorable structural features, so that damage costs are equal to houses with vulnerable structural features on hilltops. Further study is needed to see if these findings can be applied to other areas, such as the East Bay hills.

Presentation Type:
Oral

Presenting Author:
McCrink, Timothy

DAMAGE SURVEY OF THE 2008 SICHUAN EARTHQUAKE AND APPLICATION TO CALIFORNIA AND THE EASTERN SAN FRANCISCO BAY AREA

MIYAMOTO, Kit and GILANI, Amir, Miyamoto International, Sacramento, CA

Abstract:
On 12 May 2008, the magnitude 8.0 Sichuan earthquake occurred approximately 1,550 km southwest of Beijing, China. Millions of buildings, thousands of bridges, and many dams, roads, and lifelines collapsed or sustained severe damage. Schools and hospitals were especially vulnerable. The fatalities approached 70,000 and millions were injured or left homeless. Damage was estimated at more than US $100 billion. For the collapsed buildings, the lack of ductility, the absence of a well defined load path, and building irregularities were primary deficiencies contributing to the observed damage. Many schools, constructed with unreinforced masonry (URM) walls, collapsed. Residential buildings using URM construction also fared poorly. Nonductile reinforced concrete buildings performed slightly better. Many of these buildings sustained significant damage but did not collapse. For concrete-framed buildings, the presence of masonry infills introduced two additional failure modes: soft-story collapse and captive-column failure. Industrial buildings fared better, but many of these structures sustained equipment and nonstructural damage. While some of the surveyed damage is unique to China, many observations are applicable to other locations, including the San Francisco East Bay. For example, in past earthquakes in California, URM and nonductile concrete buildings have performed poorly; nonstructural and equipment damage has been widespread even in the event of moderate earthquakes, leading to financial losses; and lifeline damage and interruptions have been observed. Fortunately, robust assessment techniques and both conventional and innovative retrofit strategies are available to address such vulnerabilities. For example, the new edition of the California Code dedicates two chapters to seismic retrofit of URM buildings. Additionally, professional practice has taken a more comprehensive approach to quantifying the response of nonstructural components.

Presentation Type:
Oral

Presenting Author:
Miyamoto, Kit

WEAKENING OF SERPENTINITE SHEARED AGAINST QUARTZOFELDSPATHIC ROCKS AND ITS POSSIBLE IMPLICATIONS FOR CREEP ON THE HAYWARD AND CALAVERAS FAULTS

MOORE, D. E., LOCKNER, D. A., and PONCE, D. A., U.S. Geological Survey, Menlo Park, CA 94025, United States

Abstract:
Ophiolitic rocks are juxtaposed against quartzofeldspathic rocks at depth across considerable portions of the Hayward and Calaveras faults. Serpentinite associated with the ophiolite has unusual rheological (frictional) properties and may lead to the creep that is documented along these faults. To investigate this possibility, we are conducting triaxial experiments under hydrothermal conditions to determine the changes in frictional properties that might result from deformation of serpentinite in the presence of granodiorite and quartzite. All experiments were conducted at a fluid pressure of 50 MPa and effective normal stress of 100 MPa, at temperatures between 200° and 300°C (corresponding to depths of ~6–10 km) and shearing rates of 36.4-3640 mm/yr. In this T range, the coefficient of friction of granite and quartzite is 0.7–0.8 and that of lizardite and antigorite serpentinite 0.5–0.6, and the strength of each material is greater at 300°C than at 200°C. When serpentinite is sheared against granite or quartzite, however, its strength is reduced by as much as 40%, to a coefficient of friction of ~0.3. Strength reductions are greatest at 250–300°C. During velocity-stepping experiments, strength decreases substantially with decreasing shearing rate, which is inherently stable behavior, and the strength reductions are reversible when the rates are increased. Preliminary SEM and XRD analyses of the run products show little evidence of the growth of new, weak minerals. The cause of the weakening is thus presumed to be a solution-transfer process involving the dissolution of ultramafic minerals in the presence of quartz-bearing rocks. In quartzofeldspathic rocks, solution-transfer processes normally become important at T>350°C, corresponding to depths below the base of the seismogenic zone. The chemical contrast between ultramafic and quartzofeldspathic rocks juxtaposed across an active fault may therefore be the driving force for aseismic slip (creep) at T<350°C.

Presentation Type:
Poster

Presenting Author:
Moore, Diane

DEPENDENCE OF FRICTIONAL STRENGTH ON COMPOSITIONAL VARIATIONS OF ARTIFICIAL GOUGE DERIVED FROM HAYWARD FAULT ROCKS

MORROW, C. A., MOORE, D. E., and LOCKER, D. A., U.S. Geological Survey, Menlo Park, CA 94025, cmorrow@usgs.gov, dmoore@usgs.gov, dlockner@usgs.gov

Abstract:
A 3D geologic model of the Hayward Fault in the San Francisco Bay region shows different rock units juxtaposed across the fault surface as a result of displacement. The gouge found in the fault is likely to be a mixture of these various rock types. To model the mechanical behavior of the Hayward Fault better, frictional properties of mixtures of the principal rock types were determined in the laboratory. Room temperature triaxial shearing tests were conducted on binary and ternary mixtures of Great Valley Sequence graywacke, Franciscan metagraywacke, Franciscan pumpellyite-bearing metasandstone, Franciscan mélange matrix, serpentinite, and two-pyroxene gabbro.
The rock samples were crushed, sieved (<150 μm grains), and mixed in set proportions, then applied in a 1–mm layer between saw-cut sliding blocks. Each sample assemblage was saturated and sheared at a constant effective pressure of 50 MPa, corresponding to a depth of ~3 km. Coefficients of friction, μ, ranged from a low of 0.38 for the serpentinite to a maximum of 0.85 for the gabbro. While the serpentinite and the Franciscan mélange matrix were relatively weak, all other rock types were consistent with Byerlee's Law. The friction coefficient of mixtures could be reliably predicted by a simple average based on dry weight percent of the end member strengths. This behavior is in contrast to some mixtures of common gouge materials, such as montmorillonite plus quartz, which exhibit nonlinear frictional strength trends with varying weight percent of constituents. All materials tested except serpentinite were velocity strengthening at sliding rates between 0.01 and 1.0 μ/sec, therefore promoting creeping behavior. The addition of serpentinite decreased a-b values of the gouge and increased the characteristic displacement, d_c, of strength evolution. The range in strength for these rock admixtures suggests that physical models of the fault should account for variations in rock and gouge properties.

Presentation Type:
Poster

Presenting Author:
Morrow, Carolyn

IMPLICATIONS OF GEODETICALLY INFERRED COSEISMIC AND POSTSEISMIC SLIP IN THE 31 OCTOBER 2007 5.4 ALUM ROCK EARTHQUAKE FOR FAULT CHARACTERISTICS AND EARTHQUAKE HAZARD

MURRAY-MORALEDA, J. R. and SIMPSON, R. W., U. S. Geological Survey, Menlo Park, CA 94025, USA, jrmurray@usgs.gov, simpson@usgs.gov

Abstract:
The interaction between the Calaveras and Hayward faults is important to assessing earthquake hazard in the eastern San Francisco Bay region. Recent studies (e.g., Manaker et al., 2005) suggest that at depth the Hayward Fault connects with the Central Calaveras via a simple continuous surface illuminated by Mission Trend seismicity rather than via a complex left-stepping deformation zone as seen at the Earth's surface. If true, this implies that a damaging earthquake rupture could involve both faults (e.g., Graymer et al., 2007). The 31 October 2007 M 5.4 Alum Rock earthquake on the Calaveras Fault produced coseismic and postseismic displacements clearly recorded by ten nearby continuously operating Global Positioning System (GPS) instruments. The relative magnitude of the postseismic displacements and the moment release inferred from them suggest that the deformation during the first four months postmainshock was comparable to or exceeded the coseismic. Although the inferred spatial distribution of slip is not well constrained by the GPS data, it is compatible with models for the Calaveras Fault in which moderate earthquakes rupture locked patches at depth that are surrounded by areas which release stress through creep, afterslip, and microseismicity (Oppenheimer et al., 1990). The cumulative postseismic displacement and number of aftershocks over time are linearly related, as would be predicted if these phenomena arose from the same underlying process (Perfettini and Avouac, 2004). The GPS data suggest that in addition to afterslip on the Calaveras Fault surface at seismogenic depths, triggered right-lateral/reverse slip may have occurred on dipping shallow fault surfaces to the SW of the Calaveras. The combined coseismic and postseismic slip inferred from the GPS data are estimated to produce static Coulomb stress increases of a few tenths of a bar on the nearby SE ends of the Mission Trend and Northern Calaveras Fault just NW of the Alum Rock hypocenter.

Presentation Type:
Oral

Presenting Author:
Murray-Moraleda, Jessica

AIRBORNE LASER SWATH MAPPING (ALSM)-BASED GROUND MAPPING OF THE SOUTHERN HAYWARD FAULT

MYNATT, Ian (1), LIENKAEMPER, Jim (2), WHITEHILL, Caroline (1), and PRENTICE, Carol (2)
(1) Stanford University, Stanford, CA 94305
(2) USGS, Menlo Park, CA 94025

Abstract:
Accurate maps of fault traces are fundamental data for assessing the earthquake hazard associated with active faults. The acquisition of ALSM data for Northern California allows unprecedented precision and accuracy for mapping the surface traces of faults, particularly in vegetated terrain. GeoEarthScope ALSM data sets comprise filtered (bare Earth) and unfiltered 1 and 0.5 m Digital Elevation Models (DEM's) with decimeter precision in the x, y, and z components. Therefore, geomorphic features are imaged with exceptionally high resolution, allowing these features to be identified and mapped with greater ease than ever before. We utilize these data for the southern Hayward Fault and demonstrate both the field- and computer-based mapping techniques allowed by these data. ALSM was flown along a ~38 km long swath ~1 km wide beginning at the southern end of the creeping portion of the Hayward Fault and ending at the Calaveras Fault beyond the area thought to contain the transition zone between these faults. We used digitized fault traces from previous California Geological Survey mapping as initial locations and revised them based on geomorphic features seen in the ALSM data. These lines were then field checked wherever possible. This process included (1) confirmation of the location and type of features identified; (2) documentation, including photographs, of landscape features resulting from faulting; (3) revision and addition of strands based on features visible in the field but not in the data (e.g., faulting in bedrock); and (4) removal from our database of lineaments identified in the data as natural but either artificial or not fault related. We digitized our final fault traces and compiled them along with annotations of geomorphic features, thereby creating an updated fault-trace map of this area.

Presentation Type:
Poster

Presenting Author:
Mynatt, Ian

THE BOREHOLE NORTHERN HAYWARD FAULT NETWORK (NHFN): RESEARCH APPLICATIONS

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Abstract:
The NHFN is a cooperative effort of the Berkeley Seismological Lab (BSL) and Caltrans, with additional support from the USGS's ANSS program. In addition to contributing to California real-time seismic monitoring operations, the NHFN also complements Bay Area surface networks by providing downhole (50 to 200 m) wide-dynamic range recordings of very low-amplitude seismic signals with high-gain and low-noise geophones and accelerometers.
Analysis of the 19 and 20 October 2003 Orinda Ml 3.5 and 3.4 earthquakes using NHFN data has revealed more than 4,000 fore- and aftershocks the first week of the sequence, with magnitudes down to –2. The sequence source volume is about 1 cubic kilometer, and many of the events, including the ML 3.4 aftershock, exhibit complexity. Some events have one or more P arrivals between the first P and first S phases; many events occur as part of a rapid sequence. We locate the subevents of the double and multiple earthquakes and investigate their relationship in time and space to determine whether they are independent, or whether triggering or rupture propagation can explain their occurrence.
An initial 247-day search for nonvolcanic tremor activity ending on 31 December 2004 failed to identify any nonvolcanic tremor activity in the Bay Area. This absence of tremor suggests that Bay Area tremor is either of very low amplitude or is episodic with long periods of quiescence. We present findings of a longer-term search aimed at addressing this issue.
On 20 July 2007 a Mw 4.2 event occurred in Oakland, within the NHFN. Empirical Green's function deconvolution of the borehole data with the records from a nearby Md 2.7 aftershock revealed pronounced directivity indicating that the event had a strong northwestward rupture. The northward rupture was also evident in the Community Internet Intensity Map and the ShakeMap. The obtained moment-rate functions were used to determine the allowable dimensions of the Mw 4.2 rupture.

Presentation Type:
Poster

Presenting Author:
Nadeau, Robert

FAULT PROPAGATION THROUGH COYOTE EARTH-ROCK DAM DUE TO CREEP ON THE CALAVERAS FAULT, SANTA CLARA COUNTY, CALIFORNIA

NELSON, J. L, VOLPE, R. L., TEPEL, R. E. (retired), and BAKER, F. B., Santa Clara Valley Water District, San Jose, CA, 95118

Abstract:
The Santa Clara Valley Water District owns Coyote Dam, a 42-m-high earth-rock embankment built in 1935–1936 across the Calaveras Fault. Fault creep was unknown at the time, but Coyote Dam was designed with special zoning of materials to accommodate up to 4.5 meters of lateral displacement from a single earthquake-induced offset along the Calaveras Fault, which crosses the left abutment area where the dam is vertically 15 to 18 m thick.

Fault creep has propagated from the bedrock foundation to the crest of the clay core embankment, with crest displacement lagging bedrock displacement at the crest-foundation interface. The embankment crest is currently being displaced by creep on the Calaveras Fault at 14 to 16 mm/yr, which matches reported late Holocene slip rates of 14 + 5 mm/year for the central Calaveras Fault.

Analysis of dam crest monument survey data from 1936 to 2008 provides a timeline for the propagation of fault creep from the embankment foundation to the dam crest. We distinguish three periods of embankment crest deformation. From 1936 to 1944 monuments on opposite sides of the fault zone showed no significant displacement between them, indicating fault displacement did not reach the crest; instead, the strain was manifested by apparent rotation of the dam. Crest monument displacement started in 1944 and continued through 1974 at an average rate of 4 mm/yr. Since 1975, creep rate measured by crest monument surveys averages 15 mm/yr. Since construction in 1936, total right-lateral displacement measured by repeated crest monument surveys is 0.4 m. Regional slip rates suggest that displacement in the foundation should be about 1 m (14 mm/yr over 72 years). Consequently, a 0.6 m deficit may exist between measured displacement of the dam crest and estimated displacement of foundation bedrock. The differential that likely occurred during 1936–1974 might be explained by early stages of shear deformation with strain taken up by development of Riedel shears.

Presentation Type:
Oral

Presenting Author:
NELSON, JAMES

FAULT-CROSSING DESIGN OF LARGE-DIAMETER PIPELINE CROSSING CALAVERAS FAULT

NISAR, Ahmed, MMI Engineering, Oakland, CA, USA; and KELSON, Keith. William Lettis and Associates, Walnut Creek, CA, USA

Abstract:
The San Francisco Public Utilities Commission (SFPUC) supplies water to more than 2.3 million people in four of the largest San Francisco Bay area counties. The SFPUC system receives water from the Hetch Hetchy reservoir located in the central Sierra Nevada, which provides water to more than 80% of the total SFPUC system supply. Upon entering the Bay Area, water is transported across the 3,000-foot-wide Sunol Valley and the Calaveras Fault in three large-diameter pipelines called the Alameda Siphons. The Calaveras Fault is a major active fault with a high probability of a major surface-rupturing earthquake in the next 30 years. The surface fault displacement in such an event is expected to be greater than 4 feet. The existing siphons, designed in 1933, 1952, and 1966, are unlikely to withstand such large displacements without failure. A new 66-inch pipeline, Alameda Siphon 4, is being designed to withstand the expected surface fault displacement and maintain its pressure integrity.
The paper describes the structural design method and the complex relationship between uncertainty in fault location, expected surface fault displacement, and practical design considerations.

Presentation Type:
Oral

Presenting Author:
Nisar, Ahmed

MITIGATION OF FAULT-CROSSING HAZARD FOR LARGE-DIAMETER PIPELINES CROSSING THE CONCORD FAULT

NISAR, Ahmed. MMI Engineering, Oakland, CA, USA; and HITCHCOCK, Christopher. William Lettis & Associates, Walnut Creek, CA, USA

Abstract:
Contra Costa Water District's treated water service area (TWSA) supplies water to a population of approximately 230,000 people in the cities of Concord, Clayton, Clyde, Pleasant Hill, Walnut Creek, Martinez, and Port Costa. The seismically active Concord Fault runs in the northwesterly direction through the cities of Walnut Creek and Concord, bisecting the district's TWSA into eastern and western halves. Several of the district's large-diameter pipelines (> 20 inch diameter) cross the fault and are susceptible to breaks in the event of a large surface-rupturing earthquake. These pipelines are critical to water transmission southward and westward from the district's two water treatment plants located in Concord and Oakley. Since both plants are located east of the Concord Fault, most of the areas of the cities of Walnut Creek, Concord, Clayton, and Pleasant Hill would be cut off from the source of water in the district's TWSA if the pipelines crossing the fault were unavailable following significant fault displacement.
The Concord Fault exhibits significant creep (on the order of 3 to 4 mm/year) manifested by curb offsets and en-echelon cracking of pavements at several locations in Concord. The fault has a long-term geologic slip rate of 3.4 ± 0.3 mm/yr estimated from a 6,000-year record of stream channel offsets. Although the Concord Fault does not have a historic record of large earthquakes, the fault has associated microseismicity that indicates it is an active fault. While the near-term probability of a major earthquake on the fault is moderate to low, it is a high-consequence scenario in terms of its impact on the water supply for a large population.
This paper discusses a cost-effective strategy that was designed and constructed to mitigate the fault-rupture hazard for ten large-diameter pipelines ranging in size from 20 to 48 inches.

Presentation Type:
Poster

Presenting Author:
Nisar, Ahmed

PACIFIC GAS AND ELECTRIC GIS-BASED EARTHQUAKE PLANNING AND EMERGENCY RESPONSE

NISHENKO, S. P., FERRE, K., FIELD, L., FUJISAKI, E., LEE, C. H., McLAREN, M., and VISRAM, K., Pacific Gas and Electric Company, San Francisco, CA 64105

Abstract:
A repeat of the 1868 Hayward earthquake will be an unprecedented test of the utility infrastructure in the San Francisco Bay area. Initial projections indicate that a M 7 Hayward event will be almost as severe as an M 8 San Andreas earthquake. A better understanding of the performance of individual lifelines as well as the interdependencies between lifelines is critical to preparing for and responding to this earthquake successfully.
The Pacific Gas and Electric Company (PG&E) uses Geographic Information System (GIS) - based products such as ShakeMap, HAZUS, and System Earthquake Risk Assessment (SERA) in conjunction with improved digital hazard maps of the San Francisco Bay area as part of our Seismic Risk Management Program. As a mitigation and planning tool, GIS-based network performance software helps identify weaknesses in the transmission system and perform benefit-cost analyses of retrofit and replacement projects. GIS-based products also provide staff and management with realistic training and exercise scenarios that have improved corporate earthquake awareness and emergency preparedness.
As an emergency response screening tool, GIS rapidly identifies potential gas and electric problem areas prior to the receipt of initial damage reports from the field, helping prioritize emergency response resources. PG&E developed a response algorithm and an automated GIS process that generates a list of natural gas transmission segments that have the highest risk of failure during an earthquake. The list is automatically disseminated to the emergency response team and various districts/divisions for emergency response. As a back-up plan, lists of the highest risk segments for eight Bay Area earthquake scenarios were generated and distributed to field personnel to use if the actual ShakeMaps are not immediately available.

Presentation Type:
Oral

Presenting Author:
Nishenko, Stuart

SEISMICITY ON THE CENTRAL AND SOUTHERN CALAVERAS FAULT AND EARTHQUAKE FORECASTS

OPPENHEIMER, D., BAKUN, W., U.S. Geological Survey, Menlo Park, CA 94025, oppen@usgs.gov, bakun@usgs.gov; UHRHAMMER, R., Seismological Laboratory, University of California, Berkeley, CA 94720, bob@seismo.berkeley.edu; BOATWRIGHT, J., and SIMPSON, R., U.S. Geological Survey, Menlo Park, CA 94025, boat@usgs.gov, simpson@usgs.gov

Abstract:
We re-examine the Oppenheimer et al. (1990) zonation of the Calaveras Fault in light of the 2007 Alum Rock earthquake. From an analysis of M>5 earthquakes since 1910 on the central and southern Calaveras Fault and spatial patterns of microearthquake data for the period 1970–1990, they had proposed that persistent aseismic regions at the base of the seismogenic zone represent stuck patches which slip only during moderate earthquakes. They divided the fault into six aseismic zones, I–VI from south to north, where they expected future M>5 mainshocks to rupture the Calaveras Fault. They established the mainshock rupture history for each zone since 1910 and identified two zones (I and VI) that they believed were the most likely sites for the next M>5 earthquakes. Zone V, however, was ruptured by the 2007 M5.4 Alum Rock earthquake. Synthetic Wood Anderson seismograms at UC Berkeley stations MHC and BRK for the 2007 quake are nearly identical at frequencies ~2 Hz with those from a 1955 M5.5 quake, confirming that the two quakes ruptured essentially the same fault segment. We extended the catalog of seismic activity to include historical earthquakes (1850–1910) through an analysis of Modified Mercalli Intensity (MMI) data (Bakun and Wentworth, 1997) to estimate M, source location, and uncertainties. Our isoseismal analysis suggests that in Zone I south of Highway 152, quakes similar to a 1949 M5.2 quake may have occurred in either 1890 or 1901. For a coefficient of variability of 0.4 and a 50-year recurrence interval, the next earthquake on Zone I is due before 2020. Recurrence scenarios based on similar analyses of quakes on zones II–V east of San Jose suggest future M>5 quakes on these segments are unlikely until after 2020. There is no evidence that Zone VI has failed in an independent M>5 1/2 event since 1850, suggesting that Zone VI fails aseismically or in association with the occurrence of infrequent large Hayward or northern Calaveras fault earthquakes.

Presentation Type:
Oral

Presenting Author:
Oppenheimer, David

ASSESSMENT AND REPAIR OF EARTHQUAKE-DAMAGED WOOD-FRAME BUILDINGS

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Abstract:
Over the past century great progress has been made in life-safety aspects of seismic resistant design, construction, and retrofit of Bay Area building stock. As a result, building collapses will be rare, while building damage will be extensive. Rapid recovery from the effects of a major earthquake requires, in part, efficient assessment and repair of that damage under circumstances that will strain the capacity of design professionals and contractors. In response to problems associated with building damage assessment following the Northridge earthquake, guidelines have been developed for postearthquake damage assessment of steel moment frame connections, masonry and concrete shear walls, and residential wood-frame buildings. This presentation briefly summarizes one of those guidelines, *General Guidelines for the Assessment and Repair of Earthquake Damage in Residential Woodframe Buildings*, and the associated research and testing. The presentation will illustrate how application of those guidelines can facilitate rapid and efficient recovery from the effects of a major earthquake.

Presentation Type:
Oral

Presenting Author:
Osteraas, John

EARTHQUAKE RECURRENCE ON THE SOUTH HAYWARD FAULT IS MOST CONSISTENT WITH A TIME-DEPENDENT RENEWAL PROCESS

PARSONS, Tom, U.S. Geological Survey, MS-999, 345 Middlefield Rd., Menlo Park, CA 94025

Abstract:
The theory of elastic rebound and stress renewal is an important component of earthquake forecasting (e.g., Working Group on California Earthquake Probabilities [WGCEP], 2007), wherein the assumption of earthquake periodicity allows time-dependent probability calculations. While the renewal model has gained enough acceptance to be used in formal forecasts, it has not been possible to exclude the alternative view that repeated earthquakes can occur in rapid succession, apparently without requiring time for stress regeneration (e.g., Kagan and Jackson, 1999). Therefore even time-dependent forecasts give at least some weight to time-independent Poisson process models (WGCEP, 2003, 2007). The remarkable paleoseismic series developed for the south Hayward Fault by Lienkaemper and Williams (2007) enables a consistency test between time-dependent and time-independent recurrence distributions. A Monte Carlo approach is employed, where attempts to match the observed intervals are made using an array of distributions; the relative appropriateness of different distributions is ranked according to the number of successful matches to observations. Time dependence is represented by Brownian Passage Time (BPT) distributions, and time-independent recurrence is represented by exponential distributions. It is found that a BPT distribution with a mean recurrence interval of 210 years and a periodicity of 0.6 most commonly reproduces the observed event series on the south Hayward Fault. These BPT distribution characteristics match the paleoseismic record 5 times more often than any exponential distribution: a highly significant difference as determined using a two-tailed Z-test for relative proportions. I conclude that despite uncertainties, Hayward Fault earthquakes can be shown to be quasiperiodic and are thus most consistent with a stress-renewal process.

Presentation Type:
Oral

Presenting Author:
Parsons, Tom

CALIFORNIA GEOLOGICAL SURVEY ZONES OF REQUIRED INVESTIGATION FOR EARTHQUAKE-INDUCED LANDSLIDES: LIVERMORE VALLEY, CALIFORNIA

PEREZ, F. G., WIEGERS, M. O., and HAYDON, W. D., California Geological Survey, Sacramento, CA 95814, USA, Ante.Perez@conservation.ca.gov, Mark.O. Wiegers@conservation.ca.gov, Wayne.Haydon@conservation.ca.gov

Abstract:
The California Geological Survey (CGS) recently released the Seismic Hazard Zones maps of the Livermore Valley encompassing the 7.5-minute quadrangles of Altamont (preliminary map) and Dublin and Livermore (official maps). Areas that are most susceptible to seismically induced landslides are depicted on the maps as Zones of Required Investigation where site-specific geotechnical investigations are required to be undertaken prior to urban development. In establishing the landslide hazard zones, CGS used the best available terrain, geologic, geotechnical, and seismological data. These data are combined in a modified Newmark analysis to determine those slopes with the highest potential for earthquake-induced landsliding. For the Dublin and Livermore quadrangles, 5-m Digital Terrain Models were obtained from Interferometric Synthetic Aperture Radar (IfSAR) where vegetation, buildings, and other cultural features were digitally removed. The resulting bald earth topography is used not only in generating the slope gradient and slope aspect parameters but also in updating the boundaries of the different geologic units and existing landslides. Geotechnical data, particularly shear strength data, were collected to determine the rock strength of the geologic materials. In cases where shear strength data were insufficient to carry out a valid statistical analysis, data from adjacent quadrangles with similar lithology and depositional environment were used in the slope stability analysis. In addition, the percentage of area affected by slides for each rock unit was considered in the strength ranking.
The data collected and evaluated were transformed into primary and derived GIS layers. Three of the ~15 GIS layers — Geologic Materials, Landslide Inventory, and Landslide Hazard Potential — are considered stand-alone maps. In addition to the Seismic Hazard Zones map, the Landslide Inventory layer is being published as part of CGS' Landslide Inventory Map Series.

Presentation Type:
Poster

Presenting Author:
Perez, Florante

BAY AREA URBANIZATION AND EXPOSURE OF CRITICAL FACILITIES AND INFRASTRUCTURE TO HAZARDS ASSOCIATED WITH HAYWARD FAULT EARTHQUAKES

PERKINS, Jeanne B. and MAGARY, Kate, Association of Bay Area Governments (ABAG), Oakland, CA 94604, USA, jeannep@abag.ca.gov, katem@abag.ca.gov

Abstract:
Two things make the Hayward Fault dangerous: the number of years since the 1868 earthquake and the urbanization of the area near the fault.
One of the results of that urbanization is that facilities owned by cities, counties, and special districts also are located in the East Bay. There is a persistent "myth" that the Hayward Fault can be determined by "connecting the critical facilities."
As part of ABAG's role in leading the developing the Local Hazard Mitigation Plan for the Bay Area, data were collected on critical facilities owned by cities, counties, and special districts throughout the region, a database that is currently being expanded and revised. There are fewer critical facilities near the fault than there were 20 years ago, and many of the remaining facilities have been rebuilt or retrofitted. If the 1868 Hayward earthquake were to occur in 2008, about one percent of those facilities would be exposed to MMI IX, one eighth to MMI VIII, and approximately half to MMI VII. (Note that the percentage of critical facilities exposed to significant shaking is larger if more of the Hayward fault ruptures.) In addition to closing and moving facilities, facilities have been retrofitted and replaced. But more can be done. The focus to date has been on city halls, county administration buildings, police and fire facilities, and sewer and water facilities. Yet even with that limited scope, local governments identified an additional $250–$300 million of additional funds needed, largely for seismic retrofits. Even buildings and facilities constructed in the 1980s are being structurally retrofitted.
On the other hand, urbanization is also served by a network of roads and water and sewer pipelines owned and maintained by cities, counties, and special districts. Infrastructure mirrors development patterns. Thus, these networks tend to be more vulnerable than individual facilities.

Presentation Type:
Poster

Presenting Author:
Perkins, Jeanne

LONG-TERM DISASTER RECOVERY PLANNING: ESSENTIAL FOR LOCAL GOVERNMENTS

PERKINS, Jeanne B., Consultant, Association of Bay Area Governments (ABAG), Oakland, CA, 94604, USA, jeannep@abag.ca.gov

Abstract:
While earthquake hazard mitigation is essential to minimize damage, the threat of an earthquake makes it imperative and urgent that local governments also plan for rebuilding and recovery. Hurricane Katrina and other catastrophic disasters show that city managers and county administrators need to have a plan that to ease the confusion and logistical challenges of repairing and rebuilding government facilities, roads and pipelines, housing, and the local economy.
The Association of Bay Area Governments (ABAG) is taking a leadership role in identifying the key components of recovery planning and in measuring the extent to which this type of planning has been put in place, or is being initiated, by the cities and counties of the San Francisco Bay area. Critical components of such a plan include (1) ensuring that federal assistance dollars flow effectively and efficiently; (2) planning for long-term housing recovery; (3) planning for speeding the recovery of the local economy through working with businesses; and (4) planning for the repair or rebuilding of government facilities and services.
A survey of city and county activities conducted in July and August 2008 has identified the strengths and weaknesses of current planning efforts. For example, local governments are much more prepared to rebuild their own facilities and services than they are to speed the recovery of housing and the economy. Some changes in local government procedures, as well as in federal law, may be needed. Obstacles to long-term recovery planning include the standard issues of lack of staff and “model” programs, as well as underestimating the complexity of the process needed to create an effective plan.
For further information, see http://quake.abag.ca.gov/recovery.
The author would like to thank Linda Min (ABAG) for her assistance in conducting the local government survey.

Presentation Type:
Oral

Presenting Author:
Perkins, Jeanne

PROBABILISTIC SEISMIC HAZARD IN THE SAN FRANCISCO BAY AREA BASED ON SEISMICITY SIMULATION

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Abstract:
Long-term seismicity rates, fault interactions, and occurrence patterns of moderate to large earthquakes are key products of models of fault systems controlled by the mechanics of crustal deformation. Understanding how such fault systems evolve in time under a relevant set of governing physical laws is a needed critical step toward reliable earthquake forecasting. We can address issues relevant to probabilistic seismic hazard analysis (e.g., recurrence time, coefficient of variation, probability of multisegment rupture) with numerical simulations of seismicity. A seismicity simulator essentially provides a means of tracking the increasing tectonic stress as it loads the faults and determines how stress is redistributed among the network faults as the result of an earthquake. I implement a seismicity simulator that includes the effects of (1) tectonic loading of a plate boundary zone; (2) static stress transfer; (3) viscoelasticity of the ductile lower crust and mantle; and (4) length- and depth-dependent fault slip. I apply it to a network of multiple interacting faults in the San Francisco Bay area. Earthquake initiation, propagation, and termination are governed by a cascade model using a Coulomb failure function. 30,000 years of simulated seismicity yield probability density functions of interevent times on all major faults at practically a continuum of magnitude thresholds. At a threshold of M6.5, reasonable combinations of controlling parameters yield mean interevent times of 140 years for the southern Hayward and Rodgers Creek faults, 275 years for the northern Hayward Fault, and 250 years for the northern Calaveras Fault. To help interpret simulation results I explore systematic covariations among mean characteristic magnitude, coefficient of variation (typical values are 0.4 to 0.6), degree of dynamic overshoot, and mantle viscosity.

Presentation Type:
Oral

Presenting Author:
Pollitz, Fred

SEGMENTATION OF THE HAYWARD FAULT BASED ON GEOPHYSICAL DATA

PONCE, D. A., GRAYMER, R. W. JACHENS, R. C., and SIMPSON, R. W., U.S. Geological Survey, 345 Middlefield Rd, Menlo Park, CA 94025, USA, ponce@usgs.gov

Abstract:
Gravity, magnetic, 3D geologic, and seismicity data suggest segmentation of the Hayward Fault is more complex than the conventional two-segment model that splits the fault into northern and southern segments. The Hayward Fault contains several fault-zone discontinuities, some of which may represent segment boundaries, along its 95-km length from San Pablo Bay to its connection at depth with the Calaveras Fault just south of Calaveras Reservoir.
One discontinuity coincides with the currently accepted segment boundary between the northern and southern Hayward Fault at Rocky Mound near Berkeley (Working Group, 2003). A prominent seismicity cluster at this location correlates to a subsurface structural complexity as well as a prominent change in rock type inferred from geologic and geophysical data. This site probably represents the northernmost extent of the 1868 rupture based on geodetic and trenching data (Yu and Segall, 1996; Lienkaemper et al., 1999).
Another prominent discontinuity is located abut 13 km to the south of the first at the northern end of a gabbro body near San Leandro. Geophysical and geologic data show this site marks a dramatic change in physical properties that extends throughout the seismogenic zone and may concentrate stress and serve as a nucleation point for large earthquakes. The northern extent of the gabbro body could represent a segment boundary in itself or, possibly, a subsegment of the southern Hayward Fault. This location is near the intensity center for the 1868 earthquake (Bakun, 1999); if the 1868 earthquake nucleated at this boundary, the rupture would have propagated bilaterally. Reduced ground shaking in Oakland and Berkeley during the 1868 earthquake (Boatwright, 2007), might be explained by directivity of seismic energy to the south along the dense and rigid gabbro body, by attenuation of seismic energy in sheared Franciscan Complex rocks to the north of this location, or both.

Presentation Type:
Poster

Presenting Author:
Ponce, David

SEASONAL ACCELERATION AND STRUCTURE OF SLOW-MOVING LANDSLIDES IN THE BERKELEY HILLS

QUIGLEY, K. C., BURGMANN, R., Deapartment of Earth and Planetary Science, University of California, Berkeley, CA, USA; GIANNICO, C., and NOVALI, F., Tele-Rilevamento Europa, Milano, Italy

Abstract:
This study investigates the seasonal dependence and structure of large, slow-moving landslides in the Berkeley Hills with InSAR (Interferometeric Synthetic Aperture Radar) data from the ERS1 and Radarsat satellites. Permanent scatterer analysis provides data sets that link geographic points with a time series of range change, allowing for evaluation of time-dependent landslide motion. The two satellites have different view angles: ERS1 from the east and Radarsat from the west. This helps resolve contributions from horizontal and vertical motions to the observed range change. For consistency, polygons drawn in GIS (Geographic Information Systems) set the same borders of the slide area for both satellites' data sets. Two methods were used to explore seasonal dependence. The first was stacking the data of multiple points and fitting the emerging signal to a linear trend superimposed with a 1-year period sinusoid. The second method was to stack the data by month. The resulting signal shows that range change increases during the rainy season and reaches a minimum during the dry season. To better resolve slide structure we select a swath profile about the axis of each slide. For ERS1 and Radarsat data within the swath, we use points from the two range change directions that are in the same general location and deconvolve the horizontal from vertical motion. The changes in the average range change velocity near the head and toe of the slide provide information on the depth and distribution of sliding. Although these slides are slow moving, they cause costly damage to homes and underground pipes. In addition, due to the proximity of the Hayward Fault, a seismic event in a wet year may trigger a much larger slip and is a matter of public safety. Understanding the slides temporally and spatially is a first step toward mitigation. In the future, we hope to integrate data from a recently established GPS site, ground-based T-LiDAR, a borehole inclinometer, and a local rain gauge.

Presentation Type:
Poster

Presenting Author:
Quigley, Kathryn

AN OVERVIEW OF THE AB 300 REPORT, SEISMIC SAFETY INVENTORY OF CALIFORNIA PUBLIC SCHOOLS

ROJAHN, Christopher, HEINTZ, Jonathan A., Applied Technology Council, Redwood City, CA, USA; and BELLET, Dennis, Division of the State Architect, Sacramento, CA, USA

Abstract:
In November 2002, the California Department of General Services (DGS) issued its report, *Seismic Safety Inventory of California Public Schools*, in fulfillment of California Assembly Bill (AB) 300, which required DGS to conduct an inventory of public school buildings (kindergarten through grade 12, inclusive) that are of concrete tilt-up construction and those with non-wood-frame walls that do not meet the minimum requirements of the 1976 Uniform Building Code (UBC), which was adopted for the design and construction of public schools on 1 July 1978. The resulting inventory of non-wood-frame California public schools designed and built before 1 July 1978 contained 9,659 buildings (92 million square feet), which were then each classified into one of the following seismic vulnerability categories:
Category 1: those buildings likely to perform well and expected (but not guaranteed) to achieve life-safety performance in future earthquakes (2,122 buildings, 27 million square feet, or 6% of the total square footage of California public schools); and
Category 2: those buildings not expected to perform as well as Category 1 buildings in the future and that require detailed seismic evaluation to determine if they can be expected to achieve life-safety performance (7,537 buildings, 65 million square feet, 14% of the total square footage of California Public schools).
The remaining 80% of the square footage of California public schools (379 million square feet), which is constructed of wood-frame walls, was eliminated from consideration in this survey because of the good performance of this construction type in prior earthquakes.
The percentage of square footage of Category 2 buildings by construction type is as follows: concrete frame/wall buildings, 21%; mixed construction, 6%; steel-frame, 5%; precast concrete tilt-up and precast concrete frame buildings, 23%; and reinforced masonry-wall buildings, 45%.

Presentation Type:
Oral

Presenting Author:
Rojahn, Christopher

CALIFORNIA GEOLOGICAL SURVEY ZONES OF REQUIRED INVESTIGATION FOR LIQUEFACTION: LIVERMORE VALLEY, CALIFORNIA

ROSINSKI, Anne M., California Geological Survey, Menlo Park, CA, USA

Abstract:
Official maps of Dublin and Livermore and a preliminary map of the Altamont 7.5-minute quadrangles (1:24,000 scale) show areas that may be susceptible to earthquake-induced liquefaction. The maps are the result of the three-dimensional integration of geotechnical and geological data. Approximately 450 geotechnical borehole logs were collected, analyzed, entered into a geotechnical GIS database, and evaluated for susceptibility of the deposits to liquefaction. In addition, a map showing depth to historically highest ground water level was prepared. The continuous relocation over the years of temporary water-filled pits associated with gravel mining in central Livermore Valley has caused localized changes to permeability resulting in variable groundwater conditions.
The majority of the boundary for the Zone of Required Investigation (ZORI) is defined by the contact of Holocene deposits with late Pleistocene deposits, or bedrock, and extends along the base of the foothills surrounding the Livermore Valley. Near Hacienda Drive and Central Parkway, sediment mapped as late Pleistocene to Holocene alluvial fan deposits (Qf) is included in the ZORI. Although the age of the unit suggests that the sediment has had sufficient time to consolidate, thus rendering it unlikely to liquefy, subsurface data indicate that the deposit in question includes a greater abundance of silt, and lower penetration resistance, compared to occurrences of Qf mapped in other portions of the western margin of the Livermore Valley. Near the intersection of Hopyard Road and Arroyo Mocho, an area once known as Willow Swamp is excluded from the ZORI. Ground water is within 10 to 20 feet of the ground surface throughout much of this area, but it is underlain by Holocene basin sediments (Qhb) locally made up of approximately 32% clay. Although soft soil failures are possible in young clay sediments, liquefaction is unlikely.

Presentation Type:
Poster

Presenting Author:
Rosinski, Anne

AN INVESTIGATION OF THE IMPACT OF VARIABILITY IN SOURCE MODELING AND SEISMICITY FEATURES OF THE HAYWARD-RODGERS CREEK FAULT SYSTEM ON NEAR-SOURCE GROUND MOTIONS

ROWSHANDEL, B. and WILLS, C. J., California Geological Survey, Sacramento, CA 95814

Abstract:
Uncertainties in seismic source modeling have large impacts on estimated ground motion hazard, damage, and socioeconomic losses. One important issue in seismic source modeling is fault segmentation and segment seismicity. Although large ruptures often terminate at geometrical complexities, geologic and paleoseismic data suggest that segment boundaries are not major impediments to rupture.
Segmentation and seismic history of the Calaveras, Hayward, and Rodgers-Creek fault systems are very uncertain. In existing PSHA studies the above faults are taken as mostly separate structures and segmented based on their surface-trace geometry and historical seismicity. Recent studies of the region have shown that fault geology and geometry at depth are quite different than those at the surface. In the north, a dilatational step-over between the Hayward and Rodgers Creek faults lies beneath San Pablo Bay, where at the surface the two faults converge within 4 km of one another. A fault link between Hayward and Rodgers Creek, such as normal faults in the extensional pull-apart basin, could facilitate a through-going rupture of both faults. In the south, at the junction of the Hayward and Calaveras faults, geologic mapping shows a complex zone of deformation at the surface, while seismicity at depth suggests a single through-going fault below about 5 km. The direct connection of the southern Hayward and central Calaveras at depth could also generate earthquakes with magnitude greater than 7.
Probabilistic analyses of ground motion hazards due to the Hayward-Rodgers-Creek-Calaveras fault system are performed with emphasis on the variability in source modeling, particularly the impact of segmentation. The hazard is deaggregated in terms of contributions from different source and seismicity models. Simple models are used to investigate the impact of source-to-source rupture jumps on the resulting ground motions. Directivity effects for the longer-period ground motions are also considered.

Presentation Type:
Oral

Presenting Author:
Rowshandel, Badie

LANDSLIDE MAPPING ON SONOMA MOUNTAIN, SONOMA COUNTY, CALIFORNIA: EARTHQUAKES, WEAK ROCK, AND SUBURBAN DEVELOPMENT

RUBIN, R. S., Geomatrix Consultants, 2101 Webster Street, 12th Floor, Oakland, CA, 94612, ron.rubin@amec.com; and ALLEN, J. R., CSU East Bay, Dept. of Earth and Environmental Sciences, Hayward, CA., james.allen@csueastbay.edu; online LS maps: http://www.sci.csueastbay.edu/earth/allen/index.html

Abstract:
Landsliding is a notable Quaternary geologic process on Sonoma Mountain (SM) in Sonoma County, California. Landslide complexes spanning several square miles have been documented, originating a significant effect on the geomorphic character of SM and making it distinctive within the area. SM geology is characterized by Miocene-Pliocene fluvial and marine sedimentary rocks, Miocene volcanic rocks, extensive landslides, and active faulting along the Rodgers Creek Fault (RCF). Landslide complexes and stratigraphic relationships between sedimentary and volcanic rock units have complicated local geologic and geomorphic mapping, including geomorphic features associated with the RCF. To date, geologic mapping on SM has not focused on landslides. A more thorough understanding of landslides on SM may clarify local bedrock relationships, and may facilitate more accurate mapping of the RCF.
Continued development on SM increases the potential for landslide-related damage due to movement of existing landslides or initiation of new landslides. The RCF, along with the associated Hayward Fault extending southeast, is widely recognized as having a high probability for producing a major earthquake in the near future. Large earthquakes have triggered landslides in the Bay Area as recently as 1989 during the Loma Prieta earthquake, and such an event on the RCF would likely result in landslides on SM. Above-average amounts of rainfall can also trigger landslides of all sizes. Many such landslides were documented in Sonoma County during the 1997–1998 El Niño storm events, and some of the landslide activity occurred on pre-existing landslides. Considering all of the above, we have begun detailed landslide mapping in the area of SM using a combination of aerial photograph interpretation, LiDAR imagery, field mapping, and previous published and unpublished maps. Our continued efforts may expand to other areas in Sonoma County where reduction of landslide-related damage is a priority.

Presentation Type:
Poster

Presenting Author:
Rubin, Ron

SEISMIC IMAGING OF THE MISSION FAULT IN FREMONT, ALAMEDA COUNTY, CALIFORNIA

RYMER, M. J., CATCHINGS, R. D., GOLDMAN, M. R., SICKLER, R. R., CRILEY, C. J., KASS, J. B., U.S. Geological Survey, Menlo Park, CA 94025; GANDHOK, G., and FOGWELL, T. W., Weiss Associates, Emeryville, CA 94608

Abstract:
During June 2008, we acquired high-resolution seismic reflection and refraction data, using both P waves and S waves, along four profiles at Ohlone College, Fremont, California. The studies, in part, were conducted to determine the location of the Mission Fault. The seismic profiles crossed an approximately 10-km northwestward projection of the mapped trace of the fault. Our four profiles ranged in length from about 300 to 500 m, were recorded by 101 to 119 channels, and had geophone spacings of 2.5 to 5 m. Seismic waves were generated by multiple sledgehammer impacts or by Betsy-Seisgun “shots” at all recording locations. S waves were generated by multiple sledgehammer impacts on both ends of a shear-wave block. We developed tomographic seismic velocity images and stacked and migrated reflection images from the P-wave data to image lateral velocity anomalies and vertically offset reflectors associated with possible faults along the profiles. Preliminary refraction and reflection images suggest that the Mission Fault trends more northwesterly than previously inferred. One of our profiles, with the deepest P-wave and S-wave ray paths (about 90 m and 70 m, respectively), shows a prominent dipping lateral velocity low. The velocity low is coincident in location with pronounced offsets and changes in dip of reflectors in the migrated reflection image. Overall, we infer the Mission Fault to be about 100 m farther to the SW than previously projected. Apparent dip of our inferred fault in the upper 130 m is about 62 degrees NE. An antithetic fault is also inferred in the migrated reflection image that dips more steeply to the SW. Below about 130 m the two faults merge and form a fault with an apparent dip of about 77 degrees NE. If this is the Mission Fault and if the deeper, steeper dips persist to seismogenic depths, it is coincident with a seismicity trend between the Hayward and Calaveras faults.

Presentation Type:
Oral

Presenting Author:
Rymer, Michael

SAN FRANCISCO BAY AREA PALEOSEISMOLOGY: A PERSPECTIVE

SCHWARTZ, D. P., U.S. Geological Survey, Menlo Park, CA 94025, dschwartz@usgs.gov

Abstract:
The 1989 Loma Prieta earthquake was a catalyst for paleoseismic research in the San Francisco Bay area. In the almost 20 years since, progress, to varying degrees, has been made in two areas: (a) timing of past events and (b) slip rates. A Bay Area goal has been a 2,000-year earthquake chronology for each of the major faults. Through the BAPEX project (1998–2001) and subsequent work, this goal has been partially realized. Studies along the southern Hayward Fault (Tule Pond site) and Santa Cruz Mountains section of the San Andreas Fault (Watsonville sites) have been major successes, while chronologies with larger timing/completeness uncertainties have been developed for the North Coast San Andreas (Vedanta, Ft. Ross), Calaveras (Leyden Creek), northern Hayward (Mira Vista), and Concord-GreenValley (Mason Road) faults. Only short records exist for the Rodgers Creek and San Gregorio faults, and there are none for the Peninsula San Andreas and Greenville faults. Onshore paleoseismic studies have been augmented by the use of offshore turbidites to extend the North Coast San Andreas earthquake record through the Holocene, and nonnative pollen has been useful in dating early historical (18th–19th century) ruptures. These recurrence data provide important insights into regional stress release, the Bay Area earthquake cycle, and long-term fault interactions. Slip rates are primary inputs for seismic hazard analyses such as the 2003 and 2007 probability reports. The number of slip rates per fault in the Bay Area is limited, however, and uncertainties can be large. Only two Holocene slip rates have been published for the San Andreas Fault, one each for the Hayward, Rodgers Creek, northern Calaveras, central Calaveras, and Concord-Green Valley faults, and none for the Greenville Fault.
The past is the key to the future. While much has been accomplished paleoseismically, more remains to be done if we are to improve our understanding of future earthquake occurrence in the Bay Area.

Presentation Type:
Oral

Presenting Author:
Schwartz, David

CALTRANS SEISMIC HAZARD CHARACTERIZATION: NEW PROCEDURES ONLINE

SHANTZ, Tom and MERRIAM, Martha, California Department of Transportation, Sacramento, CA, USA

Abstract:
Caltrans recently adopted new procedures for the development of response spectra for structure design. These procedures incorporate both deterministic and probabilistic criteria. The Next Generation Attenuation (NGA) models (2008) are used for deterministic assessment (with a revised late-Quaternary age fault database), and the USGS (2008) 5% in 50-year hazard maps are used for probabilistic assessment. A minimum deterministic spectrum based on a **M**6.5 earthquake at 12 km is included. These spectra are enveloped and the largest values are used.
This presentation will explain the new Caltrans procedures, demonstrate a new publicly available Web-based design tool for calculating the design spectrum, and compare new and old design spectra for several East Bay locations.

Presentation Type:
Oral

Presenting Author:
Shantz, Tom

PERSISTENT MICROZONES SUGGEST 1906 INTENSITY PATTERNS IN AND NEAR SAN JOSE, CALIFORNIA, FOR A MAJOR EARTHQUAKE ON THE SOUTHERN HAYWARD FAULT

SHOSTAK, Nancy C., San Jose State University, San Jose, CA 95192, nshostak@geosun.sjsu.edu; BOATWRIGHT, John, and BUNDOCK, Howard, U.S. Geological Survey, MS 977, 345 Middlefield Road, Menlo Park, CA 94025

Abstract:
The next major earthquake on the southern Hayward Fault may produce patterns of shaking intensity near San Jose, California similar to those of the 1906 earthquake. The city of San Jose had similar intensity patterns in 1868 and 1906, despite the different azimuths of the two sources. In the San Jose area, 1906 intensities ranged from MMI 6 to 9 and averaged MMI 7.4. Much of the variation in intensity in areas up to several square kilometers (microzones) is controlled by the underlying geology. Map patterns of intensity indicate that the 3–23 m thickness of the top, unconsolidated layer of alluvium is evidently the major controlling factor, rather than the 0.25–1.25 km depth to the buried Mesozoic basement. Modern ground-motion studies substantiate the persistence of the 1906 patterns. Shaking was particularly severe in 1906 (MMI 8.2) in two microzones: one in a 0.4 square km area astride the Silver Creek Fault, east of central San Jose, and the other in a 1.0 square km area along the Alameda, a road between San Jose and Santa Clara. High site amplification has been recorded in both microzones for the 2004 Parkfield and other modern earthquakes. Ground-motion records suggest the Silver Creek Fault directs energy trapped in the adjacent Evergreen basin toward the surface, and well logs indicate a very shallow layer under the Alameda that may resonate with short buildings. The city of Campbell, which overlies the deep, sedimentary Cupertino basin, has a strikingly low 1906 intensity of MMI 6.6. At Campbell, the 1906 intensity was evidently controlled not by depth to bedrock but by unconsolidated sediment too thin to resonate with the buildings. In addition, resonant periods of deep basins are longer than periods of buildings with one to three stories. This result runs counter to the idea that deep sedimentary basins necessarily intensify shaking. Understanding the lesson of persistent microzones can help anticipate and mitigate damage on a community, not just citywide, scale.

Presentation Type:
Poster

Presenting Author:
Shostak, Nancy

A NEW LOOK AT CALAVERAS FAULT ZONATION USING DOUBLE-DIFFERENCE RELOCATED EARTHQUAKES

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Abstract:
Oppenheimer et al. (1990) identified six zones (I–VI) along the Calaveras Fault that could host moderate-sized earthquakes on the basis of the locations of hypocenters, aftershocks, and the association of rupture areas of recent earthquakes with aseismic (stuck) regions. A new catalog of double-difference (DD) relocated seismicity (Waldhauser and Schaff, 2008) with greatly improved relative locations for nearby events provides a more sharply focused image of the aseismic regions and intervening areas of microseismicity, confirming the zonation but adding considerable detail. For example, Zone V, site of the 2007 M5.4 Alum Rock earthquake, contains a well defined aseismic region that extends south from the hypocenter. It is entirely surrounded by microseismicity that defines a plane with a slightly different strike and dip from the plane defined by events in Zone IV just to its south. The two zones are also separated at 7 km depth by a ~0.7 km left-step offset. Similar offsets and changes in orientation, some pronounced and some subtle, exist between the other zones. Given the precision of relative DD locations, we think that these offsets are real. Some subtle changes in orientation may be velocity artifacts, which may nonetheless proxy for significant changes along the fault, perhaps caused by various geologic bodies adjacent to the fault with different material properties. Northernmost Zone VI is the only zone that has not had an identified M>5.5 earthquake since 1850. The character of the DD seismicity changes dramatically in Zone VI from that in Zone V and zones to the south. In the vicinity of Zone VI the Northern Calaveras Fault and the Hayward Fault at depth join the Central Calaveras segment. In Zone VI there is no well defined fault surface visible in the DD seismicity, but rather disorganized clumps of earthquakes, suggesting that this intersection is a site of distributed deformation attempting to accommodate slip at the junction of three major faults.

Presentation Type:
Poster

Presenting Author:
Simpson, Robert

EXPLORING SPATIAL COHERENCE BETWEEN EARTHQUAKE SOURCE PARAMETERS

SONG, S., PITARKA, A., and SOMERVILLE, P., URS Corporation, Pasadena, CA, 91101 -2560, USA, seok_goo_song@urscorp.com

Abstract:
Understanding coherence that may be embedded in kinematic motions of earthquake rupture is an essential element not only in understanding earthquake source characteristics, but in developing effective source modeling tools for strong ground motion prediction. We investigated spatial coherence between earthquake source parameters by analyzing both kinematic and dynamic rupture models. The coherence is considered not only at the same point (zero offset), but also in neighboring areas (nonzero offset), by adopting the coherence analysis method of 2D spatial data, which is commonly used in geostatistics. Our results show that earthquake slip has a significant level of correlation with temporal source parameters such as rupture velocity, peak slip rate, and slip duration (or rise time) in both kinematic and dynamic rupture models. This coherence pattern shows interesting decay patterns as the nonzero offset distance increases. Many interesting features of earthquake source characteristics, such as directional effects of earthquake rupture, can be captured by spatial coherence analysis, particularly in 2D spatial coherence analysis. For instance, the correlation maximum can be located away from the zero offset, i.e., large slip may generate faster rupture velocity ahead of the current rupture front rather than at its current location, which may be an important characteristic of rupture directivity effects. This type of coherence analysis may provide the potential for improved understanding earthquake source characteristics, and how they control the intensity and variability of near-field strong ground motions.

Presentation Type:
Poster

Presenting Author:
Song, Seok Goo

LANDSLIDES AND QUAKE LAKES FROM THE M7.9 CHINA EARTHQUAKE: ARE CALIFORNIANS IN THE SAME BOAT?

STENNER, Heidi, Exponent Failure Analysis Associates (FaAA), Oakland, CA, hstenner@exponent.com; HAMILTON, Douglas, Exponent FaAA, Irvine, CA, dhamilton@exponent.com; CYDZIK, Kristina, Exponent FaAA, Irvine, CA, kcydzik@exponent.com; CATTAROSSI, Andrea, Med Ingegneria, Padova, Italy, andrea.cattarossi@medingegneria.it; and MATHIESON, Elizabeth, Exponent FaAA, Oakland, CA, emathieson@exponent.com

Abstract:
The 12 May 2008 M7.9 Wenchuan, China earthquake destroyed five million homes and schools, causing more than 87,650 deaths. Landslides, a secondary effect of shaking, were responsible for much of the devastation. Debris flows buried homes, rock falls crushed cars, and rock slides dammed rivers. Blocked roads impeded emergency access. Our August 2008 field experience in the affected area reminded us that Californians also face serious risks posed by earthquake-induced landslides.

The topography of California is less extreme than that near Wenchuan, but large earthquakes may still cause devastating landslides, dammed rivers, and blocked access. The Wenchuan earthquake occurred at the start of the rainy season, prior to saturation of the hill slopes, and landslides have and will continue from postearthquake rains and aftershocks due to the long-term effects of intense shaking on hill slopes. California, too, has a season during which slopes are saturated, posing a greater hazard during and after earthquakes.

After the Wenchuan earthquake, lakes rapidly rose behind unstable landslide dams, threatening millions of people. One landslide above Beichuan City created Tangjiashan Lake, a massive body of water upstream of Mianyang, an area with 5.2 million people, 30,000 of whom were killed in the quake. Potential failure of the landslide dam put thousands more people at risk from catastrophic flooding.

In the San Francisco Bay area, many narrow river valleys are upstream of populated areas, including Niles Canyon above Fremont and Newark; Cull Canyon above Castro Valley and Hayward; and Penitencia, Los Gatos, and Saratoga Creeks above the Santa Clara Valley. Once a landslide blocks a river, rapid and thoughtful action is needed. The Chinese government quickly and safely mitigated landslide dams that posed the greatest risk to people downstream. It took expert geotechnical advice, the speed and resources of the army, and some luck. Californians should learn from this event.

Presentation Type:
Oral

Presenting Author:
Stenner, Heidi

PITS, FAULTS, AND HALOS: IS THE OAKLAND CONGLOMERATE A HAYWARD FAULT TECONITE?

STRAYER, L. M., ALLEN, J. R., and WILCOX, J. M., Dept. of Earth and Environmental Sciences, California State University East Bay, Hayward, 94542, USA, luther.strayer@csueastbay.edu

Abstract:
The Late Cretaceous Oakland Conglomerate (OC) of the Great Valley Sequence is a tectonite. Faulted cobbles and well developed grain-on-grain contact features between clasts are ubiquitous. The OC may owe much of this deformation to its proximity to the Hayward Fault (HF).
The OC outcrops east of the HF and Chabot Fault in the East Bay Hills, overlies the Knoxville Formation, and may have been buried by 4.5 km of younger untis. The OC is a proximal submarine fan deposit with sediment sourced to the ancestral Klamath and Sierra Nevada.
OC clasts are frequently fractured and most have grain-on-grain contact features on their surfaces. A variety of structures range from (1) bright circular halos with little or no surface dimpling; to (2) rounded “firing pin” structures that appear to have pulverized, depressed contact patches that are the locus of radial, conjugate, shear fractures that offset the surface of the clast; cross-cutting relationships suggest that dimpling and faulting are likely synchronous; and (3) clean, well formed, pressure solution pits, often rimmed by a discrete lip of adjacent matrix, likely cemented by locally available quartz. These are often cut by the faults of 2 above. Contact features 2 and 3 can occur in the same specimen. Features 1 and 2 are products of “clean” grain-on-grain contact, with 2 perhaps being a progressed state of 1. Differences between the bright halo and the pressure solution pits may be due to the presence of a thin layer of matrix sand, which facilitates pressure solution. Faults within the matrix and cobbles are often conjugate, and penetrative at the outcrop scale. Initial structural analysis suggests these faults might lend themselves to stress inversion techniques if enough examples are available.
The OC, given its very close proximity to the HF, may provide a record of the shortening direction and stress orientations directly adjacent to this important plate boundary.

Presentation Type:
Poster

Presenting Author:
Strayer, Luther

EARTHQUAKE INSTABILITY MODEL FOR FAULTING ON THE SOUTHERN HAYWARD AND CENTRAL CALAVERAS FAULTS

STUART, W. D., SIMPSON, R. W., U.S. Geological Survey, Menlo Park, CA 94025, USA, stuart@usgs.gov, simpson@usgs.gov; and BARALL, M., Invisible Software, mbinv@invisiblesoft.com

Abstract:
We have constructed a numerical mechanical model to simulate space- and time-dependent fault slip and stress on the Hayward and Calaveras faults over the time scale of decades. In this model, which is represented by the equations of an elasticity boundary value problem, fault zones satisfy a given friction law, and nucleation and slip of moderate and large earthquakes occur in a natural way. Values of fault friction parameters (e.g., “strength”) are found by trial such that a simulation agrees as well as possible with geodetic and seismicity observations. When a simulation is continued into the future, a model earthquake can be considered to be a predicted earthquake, with the uncertainty to be estimated by a set of model runs. In a simulation, the spatial variation of fault strength is one factor that determines model earthquake sizes and locations, and thus can be thought of as a control on fault segmentation for seismic hazard purposes. Here we describe a restricted model designed to simulate faulting associated with interseismic stress build-up on the Alum Rock section of the central Calaveras Fault and its subsequent seismic failure. Our model is quasistatic and thus is not strictly a full-cycle model for both interseismic and dynamic rupture times. The connection is made by using the stress field at the instant of earthquake nucleation in the quasistatic model as the initial stress field in a separate dynamic rupture simulation (Barall et al., 2008, this conference). The stress field following dynamic rupture is then inserted back into the quasistatic model to resume the simulation. In this way the interaction of consecutive nearby earthquakes can be studied as the evolving solution to a single boundary value problem.

Presentation Type:
Poster

Presenting Author:
Stuart, William

SEISMIC SOIL-STRUCTURE INTERACTION ANALYSIS OF TALL STRUCTURES IN TIME DOMAIN

SUBRAMANIAN, C., Lecturer, A.C. College of Engineering and Technology, Karaikudi, Tamil Nadu, India 630004, cgsmanian@yahoo.co.in; and
KARPAGAM (ALIAS) NACHAMMAI, M., Research Scholar, University of Wollongong, NSW, Australia 2500, karpagam_civil@yahoo.co.in

Abstract:
Interaction among structures, their foundations, and the soil medium below the foundation alter the actual response of structures considerably from what is obtained from the consideration of the structure alone. Numerical simulation of these soil-structure systems subjected to dynamic loads should include not only the structure but also the foundation and the soil medium. By including the characteristics of soil in the calculation and energy dissipation through the soil medium, a realistic evaluation of the structural response is possible. The semi-infinite medium on which the foundation is placed has to be modeled accurately so that the radiation conditions are represented properly.
Numerical methods used for soil-structure interaction analysis are finite difference method (FDM), finite element method (FEM), and boundary element method (BEM). FEM can be used effectively for the analysis of structure and bounded soil beneath the foundation, while BEM is employed to model the unbounded semi-infinite soil medium. In this paper, a sample problem of stacklike structure is considered for the numerical analysis of soil-structure interaction effects due to seismic time history.
The influence of boundary conditions on the overall system response is handled appropriately by the direct method and physical models using SAP 2000 NL. It is found that at all nodes of the structure, time history responses of soil structure interaction models are greater than those of the fixed base model. The change in frequency content and the lengthening of time period become more dominant as the flexibility of the soil increases. It can also be noticed that the maximum response is obtained for the topmost node under soft soil conditions. Thus the effect of soil structure interaction is more pronounced for soft soils.

Presentation Type:
Poster

Presenting Author:
Karpagam (Alias) Nachammai M., Subramanian C.

GEOLOGIC INTERPRETATION OF NORTHERN CALAVERAS FAULT LOCATION AND DISPLACEMENT ANALYSIS AT THE ALAMEDA SIPHON NO. 2 AND PROPOSED ALAMEDA SIPHON NO. 4, SUNOL VALLEY, CALIFORNIA

SUNDERMANN, Sean T., William Lettis & Associates, Golden, CO 80401, sundermann@lettis.com; and KELSON, Keith I., William Lettis & Associates, Walnut Creek, CA 94596, kelson@lettis.com

Abstract:
The existing Alameda Siphons are components of the Hetch Hetchy water system, which transmits water stored at Hetch Hetchy Reservoir to customers in the San Francisco Bay area. The three existing Alameda Siphons cross the Northern Calaveras Fault within the Sunol Valley and are vulnerable to failure in a major seismic event as a result of fault displacement. The characteristic earthquake for the 45-km Northern Calaveras Fault is estimated to be M6.8 by the most recent USGS Working Group of California Earthquake Probabilities report (WGCEP, 2003). Because of the fault-rupture hazard, Siphon No 2 has been identified as a high priority for upgrade, and a new Alameda Siphon (No. 4) is being considered for construction.
The principal objectives of our fault-rupture characterization and mitigation were to assess location and width of active strand(s) and characterize the amount and distribution of fault-rupture displacement in support of pipeline design. Site-specific geologic, seismologic, and geotechnical information were collected and integrated with pre-existing data sets, including siphon creep indicators, to determine fault location and geometry, style of faulting, and relative degree of activity.
The fault displacement is considered to occur on a single, narrow fault strand at any location within a 100- to 120-foot-wide deformation zone crossing No. 4 and No 2. The 975-year displacement values at the site vary from a mean value of 2.3 feet using the PFDHA approach to 4.1 feet using the approximate approach presented in the General Design Requirements. The 4.1 foot value is calculated as 2.0 times the average surface displacement derived from SFPUC methods. The difference in values can be attributed to either the PFDHA nonzero rupture probability, a reduction scaling factor, or that the WG02 rupture model strongly weights the segmented Northern Calaveras Fault rupture model as a low-magnitude floating earthquake model yielding very low weights to longer ruptures.

Presentation Type:
Oral

Presenting Author:
Sundermann, Sean

PROBABILISTIC FAULT DISPLACEMENT HAZARD ANALYSIS FOR THE SOUTHERN HAYWARD AND NORTHERN CALAVERAS FAULTS

THOMPSON, Stephen C., KELSON, Keith I., and O'CONNELL, Daniel R. H., William Lettis & Associates, Walnut Creek, CA, USA, thompson@lettis.com

Abstract:
A probabilistic fault displacement hazard analysis (PFDHA) characterized the 475- and 975-year return period displacements at major water pipeline crossings on the southern Hayward Fault in Fremont and on the northern Calaveras Fault in Sunol Valley. The approach and exceedance probabilities follow criteria established for the seismic improvement program to the pipeline system. The net displacement calculated at each fault crossing was distributed along the pipeline using site-specific characterizations from previous fault-rupture hazard investigations. The PFDHA considered four probability distributions. The fault rupture model from the 2003 Working Group defined the distribution of earthquake magnitude and recurrence. Published magnitude-displacement empirical relations provided estimates of average surface fault rupture and uncertainty in the average displacement. Additional probability distributions included the variability of displacement along a rupture about its average and the variability of displacement as a function of distance from a rupture endpoint. Results for the 975-year return period earthquake showed mean displacements of 1.5 m and 1.3 m for two sites on the southern Hayward fault located several kilometers apart, and 1.2 m for the crossing at the Northern Calaveras Fault. Additional displacements were estimated for aseismic fault creep during the interseismic period. The uncertainties from the PFDHA at the one standard deviation level are about 30% higher and lower than the mean, and are less than those calculated using deterministic analyses based on similar rupture characterizations. The lower uncertainties associated with the PFDHA approach potentially result in lower design and construction costs for mitigation. For this and other projects for which displacement hazard analyses have been performed, project owners and design consultants have appreciated quantitative presentation of uncertainties and have generally adopted lower exceedance values (i.e., higher design displacements) than the median or mean values.

Presentation Type:
Oral

Presenting Author:
Thompson, Stephen

THE EARTHQUAKE OF 1868 AND THE BIRTH OF SEISMICALLY RESISTANT ARCHITECTURE AND ENGINEERING IN SAN FRANCISCO

TOBRINER, Stephen, Professor Emeritus, History of Architecture, University of California, 232 Wurster Hall, Berkeley, 94720, USA, tobriner@berkeley.edu.

Abstract:
This lecture presents a revolutionary view of the 1868 earthquake. While popular authors have claimed San Franciscans consistently denied earthquakes and learned nothing from them, this lecture will prove that engineers and architects built earthquake-resistant buildings after the earthquakes of 1868. The earthquake stimulated a wide-ranging discussion of seismically resistant designs and spawned a series of innovative seismically resistant patents for ensuring the safety of brick buildings in earthquakes. Many of the city's most important buildings, including the United States Mint, the United States Appraiser's Building, the Palace Hotel, the Grand Hotel, and the enlargement of the Occidental Hotel, were built to withstand earthquakes and successfully withstood the earthquake of 1906. The Regents of the new University of California, having experienced the earthquake of 1868, insisted that their buildings be seismically resistant. San Franciscans also saw the effectiveness of wood as a seismically resistant material and realized how much safer it was to live in wood rather than brick dwellings. On this anniversary of one of the most destructive earthquakes to strike the Bay Area, it is essential to remember the story of forgotten citizens, engineers, and architects who did not deny earthquakes but actively intervened to ensure a safer San Francisco.

Presentation Type:
Oral

Presenting Author:
Tobriner, Stephen

A STUDY OF STRONG GROUND MOTIONS IN THE SAN FRANCISCO BAY AREA FROM THE M5.4 ALUM ROCK, CALIFORNIA EARTHQUAKE

TSAI,Y. B., ABRAHAMSON, N. A., and McLAREN, M. K., Pacific Gas and Electric Company, San Francisco, CA 94105, yxt1@pge.com, naa2@pge.com, mkm2@pge.com

Abstract:
A moderate earthquake of M5.4 took place on 30 October 2007 near Alum Rock, California at a depth of about 9 km. The earthquake was felt throughout the San Francisco Bay Area and part of the Central Valley to the east. An unusually large set of digital strong ground-motion data from 135 free-field sites is available on a Web site of the Center for Engineering Strong Motion Data (CESMD; http://www.strongmotioncenter.org/). The event was also recorded by 14 PG&E strong-motion instruments. In this study we combined these data to analyze the 5%-damped acceleration response spectra (Sa) in terms of both absolute spectral values and normalized spectral shapes of the horizontal and vertical motions. Noting that surface soil conditions are highly variable in this region (e.g., Wills et al., 2000), we further used the data from two array clusters near Saratoga and Los Gatos, respectively, to highlight the spectral characteristics of local site response. Comparisons of the Sa characteristics were then made between this event and the larger 1984 Morgan Hill and 1989 Loma Prieta earthquakes to explore potential applications of this well recorded data set for estimating future strong ground motions in the area. Finally, some of our results are compared with predictions of the new-generation attenuation (NGA) relationships (Abrahamson et al., 2008).

Presentation Type:
Poster

Presenting Author:
Tsai, Yi-Ben

TRANSPRESSIONAL TECTONICS OF THE EASTERN SAN FRANCISCO BAY REGION, CALIFORNIA, AND IMPLICATIONS FOR SEISMIC HAZARD ASSESSMENT

UNRUH, Jeffrey R., William Lettis & Associates, Inc., Walnut Creek, CA, USA, unruh@lettis.com

Abstract:
Oblique convergence (transpression) between the Pacific Plate and Sierran microplate is accommodated in the eastern San Francisco Bay area by mixed strike-slip and thrust faulting. Contrary to the "fault-normal compression" hypothesis, Quaternary thrust faults are oblique rather than parallel to major strands of the eastern San Andreas system and primarily occur in restraining left step-overs between dextral faults. Folds and thrust faults in the step-over regions exhibit right-stepping, en-echelon patterns typical of dextral wrench tectonics. These kinematics have implications for the maximum dimensions and slip rates of thrust faults in the step-over regions and thus for potential earthquake magnitudes and recurrence rates. A possible analog for moderate to large thrust earthquakes in the East Bay is the 2003 M6.5 San Simeon earthquake, which occurred on a thrust fault in a restraining step-over between the dextral West Huasna and San Simeon faults. In addition to the ~30-km-long mainshock rupture plane, aftershocks of the San Simeon earthquake illuminated a ~10-km-long southwest-dipping back thrust parallel to the main thrust near the hypocenter, several smaller southwest-dipping structures in the southeast, and additional northeast-dipping or subvertical structures southeast of the mainshock plane (McLaren et al., in press). The blind Mt. Diablo thrust fault, which transfers slip across a restraining step-over between the dextral Greenville and Concord faults, may be similar to the source of the San Simeon earthquake in terms of dimensions and structural complexity. Although variations in map-scale structure have been used to develop segmentation scenarios for the Mt. Diablo thrust fault and other contractional structures in the East Bay, the San Simeon earthquake suggests that structural complexity observed at the surface may be related to shallow, second-order features that can obscure the continuity of the seismogenic fault at depth.

Presentation Type:
Oral

Presenting Author:
Unruh, Jeffrey

ABSENCE OF LATE NEOGENE OFFSET ON THE NORTHERN CALAVERAS FAULT

WALKER, J. P., Kleinfelder, 7133 Koll Center Parkway, Suite 100, Pleasanton, CA 94566, USA, jpwalker@kleinfelder.com; and GRAYMER, R. W., U.S. Geological Survey, 345 Middlefield Rd., MS 975, Menlo Park, CA 94502,USA, rgraymer@usgs.gov

Abstract:
The northern segment of the Calaveras Fault (NCF) runs from Calaveras Reservoir north along the western edge of the Livermore and San Ramon valleys. Mapping of the Calaveras Fault shows it as far north as the town of Danville (Graymer et. al., 1996), and earlier works extended it even farther north. A high-resolution aeromagnetic survey collected by the U.S. Geological Survey shows a linear aeromagnetic high crossing the mapped trace of the Calaveras Fault on the western edge of the San Ramon Valley, near Crow Canyon. This anomaly is associated with Miocene Neroly sandstone that outcrops west of the fault in the Las Trampas Ridge Anticline, suggesting that the sandstone is continuos without appreciable offset across the mapped fault trace into the subsurface of the San Ramon Valley. Therefore, Neogene offset on the NCF must terminate at or south of the latitude of Crow Canyon, and slip previously inferred for the NCF must be assigned to other structures in the region. The amount of slip previously assigned to the NCF varies between 28 km and 80 km. Recent palinspastic reconstructions (Graymer and others, 2002) indicate that most of the right-slip offset is taken up by the Palomares-Miller Creek-Moraga-Pinole fault system to the west. Others (Unruh and Lettis, 1998) suggest that slip is transferred from the NCF by means of multiple folds and small displacement faults west of the Calaveras Fault. The 2003 Working Group on California Earthquake Probabilities suggests that slip on the NCF is transferred across the Mt. Diablo antiform onto the Concord Fault. This transfer of slip would be a right step in a right-lateral system, which should produce extensional features at this step. Only compressional structures exist between the NCF and Concord Fault, however. The lack of extension at this right step, combined with little or no late Neogene offset on the NCF indicates that the proposed Concord-NCF right step is either a very young tectonic element or does not exist at all.

Presentation Type:
Poster

Presenting Author:
Walker, James

STRATIGRAPHIC EVIDENCE FOR A MIDDLE MIOCENE ONSET OF RIGHT-LATERAL STRIKE SLIP IN THE EAST BAY

WALKER, J. P., Kleinfelder, Pleasanton, CA 94566, USA, jpwalker@kleinfelder.com

Abstract:
This study is based on the results of 16 point counts of conglomerates in the Tertiary Kirker Formation and the Miocene San Pablo Group (the Cierbo, Briones, and Neroly sandstones). The Miocene section studied in the East Bay area records an evolving depositional system during the onset of dextral slip in the Bay Area Buising and Walker (1995). The Neroly conglomerates at Happy Valley support the possibility of a large amount of dextral slip between it and the Berkeley Hills Volcanics on the Moraga-Miller Creek-Palomares fault(s) as postulated by Graymer et al. (2002).
A contrast between the northern and southern Sierran provenance of the Cierbo and the northern and central Sierran provenance of the Neroly points to the changes in the paleodrainage system east of the study area. The angular unconformities that mark all the contacts in the San Pablo Group in the eastern Los Medanos Hills, coupled with the presence of subaqueous debris flows in the Neroly at Shell Ridge, suggest the development of a local high near modern Mount Diablo if this structure was being driven by the same forces that Unruh et al. (2007) have postulated as responsible for the uplift of Mt. Diablo, this would suggest that right-lateral slip at the latitude of the Bay Area could have been initiated as early as 15 Ma.

Presentation Type:
Poster

Presenting Author:
Walker, James

THE MOUNT LEWIS FAULT ZONE: AN EMERGING PLAYER IN THE HAYWARD-CALAVERAS FAULT SYSTEM

WATT, J. T., PONCE, D. A., SIMPSON, R. W., GRAYMER, R. W., JACHENS, R. C., and WENTWORTH, C. M., U.S. Geological Survey, Menlo Park, CA, 94025, USA

Abstract:
The 30-km-long Mount Lewis seismicity trend and associated structures extend southward from the M5.7 1986 Mount Lewis earthquake and intersect the Calaveras Fault near the epicenter of the 1984 Morgan Hill earthquake. Deformation associated with this tectonic feature may be responsible for the segmentation of the Calaveras Fault at this location. Kilb and Rubin (2002) identified a main north-south-striking, right-lateral strike-slip fault plane and a number of small, steeply dipping, east-west faults from analysis of the Mount Lewis earthquake and aftershocks and inferred the growth of a young fault. Based on 2D and 3D analysis of double-difference relocated seismicity (Waldhauser, written commun., 2007), we identify additional fault planes that project upward to pre-existing structures: an unnamed fault located about 2 km east of the Mount Lewis mainshock and a locally north-trending suture within the Franciscan Complex. The faults overlap beneath the northern end of a serpentinite body within the suture and extend, respectively, north and south from there. Magnetic modeling of the serpentinite body within the suture indicates the body extends to approximately 3 km depth and has a steep westerly dip, corresponding to alignments of deeper seismicity. Although there is no offset geology or observed surface rupture along the seismicity trend, a diffuse north-south topographic lineament crosscuts the surrounding landscape. The developing Mount Lewis fault system appears to influence segmentation along the Calaveras Fault and may be accommodating stress between the Calaveras and Greenville faults, making it an important part of the 3D geologic model of the Hayward-Calaveras fault system. Geologic information from the 3D model will be used for earthquake process modeling, which will aid characterization of potential seismic hazards.

Presentation Type:
Poster

Presenting Author:
Watt, Janet

RATE CONSTRAINTS FOR THE NORTHERN HAYWARD FAULT AT BERKELEY: EVALUATION OF THE 335-METER STRAWBERRY CREEK OFFSET

WILLIAMS, P. L., San Diego State University, San Diego, CA, 92182-1020, plw3@earthlink.net

Abstract:
Motion of the Hayward Fault has displaced the modern, active course of Strawberry Creek 335 meters at the UC Berkeley campus. Landforms of the campus are highly modified but in strong balance to the loss of original features is the extensive predevelopment topographic mapping in the area. A high-resolution high-confidence slip rate is essential for improving interpretations of the tectonic history and future behavior of the northern Hayward Fault. The study utilizes the age, sedimentary history, and bed morphology of the most recently abandoned paleochannel of Strawberry Creek. A substantive basis for age dating of the feature will provide a reference for studies of regional geodetic and fault rupture mechanics. It is ironic that the UC Berkeley main campus appears to be the best location for study of the long-term kinematics of the northern Hayward Fault. The university's location was selected, in large part, because of the presence of a reliable water supply from the watershed of Strawberry Creek. The most recently beheaded and abandoned drainage of Strawberry Creek, the "Mining Circle Channel" (MCC), is offset 580 m from Strawberry Canyon.
The timing of stream abandonment can be recovered from careful examination of the relationship between fluvial and colluvial material in the buried deposits of the MCC. The ancient morphology of the abandoned MCC is evident along the west access road to Stern Hall, Foothill Student Housing. Excavation is expected to expose a cross-section of fluvial and colluvial channel sediments. The age of transition from alluvial to colluvial sedimentation can be taken as the time of initiation of the modern channel. Successful dating of the MCC abandonment age will constrain the northern Hayward Fault's rate with errors anticipated as ca. 1 mm/yr.

Presentation Type:
Oral

Presenting Author:
Williams, Pat

ISSUES AT THE SEISMIC HAZARD/SEISMIC DESIGN INTERFACE IN THE SAN FRANCISCO BAY REGION

WONG, I. and THOMAS, P., Seismic Hazards Group, URS Corporation, Oakland, CA, ivan_wong@urscorp.com

Abstract:
In the last few years, structural engineers have increasingly requested site-specific seismic design ground motions in the San Francisco Bay region coinciding with a boom in construction of large high-occupancy buildings and critical and important facilities such as hospitals and schools. During this same time period, the Pacific Earthquake Engineering Research (PEER) Center's Next Generation of Attenuation (NGA) relationships have been developed and released. These new relationships have strongly impacted the USGS National Hazard Maps, the basis of the NEHRP MCE maps and the International Building Code by decreasing the ground motion hazard in the western U.S., particularly in California. As a result, several issues have been raised and in some cases, proposed changes have been made in seismic design procedures. One such proposed change is the use of the maximum component of ground motion in seismic design rather than the geometric mean. Another potential change is for the deterministic caps that can be implemented in seismic design, the 84th percentile ground motions are recommended for use rather than 1.5 times the median ground motions because the aleatory uncertainties (sigma) are higher in the NGA models. There exists differences in the NGA spectral shapes as compared to code-specified spectra as a result of the site effects included in the NGA models and this issue has yet to be addressed. Fault rupture directivity, which is a major factor in seismic design in the San Francisco Bay region, due to the proximity of the Hayward and San Andreas faults has also been debated. It appears based on work associated with the NGA Project, the traditional practice of using the adjustments proposed by Somerville et al. (1997) and Abrahamson (2000) appears to be too conservative. New approaches have been published but these have yet to be put into practice. Another issue is whether use of the maximum component and the 84th percentile deterministic cap should also be adjusted for fault rupture directivity resulting in possibly overconservative design. The importance of V_S30 (average shear-wave velocity in the top 30 m) at sites has been elevated because it is a parameter in the NGA relationships. However, often site-specific measurements of V_S30 are not available and so estimates need to be made. It would be important that the uncertainty in these values and site variability are not neglected because of their impact on the NGA spectral shapes. Finally, the debate continues on the number of time histories required in dynamic analyses and whether they should be scaled or spectrally matched. These issues will need to be addressed in the next few years as the impacts of the NGA models become better understood and use of the NGA relationships matures.

Presentation Type:
Oral

Presenting Author:
Wong, Ivan

QUANTIFYING THE EARTHQUAKE THREAT IN THE SACRAMENTO-SAN JOAQUIN DELTA, CALIFORNIA: HOW BAD CAN IT GET?

WONG, I., THOMAS, P., Seismic Hazards Group, URS Corporation, Oakland, CA, ivan_wong@urscorp.com; UNRUH, J., William Lettis & Associates, Walnut Creek, CA; HANSON, K., and YOUNGS, R., Geomatrix Consultants Inc., Oakland, CA

Abstract:
Within the Sacramento-San Joaquin delta are more than a thousand miles of fragile levees whose failure could be catastrophic to the economy of California. Earthquakes are the greatest natural threat to the integrity of the delta's levee system, and so as part of the state-funded Delta Risk Management System study, we have characterized the ground shaking hazard within the delta. Based on a seismic source model that builds upon the characterizations of the major faults in the San Francisco Bay region from the Working Group on California Earthquake Probabilities (WGCEP, 2003) and several newly recognized faults, probabilistic seismic hazard maps of the delta were developed. Of particular significance are several seismic sources within the delta which were characterized as part of this study, including the northern and southern Midland Fault and two areal zones of deformation, which we call the Montezuma Hills and Thornton Arch zones. These potential seismic sources have been the subject of very little research and thus there is greater uncertainty in their characterization compared to the better studied major faults in the Bay region. Newly developed ground-motion attenuation relationships from the Pacific Earthquake Engineering Research Center's Next Generation Attenuation (NGA) Project were used in the hazard analysis. Quasi-time-dependent hazard in 2005, 2050, 2100, and 2200 was calculated. The time-dependent behavior of the major faults was adopted from the WGCEP (2003), which weighted both time-dependent and independent models in its forecasts. The hazard was calculated for a firm-soil site condition. For a return period of 500 years, the time-dependent probabilistic peak horizontal accelerations ranged from 0.2 to 0.4 g. Time-independent (Poissonian) hazard for the delta differs little from the time-dependent hazard because the hazard is generally being controlled by the local delta faults. The hazard as expected is higher at sites closer to the major faults. Overall, the moderate to high level of ground shaking hazard in the delta is such that levee failure is expected in the next large Bay Area earthquake.

Presentation Type:
Oral

Presenting Author:
Wong, Ivan

GEOLOGY AND DISPLACEMENT CHARACTERISTICS OF THE SOUTHERN HAYWARD FAULT ZONE AT BAY DIVISION PIPELINES 3 AND 4 CROSSING, FREMONT, CALIFORNIA

WRIGHT, R. H., bwright@amec.com; HALL, N. T., thall@geomatrix.com; TRAUBENIK, M. L., mtraubenik@amec.com, AMEC Geomatrix Inc., Oakland, CA 94612; and WESLING, J., Department of Conservation, Sacramento, CA 95814, john.wesling@concervation.ca.gov

Abstract:
Geologic investigations, including five trenches, located and characterized active traces of the Hayward Fault zone (HFZ) at the crossing with San Francisco Public Utilities Commission's BDPL 3 (built in 1950s, 78-in diam.) and BDPL 4 (built in 1960s, 96-in diam.) near the intersection of I-680 and Mission Blvd. The site is SW of the postulated left step between the Calaveras Fault zone (CFZ) and the HFZ at Mission Peak, which is defined by a zone of microseismicity between the two faults. At the BDPL crossing, the HFZ is about 730 ft wide and consists of three active traces: a primary trace and two secondary faults with components of reverse slip consistent with compressional deformation associated with the step-over. Future displacements are expected to be predominantly right slip with up-on-the-east reverse slip not exceeding 15% of the lateral slip.
The central trace is marked by a 3.5-ft-wide gouge zone in probable Holocene alluvium that strikes N30-32°W, dips 79° NE, and lies within a zone of aseismic creep (long-term rate 7.1±1.7 mm/yr) that extends about 7 ft NE and at least 30 ft SW. Here historical fill has been deformed by creep and possibly by rupture during the 1868 earthquake. The majority of coseismic right slip during a maximum earthquake is expected on this trace.
About 380 ft to the SW, the west trace consists of a 4-ft-wide main fault bordered by an up to 15-ft-wide zone of secondary faults on the NE and a near-surface zone of down-on-the-SW monoclinal warping that is at least 20 ft wide. Shears within this fold cut early Holocene sediments (8,500 radiocarbon years B.P.) and displace overlying sediments up to 0.2 ft. The main fault in Trench 4 strikes N12°W and dips 50°NE at a depth of 13 ft below the base of fill. In Trench 5, this fault strikes N20-30°W and dips 70° NE. The preferred rupture scenario places up to 15% of horizontal slip and two thirds of vertical slip across the west trace.
About 350 ft NE of the central trace, the east trace consists of a 9-ft-wide main fault bounded by a 60-ft-wide zone of secondary faulting on the SW and by a 100- to 200-ft-wide zone of uplift and folding on the NE. The main fault strikes N62°W, dips 38° NE (thrust), and displaces the base of the soil developed on young alluvium. The preferred rupture scenario has up to 5% of horizontal slip and one third of vertical slip across the east trace.

Presentation Type:
Poster

Presenting Author:
Wright, Robert H.

HAYWARD FAULT EARTHQUAKE: WHO WILL PAY?

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Abstract:
A repeat of an earthquake on the Hayward Fault in 2008 could have potential losses exceeding $200B and displace more than 70,000 households. To estimate the range of potential losses, we evaluated six scenarios: three realizations of a M6.75 earthquake on the South Hayward Fault and three realizations of a M7.05 on the entire Hayward Fault, using 3D ground motion simulations conducted by B. Aagaard (USGS) and R. Graves (URS). The simulations vary by epicenter location and include significant directivity effects. Losses would be concentrated in five counties, most significantly in Alameda, followed by Santa Clara, Contra Costa, San Francisco, and San Mateo counties. The losses were computed using publicly available loss estimation software, HAZUS-MH, as well as proprietary RMS models. We estimate total direct economic losses in excess of $150B to private property, contents, and time element coverages (additional living expenses and business interruption). Fire following the event could increase that total by more than $20B. Damage to infrastructure, including roads, likely dam failures, and potential rupture of the Hetch-Hetchy aqueduct, could compound the total direct economic losses by an additional $20B+. Apartment buildings are expected to suffer the largest damage compared to single-family homes and other commercial buildings, with many ZIP codes along the fault having mean damage ratios between 30% and 40%. Recovery will be hampered by a lack of insurance, as only about 10% of the total loss will be covered by insurance payments. By comparison, roughly $66B of insurance dollars (~55% of total loss) flowed into the southern Louisiana region to aid in recovery of Hurricane Katrina's $125B in total economic loss.

Presentation Type:
Oral

Presenting Author:
Zoback, Mary Lou

October 22-24, 2008
140th Anniversary of the 1868 Earthquake

THIRD CONFERENCE ON EARTHQUAKE HAZARDS IN THE EASTERN SAN FRANCISCO BAY AREA

Attendees of East Bay Earthquake Conference, Oct. 22-24, 2008
California State University, East Bay

No.	Last name	First name	Affiliation
1	Aagaard	Brad	US Geological Survey
2	Abrahamson	Norman	PG&E
3	Agnew	James	Calif. Dept. of Water Resources (DWR)
4	Amir	Erika	San Francisco State University
5	Baker	Jim	Santa Clara County Planning Office
6	Baker	Brett	Santa Clara Valley Water District
7	Bakun	William	U.S. Geological Survey
8	Barall	Michael	Invisible Software
9	Baublitz	Michael	GeoBlitz
10	Bela	James	NASW
11	Blanpied	Michael	U.S. Geological Survey
12	Bleier	Tom	QuakeFinder
13	Borchardt	Glenn	Soil Tectonics
14	Bozargnia	Yousef	Pacific Earthquake Engineering Research Center
15	Brady	Gerald	
16	Brocher	Tom	U.S. Geological Survey
17	Brown	Holly	UC Berkeley Seismological Lab
18	Bryant	William	California Geological Survey
19	Bundock	Howard	U.S. Geological Survey
20	Burgmann	Roland	UC Berkeley
21	Burnham	Kathleen	independent research
22	Burns	Robert	CA Dept. of Water Resources - Safety of Dams
23	Carey	Michael	Adobe Geotech
24	Carter	Joan	Branham High School
25	Catchings	Rufus	U.S. Geological Survey
26	Çelebi	Mehmet	U.S. Geological Survey
27	Chen	Rui	CGS
28	Clark	Michael	Clark Geotechnical
29	Cole	Bill	Geoinsite, Inc.
30	Connelly	Steve	Steven F. Connelly, C.E.G.
31	Cox	Dale	USGS Multi-Hazards
32	Craig	Mitchell	California State University, East Bay
33	Cushing	Donald	Cushing Associates
34	Deem	Grant	San Jose State University
35	DeLong	Steve	USGS
36	DeMartini	Clifton	retired
37	Detterman	Mark	Blymyer Engineers, Inc.
38	Detterman	Karel	
39	Detweiler	Shane	U.S. Geological Survey
40	Deyhle	Annette	Institute of HeartMath
41	Donoghue	Tom	Equity Office
42	Dreger	Doug	UCB
43	Drumm	Patrick	Earth Focus Geological Services, Inc.

44	Dwyer	Michael	consultant
45	Eidinger	John	G&E Engineering Systems
46	Ellsworth	Bill	U.S. Geological Survey
47	Feltman	John	Pacific Geotechnical Engineering
48	Fenton	Johanna	FEMA
49	Ferre	Kent	Pacific Gas and Electric Company
50	Fisher	Reid	Pacific Geotechnical Engineering
51	Fletcher	Jon	U.S. Geological Survey
52	Ford	Sean	Berkeley Seismological Laboratory
53	Freund	Friedemann	NASA Awes
54	Funning	Gareth	University of California, Riverside
55	Furlong	Kevin	Penn State University
56	Garbutt	Phillip	
57	Givler	Robert	William Lettis and Associates, Inc.
58	Golesorkhi	Ramin	Treadwell & Rollo, Inc.
59	Gouchon	John	Treadwell & Rollo, Inc.
60	Graves	Robert	URS Corporation
61	Graymer	Russell	U.S. Geological Survey
62	Haddadi	Hamid	California Geological Survey
63	Hagos	Lijam	California Geological Survey
64	Hakhameneshi	Manny	University of California, Davis
65	Hall	N. Timothy	AMEC Geomatrix
66	Hamilton	Douglas	Consulting Geologist
67	Hardebeck	Jeanne	US Geological Survey
68	Harrington	Kennith	U.S. Army Corps of Engineers
69	Hecker	Suzanne	U.S. Geological Survey
70	Hellweg	Margaret	Berkeley Seismological Laboratory
71	Higgins	Chris	California Geological Survey
72	Hirsch	Derrick	U.S. Geological Survey
73	Holden	Richard	U.S. Bureau of Labor Statistics
74	Holzer	Thomas	U.S. Geological Survey
75	Houlie	Nicolas	Berkeley Seismological Laboratory
76	Howard	Jeff	California Division of Safety of Dams
77	Hutching	Lawrence	Law, Berkeley Medical Lab
78	Ishida	Craig	California State University, East Bay
79	Jefferis-Nilsen	Paula	San Jose State University
80	Johanson	Ingrid	UC Berkeley
81	Johnson	Philip	Cotton, Shires & Associates
82	Johnson	Tracy	BARTD
83	Johnston	Malcolm	U.S. Geological Survey
84	Kadysiewski	Steve	
85	Kalkan	Erol	California Geological Survey
86	Kardon	Joshua	Joshua B. Hardon & Co.
87	Kelson	Keith	William Lettis and Associates, Inc.
88	Kim	Ahyi	Berkeley Seismological Laboratory
89	Knudsen	Keith	URS Corporation
90	Kriens	Bryan	ES Geotechnologies

91	Kropp	Alan	Alan Kropp & Associates
92	Lambert	Richard	Skyline College
93	Lane	Laurie	CSUEB
94	Lee	David	EBMUD
95	Lienkaemper	James	U.S. Geological Survey
96	Linder	Gloria	
97	Ling	Lei	Berkeley Seismological Laboratory
98	Lockner	David	U.S. Geological Survey
99	Lopez	Geana	Pacific Geotechnical Engineering
100	Magary	Kate	ABAG/SFSU
101	Mathieson	Betsy	Exponent Failure Analysis
102	Mathur	Ravi	Parsons
103	McCann	Martin	JBA
104	McClellan	Patrick	First American Natural Hazard Disclosures
105	McClure	Roan	Mountain Home Foundation
106	McCrink	Timothy	California Geological Survey
107	McKinney	Mike	California Geological Survey
108	McLaren	Marcia	PG&E
109	Mehrdadi	Michael	Calif. Dept. of Water Resources (DWR)
110	Mendoza	Theresa	U.S. Army Corps of Engineers
111	Merriam	Martha	California Department of Transportation
112	Miyamoto	H. Kit	Miyamoto International, Inc.
113	Mooney	Walter	USGS
114	Moore	Diane	U. S. Geological Survey
115	Morrow	Carolyn	U.S. Geological Survey
116	Murray-Moraleda	Jessica	U.S. Geological Survey
117	Nadeau	Robert	U.C. Berkeley Seismological Lab
118	Nelson	James	Santa Clara Valley Water District
119	Newman	Susan	SSA
120	Nieh	Raymond	
121	Nisar	Ahmed	MMI Engineering
122	Nishenko	Stuart	Pacific Gas and Electric Company
123	Onishi	Tiemi	USGS
124	Oppenheimer	David	U.S. Geological Survey
125	Osteraas	John	Exponent, Inc.
126	Parrish	John	
127	Parsons	Tom	U.S. Geological Survey
128	Patton	Bruce	California Department of Insurance
129	Perez	Florante	California Geological Survey
130	Perkins	Jeanne	Jeanne Perkins Consulting
131	Perry	Cynthia	BFP Engineers, Inc.
132	Pollitz	Fred	U.S. Geological Survey
133	Ponce	David	U.S. Geological Survey
134	Porter	Lawrence	Geocarte
135	Powers	Matthew	GEI Consultants
136	Pratt	David	East Bay Municipal Utility District
137	Prentice	Carol	U.S. Geological Survey

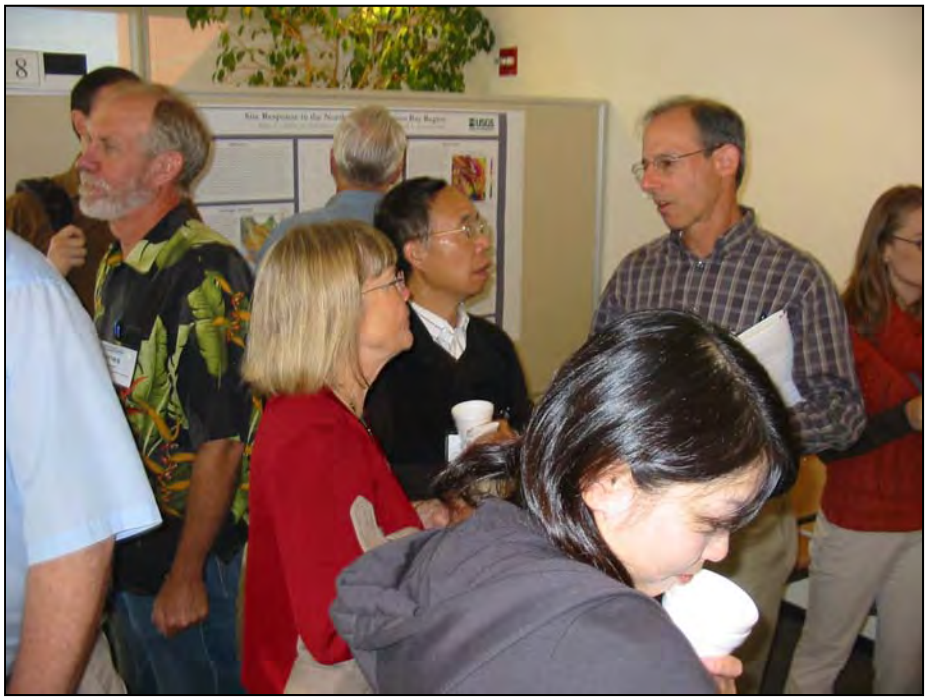
138	Purasinghe	Rupa	California State University at Los Angeles
139	Quigley	Kathryn	UC Berkeley
140	Real	Charles	California Geological Survey
141	Redmond	Lucy	Rutherford & Chekene
142	Reid	George	GRA Associates, Inc.
143	Richardson	Louis	Consulting Geologist
144	Rojahn	Christopher	Applied Technology Council
145	Roman	William	W Roman & Assoc.
146	Rosidi	Dario	CH2M HILL
147	Rosinski	Anne	California Geological Survey
148	Rowley	Randy	RGH Consultants
149	Rubin	Ron	AMEC Geomatrix
150	Ryder	Isabelle	U.C. Berkeley
151	Rymer	Michael	U.S. Geological Survey
152	Saczynski	Thomas	KBR
153	Sawyer	Thomas	Piedmont GeoSciences, Inc.
154	Sayre	Ted	Cotton, Shires & Associates
155	Schwartz	David	U.S. Geological Survey
156	Sedlock	Richard	San José State University
157	Seemann	Mark	California OES
158	Seitz	Jeffery	Cal State East Bay
159	Seymour	David	Kleinfelder
160	Sharpe	Roger	City of Berkeley Disaster and Fire Safety Commission
161	Shostak	Nan	San Jose State University
162	Shulters	Mark	USGS
163	Simpson	Robert	U.S. Geological Survey
164	Sloan	Doris	UC Berkeley
165	Snyder	Amy	Snyder & Wilson Engineering
166	Snyder	David	Snyder & Wilson Engineering
167	Sochar	Scott	Fugro West, Inc.
168	Somerville	Paul	URS Corporation
169	Song	Seok Goo	URS Corporation
170	Spudich	Paul	U.S. Geological Survey
171	Stenner	Heidi	Exponent Failure Analysis
172	Stockwell	John	CSUEB
173	Strayer	Luther	California State University, East Bay
174	Stuart	William	U.S. Geological Survey
175	Sundermann	Sean	William Lettis & Associates, Inc.
176	Taft	Richard	Chevron Corporation
177	Tajirian	Frederick	Chevron Energy Technology Company
178	Tanikawa	Sachiko	Diablo Valley College
179	Taylor	Charles	retired
180	Teitler	Lora	California State University, East Bay
181	Telleen	Karl	Rutherford & Chekene
182	Tepel	Robert	State Mining and Geology Board
183	Terra	Fabia	URS Corporation
184	Teruya	LeAnne	San Jose State University

185	Testa	Stephen	State Mining and Geology Board
186	Thompson	Stephen	William Lettis & Associates, Inc.
187	Tobiner	Stephen	U.C. Berkeley
188	Tsai	Yi-Ben	Pacific Gas and Electric Company
189	Tsztoo	David	
190	Turner	Fred	California Seismic Safety Commission
191	Unruh	Jeff	William Lettis & Associates, Inc.
192	Verschuur	Joanneke	
193	Villamil	Joel	Marx/Okubo Associates
194	Walker	Jim	Kleinfelder
195	Wang	David	Parikh Consultants, Inc.
196	Watt	Janet	U.S. Geological Survey
197	Whitehill	Caroline	Stanford University-USGS
198	Wiegers	Mark	California Geological Survey
199	Williams	John	Geology - San Jose State University
200	Williams	Patrick	SDSU
201	Wills	Chris	California Geological Survey
202	Wong	Ivan	URS Corporation
203	Wooddell	Kathryn	Pacific Gas & Electric Co.
204	Wright	Robert	AMEC Geomatrix
205	Zoback	Mary Lou	RMS
206	Zucker	Mel	Skyline Collection

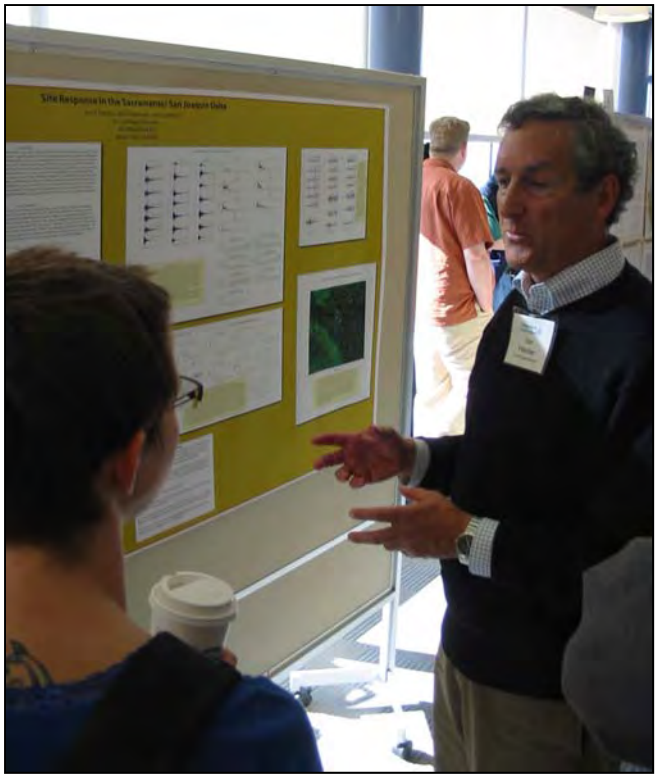
Erol Kalkan explaining his poster to a group of interested onlookers.

Enjoying the sunshine outside the conference facilities during a coffee break.

James Agnew and friends picking up their lunches.



Marcia McNutt and David Oppenheimer in discussion at a poster session.



Jon Fletcher explaining his poster to Evelyn Aleridge.

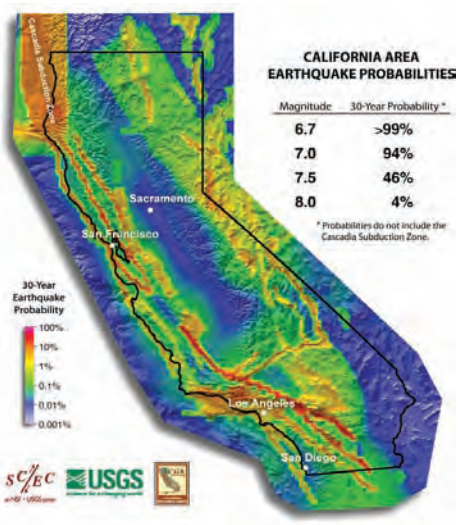
Roan McClure fielding a question about his poster.

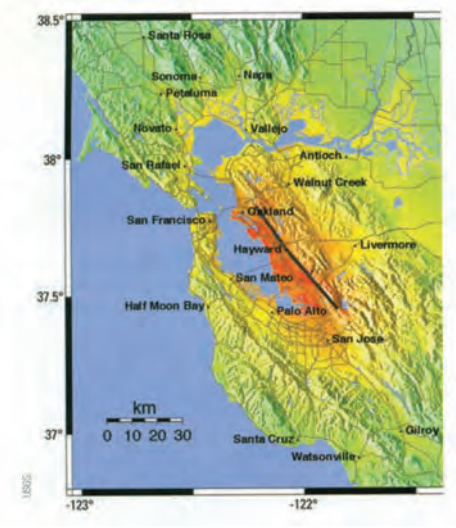
Teacher Training Workshop

The Tectonic Time Bomb in our Backyard
Earthquake Hazards in the San Francisco Bay Area

July 28th, 2009, 9:00 a.m. - 4:00 p.m.

California State University, East Bay





Topics:

This workshop will cover how the Bay Area fits into Global Plate Tectonics, as well as faults and earthquakes, seismic hazards, earthquake preparedness, and seismic retrofitting. The workshop is open to K-14 teachers.

Each participant will receive a $100 stipend, maps, and materials for use in their classroom to demonstrate earthquake slip on faults and seismic waves.

Program:

Presentations by speakers and classroom exercises, CSUEB.

Field trip to the Hayward Fault: Trace the fault through downtown Hayward by the damage it causes to streets and buildings. Then visit Memorial Stadium astride the fault on the UC Berkeley Campus and see the effects of fault creep.

Presenters:

Peggy Hellweg, Research Seismologist at UC Berkeley's Seismological Laboratory, where earthquakes have been monitored since 1887. Her special interests include small earthquakes and earthquake early warning.

Mitchell Craig, Associate Professor at CSU East Bay. His research interests include near-surface geophysical exploration of East Bay faults using seismic and ground-penetrating radar methods.

How to register:

The workshop will be limited to 24 participants.
To register, or for further information, email mitchell.craig@csueastbay.edu including your name, contact information, school, subject(s), and grade that you teach.

This workshop is made possible through the support of the U.S. Geological Survey

Participants - Teacher Training Workshop on Earthquake Hazards
CSU East Bay, July 28th, 2009

Name	School	City
Balassone, Vince	Independent Elementary School	Castro Valley
Casas, Alicia	Grant Elementary	San Jose
Chien, Joy	Fallon Middle School	Dublin
Coburn, Carol	Presidio Middle School	San Francisco
Crum, Donna	Creekside Middle School	Castro Valley
Cruz, Sarah	Washington Elementary	San Leandro
Dennis, Monica	Fallon Middle School	Dublin
Fujiwara, Patty	Albany High School	Albany
Furey, Brendan	Visitacion Valley Middle School	San Francisco
Laird, Johnna	Glenmoor Elementary	Fremont
Liu, Jia	W.C. Overfelt High School	San Jose
Morse, Melinda	Alvarado Middle School	Union City
Paonessa, Cathy	Treeview Elementary	Hayward
Shioji, Ann	Yerba Buena High School	San Jose
Stark, Hollie	Centerville Junior High	Fremont
Sun, Hannah	Lawson Middle School	Cupertino
Thananjeyan, Nima	Milani School	Newark
Willats, Andy	Piedmont High School	Piedmont
Wilson, Birch	Wilcox High School	Santa Clara
Wright, Dana	E.L. Musick Elementary	Newark
Zhang, Gordon	James Denman Middle School	San Francisco