U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

USGS
National Earthquake Hazard Reduction Program
(*NEHRP*)
in
Northern California
in FY94

By

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Explanation

This listing is a compilation of currently active (October 1, 1993- September 30, 1994) efforts funded by the US Geological Survey (*USGS*) along the San Andreas fault system in Northern California through the National Earthquake Hazard Reduction Program (*NEHRP*). It is intended as a resource for identifying ongoing work and contacts knowledgeable about specific earthquake issues in Northern California.

The listing includes projects conducted by USGS scientists, and by non-USGS scientists supported through the USGS NEHRP Grants and Contracts Program. Note that projects in northern California funded by other NEHRP program agencies -the Federal Emergency Management Agency (*FEMA*), the National Science Foundation (*NSF*), and the National Institute of Standards and Technology (*NIST*) are not included.

The projects are ordered by the elements in the strategic plan "*Goals, opportunities, and priorities for the USGS Earthquake Hazard Reduction Program*," USGS Circular 1079, 1992, by Robert A. Page, David M. Boore, Robert C. Bucknam, and Wayne R. Thatcher. This plan is often referred to as the "Page Plan." The Page Plan Elements are listed on page ii of this report.

Page Plan (Column 1). Where more than one Page Plan element is applicable, the project is listed under the principal element; the other appropriate elements are listed in column 1.

Principals (Column 2). Names of principal investigators.

Org. (Column 3). Organization of principal investigators.

Telephone # (Column 4). Telephone # of principal investigators.

Project Title (Column 5). Description of Project.

Summary (Column 6). Overall objectives of project.

FY94 Plans (Column 7). Current activities and objectives.

Affected Counties (Column 8). Counties where field work is anticipated or likely to be particularly affected by the project results.

Page Plan Elements

I. Understanding the Earthquake Source

I.1 Determine the physical properties and mechanical behavior of active fault zones and their surroundings.

I.2 Develop quantitative models of the physics of the earthquake process

II. Determining Earthquake Potential

II.1 Determine the geologic and geophysical setting and characteristics of seismically active regions.

II.2 Determine the occurrence, distribution, and source properties of earthquakes and relate seismicity to geologic structures and tectonic processes.

II.3 Determine the nature and rates of crustal deformation.

II.4 Characterize the earthquake potential of the U.S. on a regional and national basis.

II.5 Identify active faults, define their geometry, and determine the characteristics and dates of past earthquakes.

II.6 Make long-term probabilistic forecasts of the likelihood of large earthquakes on active faults.

II.7 Monitor intensely a few selected regions of high seismic potential.

II.8 Develop and evaluate methods of short- and intermediate-term prediction of earthquake occurrence.

III. Predicting the Effects of Earthquakes

III.1 Acquire data needed for the prediction of ground shaking, ground failure, and response of engineered structures.

III.2 Predict strong ground shaking.

III.3 Predict ground failure.

III.4 Evaluate earthquake hazards and losses.

IV. Using Research Results

IV.1 Transfer hazard information and hazard-assessment methods to users.

FY94 Earthquake Hazard Reduction Projects in Northern California

Page Plan Elem.	Principals	Org.	Tele-phone #	Project Title	Summary	FY94 Plans	Affected Counties
I.1 Determine the physical properties and mechanical behavior of active fault zones and their surroundings.							
I.1	John Booker	U Wash.	206-543-9492	Tensor Electromagnetic Profiling Across the San Andreas Fault	High fluid pressures and pressure fluctuations in the fault may be important in many aspects of the earthquake cycle. Imaging and monitoring electrical conductivity is an important means to investigate the role of fluids at depth near and in faults.	New. Acquire a continuous tensor electromagnetic profile across the San Andreas fault at a site to be selected in central California.	All
I.1	Chi-Yu King	USGS /Menlo /EGG	415-329-5163	Fault-zone Gas Studies	Conduct gas-geochemical survey across faults in Northern California.	New. Conduct soil-air radon survey at a 2-D array of sites across several fault segments; analyze concentrations of hydrogen, helium, argon, carbon dioxide, and mercury vapor; analyze helium isotopes.	All
I.1	Colin Williams	USGS /Menlo /EGG	415-328-4881	Geothermal Studies	Measurements of thermal conditions near active faults provide important constraints on models of the earthquake generation process.	New. Reevaluate thermal conditions in the San Francisco Bay Area. Measure heat flow in proposed new coreholes on the SF Peninsula.	All
I.1	Bob Jachens	USGS /Menlo/ Geophys	415-329-5300	Gabilan Drillsite Geophysics	Potential field study of the subsurface structure along the northern Gabilan Range segment of the San Andreas fault.	New. Collect additional gravity data and contract aeromagnetic survey.	San Benito, Monterey
I.1	George McMechan	U Texas, Dallas	214-690-2213	Application of Ground Penetrating Radar to Investigation of Near-Surface Fault Properties in the San Francisco Bay Region (FY93 funding ends 4/1/94)	High-resolution ground-penetrating radar (GPR) may provide a powerful and cost effective complementary technique to map detailed stratigraphy of fault-related sedimentary structures to determine earthquake offset and recurrence history.	New. Collect GPR data on ≈30 lines of≈0.5km length at sites of ongoing investigations of earthquake potential, earthquake effects, and regional deformation. Compare results against those obtained by other techniques.	Alameda, San Francisco, Napa, San Mateo, Santa Clara, Santa Cruz, Contra Costa, Marin

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I.2 Develop quantitative models of the physics of the earthquake process.							
I.2	Bruce Julian	USGS /Menlo/ SEIS	415-329-4797	Earthquake Focal Mechanism Determination	Invert digital seismic data to derive source parameters of earthquakes in the SF Bay Area.	Continuation. Extend inversion methods to handle amplitude ratios. Interface algorithm to interactive analysis system. Set up programs to retrieve data fron data centers. Analyze SF Bay Area events.	All
I.2	Norm Sleep	Stanford U	415-723-0882	Creep and Compaction within Fault Zones: An Explanation of Why Major Strike-Slip Faults Are Weak (FY93 funding ends 12/1/93)	Develop a model featuring ductile creep, compaction, and high fluid pressures in the fault to explain why earthquakes often occur at apparently low coefficients of friction.	New. Expand current 1-dimensional model to include faults of finite width and depth, preseismic slip on other planes, interactions of parallel faults, and implications for Bay Area faults.	Santa Clara, San Mateo
I.2	Greg Beroza	Stanford U	415-723-4958	Rupture history and Site Effects for the 1989 Loma Prieta Earthquake Using Digital Aftershock records as Empirical Green's Functions (FY93 funding ends 4/1/94)	Understand the extent and nature of faulting during the Loma Prieta earthquake to better assess forecasts of the quake, the potential of adjacent fault segments, and the severity of shaking in future shocks.	New. Analyze USGS and CDMG data for Loma Prieta aftershocks at sites where the mainshock was well recorded to account for source and propagation path effects; Model the Loma Prieta mainshock and assess the effect of site conditions on strong motions.	Santa Clara, Santa Cruz
I.2	Roger Bilham	U Colo.	303-492-6189	Slip Rates in the San Francisco Bay Area (FY93 funding ends 1/18/94)	Model slip partitioning across the faults in the San Francisco Bay Area. How discontinuous faults are connected and interact has important consequences for earthquake occurrence in the region.	New. 1) Model the big picture of the plate boundary from Cape Mendocino to Parkfield, 2)the slip rates and fault morphology in the Bay Area, and 3) the coseismic slip in historic earthquakes.	Alameda, San Francisco, Napa, San Mateo, Santa Clara, Santa Cruz
I.2	Paul Reasenberg	USGS /Menlo /SEIS	415-329-5002	California Seismicity Studies	Analysis of earthquake activity provides insight into the mechanics of earthquake generation.	Continuation. Use California seismicity catalogs to evaluate models of earthquake clustering.	All

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I.2	Kevin Furlong	Penn. St. U.	814-863-0567	3-D Plate Boundary Structure in the San Francisco Bay Region; Implications for the Earthquake Cycle	Evaluate the complex North America - Pacific plate boundary in the SF Bay Area, including connections between faults at depth. Develop a detailed model of stress along the East Bay faults during the earthquake cycle.	Continuation. Through integration of geologic, seismic, and geophysical data, analyze deep crustal structure imaged by BASIX; complete 3-D tomographic image; refine bay sudsidence mechanism; and revisit seismic potential of fault system.	Alameda, Contra Costa
I.2, II.3	Ross Stein, Wayne Thatcher	USGS /Menlo /EGG	415-329-4840 329-4810	Complete 1906 Earthquake Slip Distribution; Implications for the San Francisco Bay and Northern California	Although some features of the 1906 event are well known, an integrated study of the entire rupture has not been done, and the recent M7 shocks at each end (Loma Prieta in 1989 and Cape Mendocino in 1992) deserve an integrated analysis.	Continuation. Obtain the best constraints on the 1906 slip, adding recently-assembled triangulation data relevant to the offshore slip.	Santa Cruz, San Mateo, San Francisco, Marin, Sonoma, Mendocino
I.2, II.4	Bob Simpson	USGS /Menlo /EGG	415-329-4865	Fault Patterns and Strain Budgets	Bay Area faults are still responding to Loma Prieta eqk. induced stress changes. Correlate rate changes in the Bay Area with static stress changes produced by the 1989 Loma Prieta eqk.	Continuation. Refine models of the Hayward fault, attempting to explain the observed reduced rate of creep and spatial variations in the rates of slip.	Alameda, San Francisco, Napa, San Mateo, Santa Clara, Santa Cruz, Marin, Contra Costa
I.2, II.4	Joe Andrews	USGS /Menlo /EGG	415-329-5606	Modeling Fault Slip Rates in the San Francisco Bay Area	Long-term fault slip rates are fundamental data for estimating earthquake hazard and long-term earthquake probabilities. Geologic slip rates are known at only a few points, but modeling might reasonably supplement these data.	Continuation. Model major faults as surfaces of discontinuity in a finite element computer code.	Alameda, Santa Clara

Page Plan Elem.	Principals	Org.	Tele-phone #	Project Title	Summary	FY94 Plans	Affected Counties
II.1 Determine the geologic and geophysical setting and characteristics of seismically active regions.							
II.1	Manuel (Doc) Bonilla	USGS /Menlo /EGG	415-329-5615	Surface Faulting Studies	Compile information that can be used to evaluate and mitigate hazards from earthquakes. Revise the South San Francisco 1:24,000 quadrangle map.	Continuation. Examine new data for the Serra thrust fault and the Hillside fault, add extensive new fills along marg of SF Bay, add liquefaction sites, etc.	San Francisco, San Mateo
II.1	Bob McLaughlin	USGS /Menlo /WRG	415-329-4945	Geologic and Tectonic Framework, Mendocino Triple Junction	Gain better understanding of the complex tectonic setting of the Mendocino Triple Junction Area, the transition from an active transform (San Andreas fault) to a subduction margin (Cascadia Megathrust).	Continuation. Digital compilations of 1:100,000 scale maps.	Humboldt, Mendocino
II.1	Carl Wentworth, Earl Brabb	USGS /Menlo /WRG	415-329-4950 329-5140	Geologic Framework of the San Francisco Bay Region	The geologic and tectonic setting of focused investigations is critical to the interpretation of local investigations.	Continuation. Prepare small scale maps (≈1:100,000) of the region in cooperation with projects in Branches of Seismology, Eqk. Geol. & Geophys., Pacific Marine Geology, Geophysics, and with UC Berkeley.	Alameda, San Francisco, Napa, San Mateo, Santa Clara, Santa Cruz, Marin, Contra Costa
II.1	John Vidale	USGS /Menlo/ SEIS	415-329-4788	Imaging the Earthquake Source and Structure Beneath California Using the CALNET Array	Determine crust and upper mantle structure and model source properties of large earthquakes.	Continuation. Tomographic reconstruction of structure under central and northern California using CALNET data; develop a model of the California lithosphere.	All

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II.1	Tom Brocher	USGS /Menlo/ SEIS	415-329-4737	Analysis of Wide-Angle reflection/Refraction Recordings from the Bay Area Seismic Imaging Experiment (BASIX)	The 1991 BASIX experiment collected 140 km of multichannel seismic reflection data in the SF Bay Area to resolve crustal structure, offshore location of major earthquake producing faults, etc. necessary to model the tectonics of the Bay Area.	Continuation. Relate velocity structure to seismic reflections and clarify wave-propagation characteristics. Complete analysis of BASIX seismic wide-angle profiles, including forward modeling of travel times and amplitudes.	Alameda, San Francisco, Napa, San Mateo, Santa Clara, Santa Cruz, Marin, Contra Costa
II.1	Jill McCarthy	USGS /Menlo/ PMG	415-354-3140	Geometry and Evolution of the San Francisco Bay Area Faults	The 1991 BASIX experiment collected 140 km of multichannel seismic reflection data in the SF Bay Area to resolve crustal structure, offshore location of major earthquake producing faults, etc. necessary to model the tectonics of the Bay Area.	Continuation. Final interpretation and report preparation of the BASIX multichannel and high-resolution Uniboom data. The seismic results will be tied to regional geology, seismicity, and neotectonics studies on land.	Alameda, San Francisco, Napa, San Mateo, Santa Clara, Santa Cruz, Contra Costa, Marin
II.1	Davy Jones	UC Berk	510-642-2514	Tectonics of the Chabot-Mission Faults: Geologic Framework Investigations of East Bay Faults (FY93 funding ends 1/1/94)	Define the structural relationships in the area of recent small earthquake activity near Mission Peak east of Fremont (the Mission fault) where the Hayward and Calaveras faults appear to connect.	Continuation. The multiple faults already discovered suggest a scope broader than the Mission fault. Expand stratigraghic and structural studies north to the Hayward, southeast to the Calaveras, and south to the Silver Creek fault.	Santa Clara, Alameda
II.1	Steve Holbrook	Wood's Hole Ocean. Inst.	508-457-2000 Ext 2581	Crustal Velocity Structure Beneath San Francisco Bay from Analysis of BASIX Wide-Angle Seismic Data (FY93 funding ends 12/1/93)	Determine structure and seismic velocities of the Bay Area crust at depth to constrain geometry and possible interactions between major faults.	New. Interpret wide-angle reflection seismic data collected along 2 OBS lines shot during the BASIX experiment. These data are critical to resolving shallow crustal structure beneath the bay.	Alameda, San Francisco, Napa, San Mateo, Santa Clara, Santa Cruz

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II.1, II.2	Davy Jones, Tom McEvilly	UC Berk	510-642-2514 642-4494	Marine Seismic Investigations of the East Bay Faults (FY93 funding ends 1/1/94)	The September 1991 BASIX experiment collected a massive data set to characterize the crustal structure and tectonic setting of the area. These topics are fundamental to understanding the relationships of the major faults through the area.	Continuation. Further processing and interpretation of the Hayward and Concord fault crossing profiles.	Alameda, San Francisco, Napa, San Mateo, Santa Clara, Santa Cruz, Contra Costa
II.1, II.2, II.4, II.5	Bob Jachens	USGS /Menlo/ Geophys	415-329-5300	San Francisco Bay Earthquake Hazards	Regional gravity and magnetic data constrain crustal models, providing the tectonic setting critical to the interpretation of local studies.	Continuation. Interpret new aeromagnetic and gravity data for the East Bay region. Complete a map of depth to basement rock for the northern San Francisco Peninsula.	Alameda, Napa, San Mateo, Santa Clara, Contra Costa
II.1, III.1	Rufus Catchings	USGS /Menlo/ SEIS	415-329-4749	Evaluation of Seismic Propagation Effects Along and Across the Hayward and San Andreas Faults	Focusing of seismic energy can explain damage patterns at distance from the Loma Prieta eqk. Will eqks. on the Hayward fault result in similar damage patterns in the East Bay?	Continuation. Clarify key features along the 1991 SF Peninsula line. Analyze seismic refraction profiles along the Hayward-Rodgers Creek faults and along a San Gregorio-Livermore line acquired in 1991 and 1993.	Alameda, San Francisco, Napa, San Mateo, Santa Clara, Marin, Contra Costa, San Benito
II.1	Tom McEvilly	UC Berk	510-642-4494	Very High Resolution Profiling of Pacific Coast Faults	Acquire and operate a very high resolution marine profiling system that has proven uniquely capable for instrumental studies of the Holocene activity of submerged faults off Japan and in San Francisco Bay.	New. Equipment acquisition (Kaijo Corp. in Japan), equipment outfitting at LBL, and marine profiling in Humboldt/Arcata Bay and in east San Francisco Bay.	Alameda, San Francisco, Napa, San Mateo, Humboldt, Contra Costa

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II.2 Determine properties of earthquakes and relate seismicity to geologic structures and tectonic processes.							
II.2	Mary Lou Zoback, Jean Olson	USGS /Menlo/ SEIS	415-329-4760 329-4779	Seismotectonics of the San Francisco Peninsula	Characterize and interpret the style of deformation on seismically-active faults on the SF Peninsula by examining the occurrence, distribution, and source properties of recent eqks. and by relating seismicity to geologic structures and tectonic processes.	Continuation. Study hypocenters between Crystal Sprs. Res. and Bolinas Bay; waveform modeling of the 1957 Daly City eqk.; analysis of seismic profile along No. SF peninsula; relocate eqks. using 3-D raytracing program.	San Francisco, San Mateo
II.2	Barbara Romanowicz	UC Berk.	510-643-5690	Source Characterization of Events in the San Francisco Bay Region	Develop techniques to model local and regional seismograms to establish detailed characteristics of earthquakes in the SF Bay Area.	Continuation. Collect and digitize seismograms of important historic eqks. and eqks. since the installation in 1986 of several broad-band stations, develop Green's functions to model path effects, and model for slip distributions of important eqks.	Alameda, San Francisco, Napa, San Mateo, Santa Clara, Santa Cruz, Contra Costa, Marin
II.2	John VanSchaack	USGS /Menlo/ SEIS	415-329-4780	CALNET, Field Operations, and Instrument Development	Provide operation and maintenance support for the extensive seismic telemetry network in Northern California.	Continuation. Continue moving telemetry links from phonelines to radios; upgrade all radio telemetry to new federal standards.	All
II.2, I.2, II.7	Bill Ellsworth	USGS /Menlo/ SEIS	415-329-4784	Seismic Studies of Fault Mechanics	Develop systems to rapidly convey information about significant eqks to users. Analyze seismic data.	Continuation. Install digital seismic network along southern Hayward fault. Study seismicity and wave propagation. Develop REDI system with UC Berkeley and PG&E.	Alameda, San Francisco, San Mateo, Santa Clara, Marin, Contra Costa, Santa Cruz

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II.2, I.2, II.7	Tom McEvilly	UC Berk	510-642-4494	Bay Area Digital Seismic Network	Installation of borehole stations of the Hayward fault digital seismic network to provide the seismic data for magnitude 0<M<7.0 Hayward fault eqks to adequately characterize the seismic character of the fault.	Continuation. Install 2 more borehole stations (7 total). Accelerometers and geophones, 24-bit digitizer, 1000sps, PacBell Advanced Digital Network continuous telemetry, backup onsite recording, data archived at UCB/USGS data archive at UCB.	Alameda, Contra Costa
II.2, I.1, I.2, II.1, II.4, II.5, II.6, II.7, II.8, IV.1	Dave Oppenheimer	USGS /Menlo/ SEIS	415-329-4792	Northern California Seismic Network	CALNET provides near real-time monitoring of earthquake activity in northern and central California. Significant activity is reported to the State of California, to the earth science community, and to the press.	Continuation. Likely record 25,000 earthquakes; improve access to data through cooperative USGS-UC Berkeley Data Archive; operate new digital stations in the East Bay; develop real-time capability; analyze seismicity data.	All
II.2	John Gephart	Cornell Univ.	607-255-4176	Investigating Temporal Variations in Stress from Focal Mechanisms of Aftershocks of the Loma Prieta Earthquake	Understanding time and space variations of stress in a region is central for understanding the mechanics of eqk. sources. Is there high or low stress along the San Andreas fault?	New. Analyze >1000 well-constrained focal mechanisms of Loma Prieta aftershocks to map time and space variations in stress and constrain various models of earthquake and fault mechanics.	Santa Cruz, Santa Clara, Monterey
II.2, IV.1	Barbara Romanowicz	UC Berk	510-643-5690	Operation of the Joint UCB/USGS Data Center:	Operate a database for earthquakes that will serve as a catalog and a means to access earthquake-related waveforms from USGS, UC Berkeley and other network sources.	Continuation. Complete loading of USGS and UCB digital data collections, initiate archival of the Hayward fault digital seismic network and continuous GPS data, and enhance the user interface for data access.	Alameda, San Francisco, Napa, San Mateo, Santa Clara, Santa Cruz

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II.3 Determine the nature and rates of crustal deformation.							
II.3	Dave Jackson	UCLA	310-825-0421	GPS Studies at Cholame and Vicinity	Cholame may represent a barrier to slip on the San Andreas fault that prevents most Parkfield eqks. from growing into M≥7 eqks. When the next M6 Parkfield eqk. occurs, strain accumulation at Cholame will factor into estimates of future M7 eqks. there.	New. Resurvey the Cholame GPS net and model the results in terms of block and fault model.	San Benito, Monterey, Kern, King, Fresno, San Luis Obispo, Santa Barbara
II.3	John Langbein	USGS /Menlo /EGG	415-329-4853	Geodetic Strain Monitoring	High precision monitoring of surface deformation provides data on the mechanics of fault failure and may clarify the prospects for short- and intermediate-term earthquake prediction.	Continuation. Monitor the 17 baselines of the geodetic network as part of the prediction experiment at Parkfield. Complete installation of a radial network centered on Monument Peak that spans the Hayward and Calaveras faults.	San Benito, Monterey, Kern, King, Fresno, San Luis Obispo, Santa Barbara, Alameda, Santa Clara
II.3	Mike Lisowski	USGS /Menlo /EGG	415-329-4855	Crustal Strain	Geodetic measurements and modeling of crustal deformation across active faults provide a measure of strain accumulation to be relieved in earthquakes. Conversion from electronic distance measurements (EDM) to Global Positioning System (GPS) began in 1990.	Continuation. Resurvey the existing Bay Area and Parkfield networks. Add a 6th Bay Area GPS profile from Monterey through Hollister and beyond. Densify geodetic networks along the Hayward and Calaveras faults.	All

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II.3	Jon Galehouse	San Francisco St. U.	415-338-1204	Theodolite Measurements of Creep Rates on San Francisco Bay Region Faults	Repeated measurements of horizontal motion to a precision of a few mm since 1979 at least every 2-3 months at sites spanning active faults to determine the rate of present fault movement. Changes in rate may be an indication of a forthcoming earthquake.	Continuation. Measure horiz. motions at 24 old sites on the San Andreas, Hayward, Calaveras, Concord-Green Valley, Antioch, Seal Cove-San Gregorio, Rodgers Creek, and West Napa faults, and at 6-8 new sites on Rodgers Creek, Calaveras, and Maacama faults.	Marin, Napa, Contra Costa, Lake, San Francisco, Alameda, Santa Clara, San Mateo, Santa Cruz, San Benito
II.3	Angela Jayko	USGS /Menlo /WRG	415-329-4926	Pleistocene to Quaternary Strain Between Active Faults, San Francisco Bay Region	Constrain the rates and character of recent deformation from topographic signals. Information on regional tilting and intrablock deformation occurring between active faults is an important component in long-term regional strain accumulation models.	New. Geologic compilations at 1:100,000 and 1:24,000 of the SF Peninsula; air photo investigations; mapping paleosurfaces; acquire 1:24,000 DEMs; field studies to determine geologic controls of geomorphic surfaces.	San Francisco, San Mateo
II.3, II.1	Dave Pollard, Roland Burgmann	Stanford Univ.	415-723-4679	Post-seismic Fault Creep on the Foothills Thrust System Following the 1989 Loma Prieta earthquake	Faults in the Foothills thrust system appear active in the Holocene, and may be capable of M6-7 eqks. close to Santa Clara Valley. Additional measurements are needed to constrain possible Foothill system thrust motion following the Loma Prieta eqk.	New. GPS resurvey of geodetic benchmarks last surveyed immediately after the Loma Prieta eqk. and mechanical models of the deformation.	Santa Clara, Santa Cruz, San Mateo, Monterey
II.3	Barbara Romanowicz	UC Berk	510-643-5690	Northern California Permanent GPS (Global Positioning System) Network (Collaborative UC Berkeley and UC San Diego)	Monitor strain accumulation throughout No. Calif., and provide a reference coordinate frame for other strain measurements. Linkage of this network with the So. Calif. permanent GPS and Geodetic Array will yield continuous geodetic coverage for all Calif.	New. New 9 stn. GPS network (4 existing USGS and 5 new sites) in No. Calif. Develop data collection, processing, and analysis system jointly with USGS and So. Calif. PGGA.	All

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II.4 Characterize the earthquake potential of the U.S. on a regional and national basis.							
II.4	Tousson Toppozada	Calif. Div. Mines & Geol.	916-322-9309	Using 1800s Earthquake Sequences to Elucidate the Increased SF Bay Area Seismicity since 1979 (FY93 funding ends 9/27/94)	The increased rate of damaging earthquakes in the SF Bay Area since 1979 is reminiscent of that preceding the 1868 and 1906 earthquakes. Compare the recent activity with that preceding the 1868 shock on the Hayward fault.	New. Calibrate 1856–1870 locations and magnitudes to the accurate post–1978 events using reported intensity effects. Add reports from diaries and letters to newspaper accounts for pre–1868 events.	Alameda, San Francisco, Napa, San Mateo, Santa Clara, Santa Cruz, Contra Costa, Marin
II.4, II.6	Martitia Tuttle, Lynn Sykes	Lamont-Doherty Geol. Obs. (Columbia U)	914-359-2900	Reevaluation of Large Historic Earthquakes in the San Francisco Bay Area Using New Primary Sources (FY93 funding ends 2/1/94)	Determine the size and location of of 1836, 1838, 1865, and 1868 eqs. to constrain hazard assessments of area faults. Gather info from untapped primary sources for these shocks.	Continuation. 1) Use untapped early 1800s sources, 2) develop magnitude-felt relation, 3) reevaluate size and location of shocks, 4) model stress and seismicity changes, 5) assess earthquake potential.	Alameda, San Francisco, Napa, San Mateo, Santa Clara, Santa Cruz, Monterey
II.4	John Wakabayashi	Dames and Moore, Inc.	510-887-1796	Investigations of On-shore Extensions of the Holocene Coyote Point and Hunters Point Fault Zones and Implications for Reactivation of Franciscan Nappe-Bounding Shear Zones	Recently identified zones of displacement of shallow Holocene sediments within SF Bay coincide with offshore extensions of major shear zones on the SF Peninsula, suggesting new poorly-defined seismic hazards.	New. Determine the location and extent of Quaternary deformation and displacements along the onland extensions on the SF peninsula of the Coyote Point and Hunters Point fault zones under SF Bay.	San Francisco, San Mateo
II.5 Identify active faults, define their geometry, and determine the characteristics and dates of past earthquakes.							
II.5	Malcolm Clark	USGS /Menlo /EGG	415-329-5624	Late Quaternary Slip Rates of Active Faults of California	Compile and evaluate late-Quaternary slip rates in California. Slip rates are used to refine seismic zones for the uniform Building Code, in hazard analysis, and in local and regional tectonic synthesis.	Continuation. Submit the revised and updated California slip rate table for publication as a USGS Bulletin.	All

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II.5, IV.1	Bob Brown	USGS /Menlo /EGG	415-329-5620	Northern San Andreas Fault System	Vertical or compressional deformation is evident from geologic relations on several Bay Area faults, and poses hazard potential not generally recognized.	Continuation. Acquire field geologic data that documents Holocene uplift and tilting west of the San Andreas fault near Point Reyes and on the San Francisco Peninsula.	Marin, San Francisco, San Mateo
II.5	Jim Lienkaemper	USGS /Menlo /EGG	415-329-5642	Slip History of the San Andreas and Hayward Faults	Quantify segmentation, recurrence rate, slip rate, and slip per eqk. on the Hayward fault. These parameters form the basis of long-term probabilistic earthquake forecasting.	Continuation. Archive the slip rate data for the Masonic site on the Hayward fault. Exploratory trenches on the Hayward fault in Oakland. Site selection for creepmeters.	Alameda
II.5	Carol Prentice	USGS /Menlo /EGG	415-329-5690	Northern San Andreas Fault System: Paleoseismology and Slip Rate Studies in Northern and Central California	Quantify segmentation, recurrence rate, slip rate, and slip per eqk. for faults in the San Andreas system in the San Francisco Bay Area. These parameters form the basis of long-term probabilistic earthquake forecasting.	Continuation. Develop sites along the Peninsula segment of the San Andreas fault where where slip rate and the dates of prehistoric earthquakes can be determined. Continue field work on the San Andreas fault at Point Arena and on Maacama fault at Willits.	San Mateo, Mendocino
II.5	Keith Kelson, Bill Lettis	Wm. Lettis & Assoc.	510-832-3716	Paleoseismic Investigation of the Calaveras Fault at Leyden Creek, Alameda Co., CA (FY93 funding ends 4/1/94)	Investigate the northern Calaveras fault, a potentially significant source of earthquakes in the eastern SF Bay Area. Refine estimates of the late-Holocene slip rate and develop age control to time the surface faulting events recognized at Leyden Creek.	Continuation. 1) Analysis of radiocarbon samples collected in trenching, 2) Localion and age of piercing line, necessary to determine slip rate, 3) time the most recent surface rupture event, 4) assess style and timing of faulting events.	Alameda
II.5	Jay Noller, Bill Lettis, Gerry Weber	Wm. Lettis & Assoc.	510-832-3716	Paleoseismic and Geoarcheological Investigations of the San Gregorio Fault, Seal Cove, CA (FY93 funding ends 4/1/94)	Characterize the San Gregorio fault, the largest potential seismic source in the area not yet studied by paleoseismology. The San Gregorio is crucial to assess the partition of slip across the region and thus constrain regional probability estimates.	New. 1) prepare 1:600 scale strip map at Seal Cove, 2) characterize geology and archaeology, 3) map offset terraces, and 4) date samples.	San Mateo

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II.5, II.3	Jay Noller, Gary Simpson, Kent Lightfoot	Wm. Lettis & Assoc.	510-832-3716	Geoarchaeological and Paleoseismic investigations of the Northern San Andreas Fault, Ft. Ross, California	Determine the slip rate and earthquake occurrence on the North Coast segment of the San Andreas fault within Fort Ross State Historic Park through the study of offset archaeological features.	Continuation. Conduct additional excavations at the Archae Camp site to reduce uncertainties in ages of offset units, locations of piercing lines, and timing of events.	Sonoma
II.5	Bill Lettis, Gary Simpson	Wm. Lettis & Assoc.	510-832-3716	Paleoseismic Investigation of the Northern Calaveras Fault (FY93 funding ends 3/1/94)	Characterize the seismic potential of the Northern Calaveras fault, which traverses the western margin of the densely-populated and rapidly-developing San Ramon Valley.	Continuation. Prioritize the 5 sites already identified for detailed study, trench at 1 and possibly 2 sites, and analyze trenching and mapping results to assess behavior of the fault.	Alameda, Contra Costa
II.5	Gerry Weber, Jeff Nolan	Weber & Assoc.	408-722-3580	Determination of Late Pleistocene-Holocene Slip Rates Along the San Gregorio Fault Zone, San Mateo Co., CA (FY93 funding ends 1/1/94)	Determine the late Pleistocene - Holocene slip rate on the San Gregorio fault in San Mateo Co.	New. Remap portions of the Quaternary deposits and marine terraces along the San Gregorio fault, select 2-3 sites for exploratory trenching, and trench. Remap wavecut platforms of Santa Cruz marine terraces near mouth of Scott Creek in Santa Cruz Co.	San Mateo, Santa Cruz
II.5	Gordon Jacoby	Lamont-Doherty Earth Obs. (Columbia U)	914-365-8616	Absolute Dating of Prehistoric Earthquakes by Tree-ring Analysis in California	Determine earthquake-induced disturbances in centuries-aged trees to document prehistoric earthquakes and thus extend the paleoseismic record.	Continuation. Finish analyses of samples collected near the San Andreas fault north of San Francisco. Collect additional samples along the 1906 rupture zone near Fort Ross and Watsonville.	Monterey, Santa Cruz, San Mateo, Marin, Sonoma, Mendocino
II.5	Glenn Borchardt	Soil Tectonics	510-654-1619	Slip Rate of the Northern Hayward Fault at Point Pinole, CA (FY93 funding ends 1/1/94)	Slip rate for the No. Hayward fault is assumed equal to that obtained for the So. Hayward fault and for the Rodgers Creek fault across San Pablo Bay. A precise slip rate for the No. Hayward fault would constrain the linkage of these faults.	New. If Hayward fault at Point Pinole was inundated by last sea highstand (≈122 years ago), paleoseismic studies at Point Pinole can constrain slip rate for northern Hayward fault. Map, sample borings, and trench to measure offsets, and date samples.	Alameda, Contra Costa, Napa

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II.5	Tim Hall, Robert Wright	Geomatrix Cons.; Harlan Tait Assoc.	415-434-9400 626-0765	Paleoseismic Investigations of the San Andreas Fault on the San Francisco Peninsula	Paleoseismic studies at key sites on the San Francisco peninsula section of the San Andreas fault to identify pre-1906 earthquakes and a Holocene slip rate.	Continuation. Log and document trenches, age dating, and reconstruction of late Holocene paleoseismic history at the No. Filoli site on the Crystal Sprs. segment and at the best of the three candidate sites in Portola Valley on the Black Mtn. segment.	Santa Clara, San Mateo
II.5, II.6	Dave Schwartz	USGS /Menlo /EGG	415-329-5651	Fault Segmentation: San Andreas Fault System	Quantify the segmentation, recurrence rate, slip rate, and slip per eqk. for faults in the San Andreas system in the San Francisco Bay Area. These parameters form the basis of long-term probabilistic earthquake forecasting.	Continuation. Analyze data from trenches on the Rodgers Creek fault; excavate two new trenches at the Grizzly Flat site on the San Andreas fault in the southern Santa Cruz Mtns.	
II.5	Lew Rosenberg, Joe Clark	Staal, Gardner & Dunne, Inc.	408-649-2354 814-845-7521	Quaternary Faulting of the Greater Monterey Area, Califomia	The greater Monterey area has experienced rapid development but little earthquake hazard reduction activity; the last notable shocks were the M6.2 Monterey Bay eqk. doublet in 1926.	New. Identify and characterize potentially-active faults in the onshore Monterey area, focusing on fault segments with mappable evidence of Quaternary displacement. Use aerial photos, detailed surficial mapping, recent seismicity, 200 well logs, etc.	Monterey
II.5	Gerry Weber, Jeff Nolan	Weber & Assoc.	408-722-3580	Paleoseismic Study of the Southern Sargent Fault	Determine the movement history of the southern part of the Sargent fault to evaluate potential hazards to the Santa Clara Valley posed by this fault.	New. Excavate trenches across the fault to document evidence of slip rate and seismic events on the southern Sargent fault.	Santa Clara, Monterey, San Benito, Santa Cruz
II.5	Dave Snyder, Glenn Borchardt	Rogers/ Pacific, Inc.	510-682-7601	Slip Rate, Recurrence Interval and Behavior of the Concord fault at Galindo Creek, Contra Costa County, California	The Concord fault is an active fault (M5.4 shock on October 24,1955) passing through the city of Concord, Calif. Although small earthquakes and creep are recognized, there is no information on recurrence intervals or long term slip rates.	New. Aerial photo analysis and trenching at the fault crossing at Galindo Creek to gather data on the recurrence interval and slip rate.	Contra Costa

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II.7 Monitor intensely a few selected regions of high seismic potential.							
II.7, IV.1	Kate Breckenridge	USGS /Menlo /EGG	415-329-4849	Fault Zone Tectonics; Low Frequency Data Archive	Continuous measurement of surface displacement along active faults determines the rate of aseismic slip. Change in rate may be an indication of a forthcoming earthquake.	Continuation. Maintain and monitor the network of creepmeters in central California. Initiate effort to identify and assemble crustal deformation data in databases readily accessible to all.	San Benito, Monterey, Kern, King, Fresno, San Luis Obispo, Santa Barbara, Alameda
II.7	Dave Lockner	USGS /Menlo /EGG	415-329-4826	High Frequency Acoustic Emission Monitoring at Parkfield	Correlation of acoustic emission (AE) with nearby strain measurements indicate AE is sensitive to local strains of 1 per billion, and may be a useful strain monitor. Identify the strain level that can be monitored by AE.	Continuation. Continuously monitor acoustic emission activity in shallow array at Varian well site near Parkfield. Results will be analyzed in terms of earth tides, local eqks., and local strain changes.	San Benito, Monterey, Kern, King, Fresno, San Luis Obispo, Santa Barbara
II.7	Carl Mortensen	USGS /Menlo /EGG	415-329-4856	Experimental Tilt and Strain Instrumentation	Provide operational and technical support for the operation and maintenance of networks of low-frequency instruments in central California from the Bay Area to Parkfield.	Continuation. Continue support of network projects and participation in interagency emergency response planning efforts.	San Benito, Monterey, Kern, King, Fresno, San Luis Obispo, Santa Barbara, Alameda
II.7	Evelyn Roeloffs	USGS /Menlo /EGG	206-696-7693	Parkfield: Water Level Data Monitoring and Interpretation	Collect water level data at Parkfield, monitor them in real time, and use the data to study fault processes at Parkfield.	Continuation. Maintain monitoring and analysis.	San Benito, Monterey, Kern, King, Fresno, San Luis Obispo, Santa Barbara

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II.7	Stan Silverman	USGS /Menlo /EGG	415-329-4862	Low Frequency Data Network/ Monitoring	Provide real time monitoring capability for low frequency data collection systems.	Continuation. Improve satelite receiver backup system. Develop software tools and documentation.	San Benito, Monterey, Kern, King, Fresno, San Luis Obispo, Santa Barbara, Alameda, Contra Costa
II.7	Roger Bilham	U Colo.	303-492-6189	Creepmeter Maintenance in California (FY93 funding ends 6/1/94)	Continuous measurement of surface displacement along active faults determines the rate of aseismic slip. Change in rate may be an indication of a forthcoming earthquake.	Continuation. Every 2-3 months visit 13 creepmeter sites in California, including 3 sites on the San Andreas fault south of the Loma Prieta earthquake rupture zone.	Santa Cruz, Monterey, San Benito
II.7	Mick Gladwin	U Queens-land (Aust.)	Inter-national 617-377-2473	Deep Borehole Strain Monitoring	Maintenance and analyis of deep borehole tensor strain instrumentation at 3 Parkfield sites, at the San Juan Bautista site, and at 2 East Bay sites.	Continuation. Provide data to Menlo Park in real time, interpretation as required in near real time, continued monitoring of Loma Prieta at San Juan Bautista, and comparisons of Parkfield sites with other data.	San Benito, Monterey, Kern,King, Fresno, San Luis Obispo, Santa Barbara, Monterey, Santa Cruz, San Mateo, Alameda, San Francisco, Santa Clara, Napa
II.7	Roger Bilham	U Colo.	303-492-6189	Creepmeters on the Hayward Fault (FY93 funding ends 4/1/94)	Measure aseismic slip (creep) at 7 surface sites to help establish how geologic slip occurs on the Hayward fault. Improve access to data, including a real time display of creep data.	New. In first year, modify one existing creepmeter in Hayward, install new creepmeters near Union City (south end) and San Pablo Bay (north end).	Alameda

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II.7, II.8	Roger Borcherdt, Malcolm Johnston, Allan Lindh	USGS /Menlo /SEIS, USGS /Menlo /EGG	415-329-5619	Measurement and Analysis of Acceleration, Velocity, and Short Period Strain Using GEOS at Parkfield	Provides onscale broad-band high-resolution measurements at 14 sites as part of the Parkfield prediction experiment. Dilatometers, seismometers and accelerometers are recorded on GEOS digital event recorders.	Continuation. Continue maintenance of array and archival of data.	San Benito, Monterey, Kern, King, Fresno, San Luis Obispo, Santa Barbara
II.7, II.8	Malcolm Johnston	USGS /Menlo /EGG	415-329-4812	Continuous High-Precision Deformation Monitoring	Continuous high precision monitoring provide data on the mechanics of fault failure and may clarify the prospects for short- and intermediate-term earthquake prediction.	Continuation. Continue Parkfield efforts. Complete installations at 8 borehole sites in East Bay (dilatometers, tensor strain, seismometers, accelerometers).	San Benito, Monterey, Kern, King, Fresno, San Luis Obispo, Santa Barbara, Alameda
II.7, II.8	John Langbein	USGS /Menlo /EGG	415-329-4853	Parkfield Coordination	The Parkfield Earthquake Prediction Experiment is a unique concentration of geophysical instrumentation on a stretch of the San Andreas fault expected to experience a M6 earthquake in the near future.	Continuation. Represent experiment to the public, the press, and to local, state, and federal agencies. Provide leadership to coordinate and integrate diverse scientific investigations at Parkfield.	San Benito, Monterey, Kern, King, Fresno, San Luis Obispo, Santa Barbara
II.7, II.8	Tom McEvilly	UC Berk	510-642-4494	High-resolution Controlled-source and Microearthquake Monitoring at Parkfield	Monitor the nucleation process of the expected M6 earthquake by resolving details of microearthquake occurrence and changes in P- and S-wave propagation characteristics.	Continuation. Maintain field systems, quarterly operation of Vibroseis system, analyze data, and archive earthquake and Vibroseis data.	San Benito, Monterey, Kern,King, Fresno, San Luis Obispo, Santa Barbara

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II.8 Develop and evaluate methods of short- and intermediate-term prediction of earthquake occurrence.							
II.8, II.7	Steve Park	UC Riverside	714-787-3438 787-4501	Variations in Electrical Properties Induced by Stress Along the San Andreas Fault at Parkfield, California	Fluctuations in electrical properties before earthquakes is predicted from laboratory studies and has been reported in other countries. Monitor resistivity using telluric arrays as part of the Parkfield earthquake prediction experiment.	Continuation. Maintain monitoring array and continue comparisons with other data.	San Benito, Monterey, Kern,King, Fresno, San Luis Obispo, Santa Barbara
II.8, II.7	Peter Malin	Duke Univ.	919-681-8889	The Parkfield Downhole Seismology Project and Varian Array	Collection and analysis of microearthhquake waveforms and event statistics. Record events smaller than can be seen on other Parkfield systems.	Continuation. Improve space-time pattern recognition and waveform analysis, develop mechanical and statistical models for stress diffusion events, assemble and distribute a microearthquake catalog, and maintain field systems.	San Benito, Monterey, Kern,King, Fresno, San Luis Obispo, Santa Barbara
II.8, II.7	Tony Fraser-Smith, R. Helliwell	Stanford U	415-723-3684	Continuation of the Measurements and Analysis of Low-frequency Electromagnetic Fields at Parkfield, California	Unusual ULF (f<10Hz) magnetic field fluctuations were observed before the Loma Prieta earthquake. Two independent ULF systems were installed near Parkfield in 1990 to record any ULF fluctuations associated with the expected M6 Parkfield earthquake.	Continuation. Maintain monitoring systems and analysis.	San Benito, Monterey, Kern,King, Fresno, San Luis Obispo, Santa Barbara
II.8	John Rudnicki	North-western Univ.	708-491-3411	Green's Functions for an Inhomogeneous Parkfield Model	Hypotheses about fault mechanics can be tested by comparing computer simulations with observations. Present simulations of the earthquake cycle at Parkfield do not use known spatial variations in crustal properties.	New. Use finite element programs to calculate stresses and displacements due to slip on the fault at depth at Parkfield, taking into account known spatial variations in seismic velocity.	San Benito, Monterey, Kern,King, Fresno, San Luis Obispo, Santa Barbara

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II.8	Bill Stuart, Evelyn Roeloffs	USGS /Menlo /EGG	415-329-4648 206-696-7693	Parkfield Fault Simulation Model	Devise a method to predict the next Parkfield earthquake by using a mechanical fault model and repeated measurements of ground deformation. The strategy is analogous to numerical short-term weather forecasting.	Continuation. Refine existing model in cooperation with John Rudnicki of Northwestern Univ. Include the effect of M4.5-5 shocks, such as occurred in October 1992, and of M7 earthquakes on the San Andreas fault south of Parkfield.	San Benito, Monterey, Kern,King, Fresno, San Luis Obispo, Santa Barbara
III.1 Acquire data needed for prediction of ground shaking, ground failure, and response of engineered structures.							
III.1	Paul Spudich	USGS/ Menlo/ SEIS	415-329-5654	Strong Motion Instrumentation for the SF Bay Region	Acquire and deploy strong motion instrumentation for the San Francisco Bay region to record data necessary to predict ground shaking.	Continuation. Equipment acquired in FY92 will be deployed to significantly improve coverage along major faults. Borehole sites along the Hayward fault will be instrumented.	Alameda, San Francisco, Napa, San Mateo, Santa Clara, Santa Cruz
III.1	Jim Gibbs, Bill Joyner	USGS/ Menlo/ SEIS	415-329-5631 329-5640	Near-surface Lithologic and Seismic Properties	Develop methods and acquire data to evaluate and map the effects of local site conditions on the ground shaking hazard. Correlate strong motion data, surface, and subsurface properties so that hazard can be mapped w/o additional drilling.	Continuation. Determine Q at borehole sites and obtain a representative sample of shallow Q determinations for the major lithologic units in the Bay Area.	Alameda, San Francisco, Napa, San Mateo, Santa Clara, Santa Cruz
III.1	Chris Dietel	USGS/ Menlo/ SEIS	415-329-5602	Aftershock Monitoring	Maintain pool of portable aftershock recording instrumentation and deploy after large earthquakes in western United States.	Continuation. Maintain readiness; playback recordings of aftershocks recorded in Southern California.	All
III.1	Howard Bundock	USGS/ Menlo/ SEIS	415-329-5621	Seismology Computer Center	Manage the development and support of computing needs for research on strong motions.	New. provide support as needed.	All

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III.1	Roger Borcherdt	USGS /Menlo /SEIS	415-329-5619	Integrated Ground Response, Liquefaction, and Structural Response Studies in the Market St. Area of San Francisco; Predictive GIS Mapping of Strong Ground Shaking in the San Francisco Bay Region, California	Record comprehensive data (borehole, surface, and structure) on the response of soft soils and structures to strong motions at Embarcadero/Justin Herman Plaza, Bessie Carmichael School, and Levi Strauss Plaza in SF. Predictive GIS mapping studies	Continuation. Complete installations.	San Francisco
III.1	Mehmet Celebi	USGS /Menlo /EGI	415-329-5623	Analyses of Data from Instrumented Structures	Acquisition of structural response data during earthquakes is essential to confirm and develop methodologies for analysis and design of earthquake resistant structural systems.	Continuation. Continue analysis of strong motion records from instrumented structures.	Alameda, San Francisco, Napa, San Mateo, Santa Clara, Santa Cruz
III.1, II.7, II.8	Joe Fletcher, Paul Spudich	USGS /Menlo /SEIS	415-329-5628 329-5654	UPSAR, USGS Parkfield Dense Seismograph Array	Record high frequency strong motions from a large local eqk. at closely spaced sites to understand source details and potential distortions of building foundations; Test hypothesis of temporal and spatial variations in coda Q before large earthquakes.	Continuation. Maintain array. Examine azimuthal variations of coda Q. Release data set on CD ROMs. Study the M4.5 earthquake of October 20,1992 that was well recorded on the array.	San Benito, Monterey, Kern, King, Fresno, San Luis Obispo, Santa Barbara
III.1	Ed Harp	USGS /Golden /ELH	303-273-8641	Landslide Instrumentation Arrays	Instrument landslides to record strong motions on moving landslides and on adjacent stable sites, dynamic pore-pressure response in the moving landslide, and coseismic history of landslide displacement.	Continuation. Cooperate with Cotton & Assoc. in subsurface investigations and instrumentation of the Week's Creek site in San Mateo Co.	San Mateo

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III.1	Bill Cole, Bill Cotton, Pat Shires	Wm. Cotton & Assoc.	408-354-5542	Geologic and Geotechnical Characterization and Analysis of the Weeks Creek Landslide, San Mateo Co, California (FY93 funding ends 4/1/94)	Characterize and analyze surface and subsurface coditions at an active landslide subject to triggering by strong motions in an earthquake.	New. Compile existing data, detailed surface mapping, determine geotechnical properties from borehole measurements and samples, install downhole accelerometer, and collaborate with USGS who have instrumented the slide.	San Mateo, Santa Cruz
III.1	Pat Shires, Dale Marcum, Bill Cole	Wm. Cotton & Assoc.	408-354-5542	Inclinometer/Piezometer Monitoring and Seismic Slope Stability Analysis, Santa Cruz and Santa Clara Counties, California	Large ancient landslides in the Santa Cruz Mtn. reactivated during the 1989 Loma Prieta earthquake, should be remeasured following the heavy rains in 1992-93 to differentiate effects of future earthquakes and elevated groundwater levels.	New. Monitor inclinometers and piezometers at slide sites twice over the next year to evaluate the activity of the landslides and to determine the groundwater pressures affecting the landslides.	Santa Cruz, Santa Clara
III.1	R. W. Boulanger, I. M. Idriss	UC Davis	916-752-6986 752-5403	Investigation and Evaluation of Liquefaction Related Ground Displacements During the 1989 Loma Prieta Earthquake (FY93 funding ends 3/1/94)	Investigate and characterize sites in the Moss Landing area where liquefaction was observed during the Loma Prieta earthquake in order to add to the data base of well-documented lateral-spreading case histories.	New. Compile existing data, borehole measurements, penetration tests, geotechnical characterization of subsurface layer that liquefied, relate ground displacements and site conditions, and assess physical mechanisms of ground displacement.	Monterey, Santa Cruz
III.2 Predict strong ground shaking.							
III.2	Paul Spudich	USGS /Menlo /SEIS	415-329-5654	Ground Motion Prediction and Inversion in Realistic Earth Structures	Develop mathematical and computational models for predicting the ground motions from earthquakes.	New. Assemble and analyze available records from the 1934 and 1966 Parkfield earthquakes.	San Benito, Monterey, Kern, King, Fresno, San Luis Obispo, Santa Barbara

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III.2	Dave Carver	USGS /Golden /ELH	303-273-8552	Site Response Map for Santa Cruz, California	Site effects on strong ground motion are fundamental to the assessment of earthquake hazard.	New. Calculate site response in the Santa Cruz Basin using Loma Prieta aftershock data collected in a densely-spaced 2-D array.	Santa Cruz
III.2	Paul Somerville	Woodward Clyde Cons., Pasadena	818-449-7650	Near Fault Ground Motion Estimates Including Directivity Effects from Large Strike-Slip Earthquakes in the San Francisco Bay Area	Estimate near-field strong ground motions from large strike-slip earthquakes in the area. Although data exists at distance from the fault, few data are available close to the fault where effects such as source directivity are important.	Continuation. Separate rupture directivity effects from wave propagation effect using strike-normal direction data to estimate propagation attenuation. Use synthetic seismograms to develop attenuation relations that take directivity into account.	Alameda, San Francisco, Napa, San Mateo, Santa Clara, Santa Cruz
III.2, III.1	Jack Boatwright	USGS /Menlo /SEIS	415-329-5609	Site Response for the Bay Area and Correlations with Geology	Predict strong ground motion parameters for the 4 scenario earthquakes in the Bay Area Probability Report (USGS Circ. 1053).	Continuation. Analyze site response in South Bay, and complete deliberations of Working Group for Predictive Maps of Strong Ground Motion.	Alameda, San Francisco, Napa, San Mateo, Santa Clara, Santa Cruz
III.2	Jonathon Bray	UC Berkeley	510-642-9843	Seismic Response of the Deep, Stiff Clay Deposits in the Oakland Area	Ground accelerations during the 1989 Loma Prieta earthquake were amplified at deep stiff clay sites in Oakland, contributing to loss of life and significant damage. Evaluating the seismic response of such sites will improve assessments of eqk. risk.	Continuation. Analysis and synthesis of laboratory tests conducted on deep soil borings collected at deep stiff clay sites. Assess expected behavior of Deep Old Bay Clay sites during future earthquakes.	Alameda

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III.3 Predict ground failure.							
III.3	Tom Holzer, John Tinsley	USGS /Menlo /EGG, USGS /Menlo /WRG	415-329-5613 329-4928	Liquefaction Research	Refine methods to predict and map the likely occurrence of liquefaction and lateral spread ground failures.	Continuation. Geotechnical analysis of Loma Prieta ground failures in Pajaro and Salinas Valleys. Additional drilling of deposits and deploy recorders between Watsonville and Salinas.	Monterey, Santa Cruz
III.3	Dave Keefer	USGS /Menlo /ELH	415-329-4893	Earthquake Induced Landslides in the East San Francisco Bay Hills	Earthquake-induced landslides present a potentially serious hazard in the East San Francisco Bay Hills. Produce a method and a series of maps for evaluating hazard and risk.	New. Compile geologic data, geotechnical properties, expected levels of seismic shaking, topography, and hydrology in a GIS to determine slope stability using Newmark (1965).	Alameda
III.3	Tim McCrink, Chuck Real	Calif. Div. Mines & Geol.	916-324-2549 323-8550	Evaluation of Newmark Method of Mapping Earthquake-Induced Landslide Hazards in the Laurel 7.5' Quad, Santa Cruz Co., CA (FY93 funding ends 1/1/94)	California law requires maps delineating special study zones for areas of earthquake hazard. Test procedure used to generate the San Mateo Co. seismic slope stability map in Loma Prieta earthquake landslide area of Santa Cruz Co.	New. Compile pre- and post-earthquake landslide inventories, geotehnical data, critical strong motion acceleration parameters, and select hazard mapping procedure that places Loma Prieta slope failures in a predicted high susceptibility category.	Santa Cruz, Santa Clara
III.3	Tom O'Rourke, Harry Stewart	Cornell U.	607-255-6470 255-4734	Liquefaction and Ground Failure in San Francisco: Site Investigation, Modelling, and Hazard Assessment for the Urban Environment (FY93 funding ends 2/1/94)	Liquefaction during the 1989 Loma Prieta earthquake in the same locations in San Francisco that liquefied in 1906 has critical implications for hazard mitigation in San Francisco and also provides opportunities to test models for predicting liquefaction.	Continuation. Evaluate post-liquefaction cosolidation, develop predictive methodology, and apply findings for planning and emergency operations of buried lifelines.	San Francisco

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III.3, III.1	Bill Lettis, Jay Noller	Wm. Lettis & Assoc.	510-832-3716	Liquefaction Susceptibility of the San Francisco and Stockton 1:100,000 sheets	Liquefaction-induced ground failure is a major cause of damage to property and lifeline facilities during large-magnitude earthquakes that can be mapped based on existing Quaternary mapping techniques.	New. Evaluate the distribution and character of near-surface geologic deposits and depth to groundwater, and assign liquefaction susceptibility ratings to specific geologic units.	San Francisco, San Mateo, Marin, Alameda, Contra Costa
III.3	Nick Sitar	UC Berkeley	510-643-8623	Evaluation of Potential for Large Deformations and Slope Failures in Seismic Loading of San Francisco Bay Mud	San Francisco Bay margins are extensively developed and filled, including major sanitary and hazardous waste landfills. The stability of fills underlain by SF Bay Mud to seismic loading is critical.	New. Apply new sampling , testing, and analysis techniques to the SF Bay Clay. Perform slope stability analyses.	San Francisco, San Mateo, Marin, Alameda, Contra Costa, Napa, Santa Clara
III.3, II.1	Dan Ponti	USGS /Menlo /EGG	415-329-5679	Evaluation of Ridge-Crest Surface Rupture Hazards in Northern California	Characterize conditions that can lead to shaking-induced off-fault ground failure in future large Bay Area earthquakes.	Continuation. Recover locations of off-fault ground failure in 1906, but not in 1989, with emphasis on the SF Peninsula and northern Mendocino counties.	Santa Cruz, San Mateo, Mendocino
III.4 Evaluate earthquake hazards and losses.							
III.4	Guna Selvaduray	San Jose St. Univ.	408-924-3874	Earthquake Caused Hazardous Materials Incidents: Construction of a Comprehensive Database	Hazardous materials incidents in earthquakes cause economic losses and possibly environmental pollution. Incidents during the 1989 Loma Prieta eqk. suggest underreporting in other earthquakes. A comprehensive database of such incidents is needed.	New. Undertake a pilot study to demonstrate that the proprietary data necessary for such a database can be accessed and made available to all in a CD ROM format.	All

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IV.1 Transfer hazard information and hazard-assessment methods to users.							
IV.1	Stan Silverman	USGS /Menlo /EGG	415-329-4862	Display Area- Building 7 Lobby	Develop displays and computer graphics for use in monitoring seismic activity and for communicating information to the media and to the public.	Continuation. Improve the appearance and utility of the Building 7 lobby display area.	San Benito, Monterey, Kern, King, Fresno, San Luis Obispo, Santa Barbara
IV.1	Jack Moehle, Barbara Romanowicz	UC Berk	510-231-9554 643-5690	Rapid Earthquake Data Integration	Provide federal, state, and local government emergency operation and disaster response groups with estimates of ground motion and likely damage distributions immediately following an M4 earthquake in No. Calif.	New. Develop and implement an automated user-oriented system for determining and distributing source parameters and estimates of regional damage for M4 eqks. in No. Calif. in near real time.	All
IV.1	Jack Moehle	UC Berk.	510-231-9554	Data Archive for the 1989 Loma Prieta Earthquake (FY93 funding ends 4/19/94)	Preserve important data for the 1989 Loma Prieta earthquake to serve as a baseline for future research.	Continuation. Gather, organize, and issue the raw data of the Loma Prieta earthquake. Archive includes printed guides and CD-ROM discs.	Alameda, San Francisco, Napa, San Mateo, Santa Clara, Santa Cruz, Monterey
IV.1	Laurie Johnson, Martha Tyler, George Mader	Spangle Assoc.	415-854-6001	Workshops for Local Governments in the San Francisco Bay Area	Improve local government use of earthquake hazard information.	Continuation. Document results of earlier studies on improving use of geologic information by local governments. Conduct 10 1/2-day workshops (one in each county) in the San Francisco Bay Area to coincide with the release of the report.	Alameda, San Francisco, San Mateo, Santa Clara, Santa Cruz, Contra Costa, Napa, Marin, Sonoma, Monterey

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IV.1	Chris Rojahn	Applied Tech. Coun.	415-595-1542	Program to Transfer USGS Engineering Seismology Research Results to Engineering Design Practice	Rapid and effective utilization of earth science information by design practitioners. Incorporation of earth science research into seismic design practices, codes, and standards.	Continuation. Identify current design practice needs, identify major issues, and implement priority actions such as workshops on specific issues.	All
IV.1	Jeanne Perkins	Assoc. Bay Area Govts. (ABAG)	510-464-7934	Development and Evaluation of Alternative Methods to Provide Earthquake Hazard Maps as GIS Data to User Communities -San Francisco Bay Area	Develop, apply, and evaluate techniques enabling existing earthquake hazard map files and GIS capabilities to be used directly by local govemment agencies and other organizations.	New. Select project review committee; design and conduct user survey; design and develop 5 sample applications; evaluate products; document and disseminate results.	Alameda, Contra Costa, Marin, San Francisco, San Mateo, Santa Clara, Solano, Sonoma
IV.1	Carl Mortensen, Liz Wegenka, Jim Buika	USGS /Menlo /EGG, USGS /Menlo /NMD, FEMA Region IX	415- 329-4856 329-4260 923-7193	Geotechnical Information in Emergency Management	Apply Geographic Information System (GIS) technology to translate and transfer seismic and geotechnical information quickly for use in emergency management following a major earthquake in the Bay Area.	New. Demonstrate capability using the San Jose 1:100,000 geologic map. Cooperate through CONCERT with other efforts at UCB (REDI system) and EQE to develop an integrated effective Bay Area capability .	Alameda, Contra Costa, Marin, San Francisco, San Mateo, Santa Clara, Solano, Sonoma
IV.1	Ed Cranswick	USGS /Golden /ELH	303-273-8609	A USGS/PSN Seismology Education Program for Primary/Secondary Schools	Develop a seismology education program for primary/secondary schools in seismogenic regions. Teach use of digital and telecommunications techniques to monitor and interpret records of local earthquakes.	New. Software development; install phone lines and equipment at 3 elementary schools in the Oak Grove School District of San Jose, California.	Santa Clara

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IV.1	Rich Bernknopf	USGS /Reston /OCG	703-648-6726	A Dynamic GIS to Forecast Economic Effects of Earthquake Policies and Regulations	Evaluate the utility of earthquake and other earth science information in a GIS for various types of public decision making. Cooperate with Santa Clara and Santa Cruz Co., City of Palo Alto, OES, CDMG, and FEMA.	Continuation. Estimate ground motions (f<1Hz) in the Santa Clara Valley for a M7.5 eqk. on the Hayward fault; compile probabilistic hazard maps with conditional probability of amplified ground shaking, liquefaction, and landslides given an acceleration.	Santa Clara
IV.1	Doug Prose	USGS /Menlo /SEIS	415-329-5716	Earthquakes in America Film Project	Produce a one-hour, introductory-level, broadcast-quality educational video about earthquakes in America.	Continuation. Continue filming; complete the video.	All
IV.1	Bill Bakun	USGS /Menlo /OEVE	415-329-4793	Bay Area Future Earthquakes Project	The Coordinating Organization for Northern California Earthquake Research and Technology (CONCERT) enhances NEHRP by cooperation and communication between the earth science, engineering, planning, and emergency response communities.	Continuation. Provide support for CONCERT and other efforts focussed on implementation of NEHRP research.	Alameda, Contra Costa, Marin, San Francisco, San Mateo, Santa Clara, Solano, Sonoma