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

USGS National Earthquake Hazard Reduction Program (*NEHRP*) in Northern California in FY93

By

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Explanation

This listing is a compilation of currently active (October 1, 1992- September 30,1993) efforts funded by the US Geological Survey (*USGS*) 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 directly, and non-USGS projects 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 for the USGS's NEHRP program as described in "*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 3 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.

Key Words (Column 6). Descriptive key words used: BASIX (Bay Area Seismic Imaging Experiment), boreholes, buildings, codes, crustal structure, database, dating samples, deformation, design, digital seismic network, directivity, earthquake cycle, electrical, electromagnetic, engineering, fault interaction, fluid pressure, geologic structure, geotechnical properties, GIS, gravity, hazard maps, instrumentation, landslide, lateral spreading, liquefaction, Loma Prieta eqk., magnetic, mapping, microearthquakes, monitoring, near field, Parkfield, planning, probability, regional framework, resistivity,seismicity, site effects, strain, stratigraphy, strong motions, tectonics, telluric, transfer, trenching, Vibroseis, wells.

Summary (Column 7). Overall rationale and objectives of project.

FY93 Plans (Column 8). current activities and objectives.

Region (Column 9). Bay Area refers to the greater San Francisco Bay Area from Monterey Co. to Marin Co.; *Parkfield* refers to the Parkfield earthquake Prediction Experiment located along the Parkfield section of the San Andreas fault in Monterey and San Luis Obispo Counties; *No. Calif.* refers to the area from Parkfield to Cape Mendocino not included in the Bay Area and Parkfield regions.

Affected Counties (Column 10). 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.

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Page Plan Elem.	Principals	Org.	Tele-phone #	Project Title	Comments (Key words)	Summary	FY93 Plans	Region	Affected Counties
I.1 Determine the physical properties and mechanical behavior of active fault zones and their surroundings.									
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	stratigraphy, deformation, tectonics, trenching, mapping	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.	Bay Area	Alameda, San Francisco, Napa, San Mateo, Santa Clara, Santa Cruz, Contra Costa, Marin
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	database, digital seismic network, monitoring, seismicity	Invert digital seismic data to derive moment-tensor representations of earthquakes in the SF Bay Area.	New. 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.	Bay Area	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	fluid pressure, earthquake cycle, fault interactions	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.	Bay Area	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	Loma Prieta, site effects, strong motions,	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.	Bay Area	Santa Clara, Santa Cruz
I.2	Roger Bilham	U Colo.	303-492-6189	Slip Rates in the San Francisco Bay Area	deformation, earthquake cycle, regional framework	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.	Bay Area	Alameda, San Francisco, Napa, San Mateo, Santa Clara, Santa Cruz

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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	BASIX, earthquake cycle, fault interaction, regional framework	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. Utilize BASIX results in conjunction with geologic, geodetic, and seismicity data to define fault segment continuity and geometry. Develop detailed models of stress and deformation within the East Bay fault system.	Bay Area	Alameda, Contra Costa
I.2, II.3	Ross Stein	USGS /Menlo /EGG	415-329-4840	Complete 1906 Earthquake Slip Distribution; Implications for the San Francisco Bay and Northern California	earthquake cycle, tectonics, regional framework, Loma Prieta eqk., fault interaction	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.	Bay Area, No. Calif.	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	earthquake cycle, fault interaction, Loma Prieta eqk., microearthquakes, seismicity, tectonics	Correlate microseismicity rate changes in the Bay Area with static stress changes produced by the 1989 Loma Prieta eqk. These relations imply that faults respond to low level stress changes.	Continuation. Expand study to include changes in microseismicity caused by all major earthquakes in the last 20 years. Construct a better dislocation model for the area with more accurate representations of tectonic features.	Bay Area	Alameda, San Francisco, Napa, San Mateo, Santa Clara, Santa Cruz, Marin, Contra Costa
I.2, II.1, II.2, II.3	Joe Andrews	USGS /Menlo /EGG	415-329-5606	Mechanics of Geometric Fault Complexities	fault interaction, tectonics	Stepovers between strike-slip faults must involve vertical deformation with slip on inclined faults. Relate seismicity, topography, and geology to faulting mechanism in stepover regions.	Continuation. Relate seismicity, topography, and geology to faulting mechanisms of earthquakes between the Calaveras and Hayward faults in the Mission Peak-Monument Peak area.	Bay Area	Alameda, Santa Clara

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II.1 Determine the geologic and geophysical setting and characteristics of seismically active regions.									
II.1	Manuel (Doc) Bonilla	USGS /Menlo /SEIS	415-329-5615	Surface Faulting Studies	mapping, site effects, liquefaction, Loma Prieta eqk., hazard maps	Compile information that can be used to evaluate and mitigate hazards from earthquakes. Revise the South San Francisco 1:24,000 quadrangle map MF-311 which is out of date and out of print.	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.	Bay Area	San Francisco, San Mateo
II.1	Carl Wentworth	USGS /Menlo /WRG	415-329-4950	Regional setting of the Parkfield Earthquake	tectonic framework, GIS, geologic structure, tectonics, Parkfield	The regional setting of the Parkfield segment of the San Andreas fault is a necessary component of a comprehensive interpretation of the Parkfield Earthquake Prediction Experiment.	New. Finish digital maps of geology, gravity, aeromagnetics, and seismicity at 1:200,000 scale. Prepare text and/or map description of the regional tectonic framework.	Parkfield	San Benito, Monterey, Kern,King, Fresno, San Luis Obispo, Santa Barbara
II.1	Carl Wentworth, Earl Brabb	USGS /Menlo /WRG	415-329-4950 329-5140	Geologic Framework of the San Francisco Bay Region	regional framework, mapping, fault interaction, GIS, stratigraphy, tectonics	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, Tectonophysics, Pacific Marine Geology, Geophysics, and with UC Berkeley.	Bay Area	Alameda, San Francisco, Napa, San Mateo, Santa Clara, Santa Cruz, Marin, Contra Costa
II.1	Tom Brocher	USGS /Menlo/ SEIS	415-329-4737	Seismic Reflection Crustal Studies Project	BASIX, crustal structure, regional framework	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. Complete reduction of CALNET data during BASIX into seismic wide-angle profiles; forward model travel times and amplitudes on the 5-day and CALNET recordings; digitize moored hydrophone data; generate seismic reflection lines.	Bay Area	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; Analysis of BASIX Marine Seismic Data across the San Andreas and hayward fault systems	BASIX, crustal structure, regional framework	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. Continue processing and analysis of the multichannel and high-resolution Uniboom data.	Bay Area	Alameda, San Francisco, Napa, San Mateo, Santa Clara, Santa Cruz, Contra Costa

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II.1	Davy Jones	UC Berk	510-642-2514	Tectonics of the Chabot-Mission Faults: Geologic framework investigations of east bay faults	tectonics, stratigraphy, geologic structure, trenching, mapping, regional framework, deformation	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.	Bay Area	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	BASIX, crustal structure	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.	Bay Area	Alameda, San Francisco, Napa, San Mateo, Santa Clara, Santa Cruz
II.1, II.2	Davy Jones, Tom McEvilly	UC Berk	510-642-2514 642-4494	Marine Seismic Investigations of the East Bay Faults	BASIX, crustal structure, tectonics	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.	Bay Area	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 framework, gravity, fault interaction, crustal structure, magnetic, tectonics	Regional gravity and magnetic data constrain crustal models, providing the tectonic setting critical to the interpretation of local studies.	Continuation. Expand the Loma Prieta 3-D upper crustal model to the north and east; interpret new aeromagnetic surveys near BASIX profiles and over San Pablo Bay.	Bay Area	Alameda, Napa, San Mateo, Santa Clara, Contra Costa
II.1, II.4, II.5	John Evans	USGS /Menlo/ SEIS	415-329-4753	Lithospheric Structure Transect across the San Andreas Fault System	crustal structure, regional framework, tectonics	Study the subcrustal structure and strain distribution across the plate boundary in the SF Bay Area by analyzing teleseismic waveforms and shear-wave splitting.	New. Initiate deployment of permanent broadband sensors on a transect from the Pacific coast to the western edge of the Graet Valley.	Bay Area	Santa Cruz, Santa Clara, Stanislaus

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II.1, II.5, III.1	John Sims	USGS /Menlo /EGG	415-329-5653	Records of Paleoseismicity in Quaternary Sediments	dating samples, earthquake cycle, trenching, Parkfield	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. Complete trenching at site near Cholame on the Parkfield segment of the SAF and at the Phelan site on the Carrizo Plain segment of the SAF. Trench a second site on the Green Valley fault.	Bay Area, Parkfield	San Benito, Monterey, Kern,King, Fresno, San Luis Obispo, Santa Barbara, Solano, Napa, Contra Costa
II.1, III.1	Rufus Catchings	USGS /Menlo/ SEIS	415-329-4749	Evaluation of Seismic Propagation Effects along the Hayward and San Andreas Faults	crustal structure, strong motions, regional framework, Loma Prieta eqk.	Focussing 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. Acquire seismic refraction profiles along the Hayward-Rodgers Creek faults and along a San Gregorio-Livermore line.	Bay Area	Alameda, San Francisco, Napa, San Mateo, Santa Clara, Marin, Contra Costa, San Benito
II.2 Determine the occurrence, distribution, and source properties of earthquakes and relate seismicity to geologic structures and tectonic processes.									
II.2	Peter Ward	USGS /Menlo/ SEIS	415-329-4736	Making NEHRP Data Available to All	database, Parkfield	The Seismic Unified Data System (SUDS) is a machine-independent method for collecting, exchanging, using, archiving, and retrieving data that promises a significant increase in human and fiscal efficiency in NEHRP.	New. Load CALNET data into a DB_Vista database management system in SUDS; implement "xpick" and a graphical user interface; implement SUDS in "hypoellipse" and "hypoinverse."	Bay Area, No. Calif., Parkfield	All
II.2	Mary Lou Zoback, Jean Olson	USGS /Menlo/ SEIS	415-329-4760 329-4779	Seismotectonics of the San Francisco Peninsula	seismicity, microearthquakes, tectonics	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.	New. Relocate the 1969-1992 CALNET catalog; analyze focal mechanism solutions; relocate the 1957-1968 Berkeley catalog eqks.; examine the 1957 Daly City sequence.	Bay Area	San Francisco, San Mateo

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II.2	Barbara Romanowicz	UC Berk.	510-643-5690	Source Characterization of Events in the San Francisco Bay Region	digital seismic network, seismicity	Develop techniques to model local and regional seismograms to establish detailed characteristics of earthquakes in the SF Bay Area.	New. Collect and digitize useful 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.	Bay Area	Alameda, San Francisco, Napa, San Mateo, Santa Clara, Santa Cruz, Contra Costa, Marin
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	No. Calif. Seismic Network	database, digital seismic network, monitoring, seismicity, transfer, strong motions, regional framework, earthquake cycle, fault interaction, instrumentation, Loma Prieta eqk., microearthquakes, Parkfield	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.	Bay Area, Parkfield, No. Calif.	All
II.2, I.2, II.7	Bill Ellsworth	USGS /Menlo/ SEIS	415-329-4784	Seismic Studies of Fault Mechanics	instrumentation, boreholes, digital seismic network, microearthquakes, monitoring, strong motions, Loma Prieta eqk., transfer	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. See McEvilly's companion project.	Continuation. Install digital seismic network along southern Hayward fault. Study shear wave velocity changes associate with the Loma Prieta eqk. Develop REDI system with UC Berkeley and PG&E.	Bay Area	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	instrumentation, boreholes, digital seismic network, microearthquakes, monitoring, strong motions	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. See Ellsworth's companion USGS project.	Continuation. Install 5 more borehole stations. 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.	Bay Area	Alameda, Contra Costa
II.2, IV.1	Barbara Romanowicz	UC Berk	510-643-5690	Joint UCB/USGS Data Center: Real-time Source Parameters and Unique Catalog for Central and Northern California Earthquakes	database, digital seismic network, microearthquakes, strong motions	Establish 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. Provide preliminary real-time estimates of earthquake source parameters.	Continuation. Coordinate catalog production with USGS for northern and central California stations. Develop procedures to determine moment tensors in real time and for cataloguing purposes.	Bay Area	Alameda, San Francisco, Napa, San Mateo, Santa Clara, Santa Cruz
II.3 Determine the nature and rates of crustal deformation.									
II.3	John Langbein	USGS /Menlo /EGG	415-329-4853	Strain monitoring	deformation, monitoring, tectonics, Parkfield	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. If preliminary measurements are successful, install a radial nework centered on Monument Peak that spans the Hayward and Calaveras faults.	Bay Area, Parkfield	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	deformation, fault interaction, Loma Prieta eqk., monitoring, strain, tectonics, Parkfield	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. GPS survey of the 5 Bay Area GPS profiles, the Geysers network, the Farallon-Sierras arc, and the Loma Prieta net. Continuous GPS at 2 sites in East Bay; add 2 new sites. Continue Parkfield work.	Parkfield, Bay Area, No. Calif.	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	deformation, monitoring, tectonics	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 horizontal motion within a width of 50-300 meters at 24 sites on the San Andreas, Hayward, Calaveras, Concord-Green Valley, Antioch, Seal Cove-San Gregorio, Rodgers Creek, and West Napa fault by triangulation using a T3 theodolite.	Bay Area	Marin, Napa, Contra Costa, San Francisco, Alameda, Santa Clara, San Mateo, Santa Cruz, San Benito

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

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II.4	Paul Segall	USGS /Menlo /EGG	415-329-4861	Mechanics of Faulting and Fracturing	deformation, fault interaction, Loma Prieta eqk., strain, tectonics	Strain diffusion is a mechanism to explain sequential rupturing of adjacent fault segments. Geodetic stations across the San Andreas fault 20 km north of the Loma Prieta rupture provide means to detect strain diffusion into the Peninsula segment.	Continuation. Model GPS data for Loma Prieta eqk. Extend studies to other parts of the San Andreas system in the Bay Area.	Bay Area	Santa Cruz, San Mateo
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	earthquake cycle, seismicity,	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 eventsusing reported intensity effects. Add reports from diaries and letters to newspaper accounts for pre–1868 events.	Bay Area	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	earthquake cycle, probability, seismicity	Determine the size and location of of 1836, 1838, 1864, 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.	Bay Area	Alameda, San Francisco, Napa, San Mateo, Santa Clara, Santa Cruz, Monterey

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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	Quaternary Slip Rates of Active Faults of California	earthquake cycle, codes	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.	Bay Area, No. Calif.	All
II.5	Jim Lienkaemper	USGS /Menlo /EGG	415-329-5642	Slip History of the San Andreas and Hayward Faults	dating samples, earthquake cycle, trenching	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.	Bay Area	Alameda
II.5	Carol Prentice	USGS /Menlo /EGG	415-329-5690	No. San Andreas Fault System: Paleoseismology and slip rate studies in northern and central Ca	dating samples, earthquake cycle, trenching	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.	Bay Area, No. Calif	San Mateo, Mendocino
II.5	Steve Lewis	USGS /Menlo /PMG	415-354-3041	Offshore Geological and Geophysical Data Compilation, Synthesis and Offshore Geologic Mapping, SF Bay Region	crustal structure, GIS, regional framework	Compile and synthesize marine geological and geophysical data offshore of the greater San Francisco Bay Area. Acquire sonar data along the offshore San Gregorio fault zone.	Continuation. Maps (1:100,000 scale) integrating onshore and offshore data. Digital side-scan sonar mosaics archived and distributed in computer-readable format.	Bay Area	San Mateo, Santa Cruz, Monterey
II.5	Paul Segall	USGS /Menlo /EGG	415-329-4861	Mechanics of Faulting and Fracturing	deformation, earthquake cycle, strain, tectonics, Parkfield	Use geodetic measurements to image the distribution of slip on the Parkfield segment of the San Andreas fault.	Continuation. Reanalyze the Parkfield geodetic and creep data to update the Harris and Segall slip-rate model in light of a vastly-increased data set and improved analytical techniques.	Parkfield	San Benito, Monterey, Kern, King, Fresno, San Luis Obispo, Santa Barbara

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II.5	Keith Kelson, Bill Lettis	Wm. Lettis & Assoc.	510-832-3716	Paleoseismic Investigation of the Calaveras Fault at Leyden Creek, Alameda Co. , CA	deformation, mapping, trenching, dating samples	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) Location 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.	Bay Area	Alameda
II.5	Jay Noller, Bill Lettis, Gerry Weber	Wm. Lettis & Assoc.	510-832-3716	Paleosesmic and Geoarcheological Investigat-ions of the San Gregorio Fault, Seal Cove, CA	mapping, dating samples	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.	Bay Area	San Mateo
II.5	Bill Lettis, Gary Simpson	Wm. Lettis & Assoc.	510-832-3716	Paleoseismic Investigation of the Northern Calaveras Fault	mapping, trenching, dating samples	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.	Bay Area	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	mapping, trenching	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.	Bay Area	San Mateo, Santa Cruz
II.5	Gordon Jacoby	Lamont-Doherty Geol. Obs. (Columbia U)	914-359-2000	Absolute Dating of Prehistoric Earthquakes by Tree-ring Analysis in Northern California	dating, earthquake cycle	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.	Bay Area No. Calif.	Monterey, Santa Cruz, San Mateo, Marin, Sonoma

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II.5	Glenn Borchardt	Soil Tectonics	510-654-1619	Slip Rate of the Northern Hayward Fault at Point Pinole, CA	boreholes, dating samples, mapping, trenching	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 (≈122years 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.	Bay Area	Alameda, Contra Costa, Napa
II.5	Tim Hall, Robert Wright	Geomatrix Cons.	415-434-9400 626-0765	Paleoseismic Investigation of the San Andreas Fault on the San Francisco Peninsula	dating samples, mapping, trenching, stratigraphy	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. Detailed logging and documentation of tenches, age dating of key offset horizons, and reconstruction of late Holocene paleoseismic histories.	Bay Area	Santa Clara, San Mateo
II.5, II.6	Dave Schwartz	USGS /Menlo /EGG	415-329-5651	Fault Segmentation: San Andreas Fault System	dating samples, earthquake cycle, trenching, Loma Prieta eqk.	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. Excavate four new trenches at the Triangle G site on the Rodgers Creek fault, and two new trenches at the Grizzly Flat site on the San Andreas fault in the southern Santa Cruz Mtns.	Bay Area	Santa Cruz, Monterey, Contra Costa, Napa
II.7 Monitor intensely a few selected regions of high seismic potential.									
II.7	Kate Breckenridge	USGS /Menlo /EGG	415-329-4849	Fault Zone Tectonics	deformation, monitoring, tectonics, Parkfield	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. Cooperate with Roger Bilham on new sites on the Hayward fault.	Bay Area, Parkfield	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	digital seismic network, microearthquakes, monitoring, instrumentation, Parkfield	Correlation of acoustic emission (AE) with nearby strain measurements indicate AE is sensitive to local strains of 1:billion, and may be a useful strain monitor. Identify the strain level that can be monitored by AE.	New. Place AE sensors in 3 10-m-deep holes near the Varian well site at Parkfield. These 4 transducers will be monitored and results analyzed in terms of earth tides, local eqks., and local strain changes.	Parkfield	San Benito, Monterey, Kern, King, Fresno, San Luis Obispo, Santa Barbara

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II.7	Carl Mortensen	USGS /Menlo /EGG	415-329-4856	Experimental Tilt and Strain Instrumentation	instrumentation, transfer, monitoring, Parkfield	Provide operational and technical suport for the opeartion 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.	Parkfield, Bay Area	San Benito, Monterey, Kern, King, Fresno, San Luis Obispo, Santa Barbara, Alameda
II.7	Evelyn Roeloffs	USGS/ Vancouver/ EGG	206-696-7693	East Bay Water Level Monitoring	wells, strain, monitoring, instrumentation	Experience at Parkfield has shown that some water wells work reliably as borehole strainmeters. Identify suitable sites for water level monitoring in the East Bay.	Continuation. Evaluate at least 2 more sites near the Hayward fault; deploy transducers and record water level and barometric pressure at each site; record rainfall at 1 site. If a suitable site is found, a permanent installation will be made.	Bay Area	Alameda
II.7	Evelyn Roeloffs	USGS /Menlo /EGG	206-696-7693	Parkfield: Water Level Data Monitoring and Interpretation	instrumentation, monitoring, strain, Parkfield	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.	Parkfield	San Benito, Monterey, Kern, King, Fresno, San Luis Obispo, Santa Barbara
II.7	Stan Silverman	USGS /Menlo /EGG	415-329-4862	Low Frequency Data Network/ Monitoring	instrumentation, monitoring, Parkfield	Provide real time monitoring capability for low frequency data collection systems.	Continuation. Improve sateelte receiver backup system. Develop software tools and documentation.	Bay Area, Parkfield, No. Calif.	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	deformation, monitoring, tectonics	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.	Bay Area	Santa Cruz, Moterey, San Benito

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II.7	Mick Gladwin	U Queens-land (Aust.)	Inter-national 617-377-2473	Deep Borehole Strain Monitoring	boreholes, strain, instrumentation, monitoring, Parkfield	Maintenance and analyis of deep borehole tensor strain instrumentation at 3 Parkfield sites, at the San Juan Bautista site, and at 2 sites installed in the east bay in 1992.	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.	Bay Area, Parkfield	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	strain, monitoring, instrumentation	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).	Bay Area	Alameda
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	monitoring, strain, digital seismic network, seismicity, strong motions, 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.	Parkfield	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	boreholes, deformation, monitoring, strain, strong motions, Parkfield	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).	Bay Area, Parkfield	San Benito, Monterey, Kern, King, Fresno, San Luis Obispo, Santa Barbara, Alameda

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II.7, II.8	John Langbein	USGS /Menlo /EGG	415-329-4853	Parkfield Coordination	earthquake cycle, monitoring, transfer, Parkfield	The Parkfield Earthquake Prediction Experiment is a unique concentation of geophysical instrumentation on a stretch of the San Andreas fault expected to experience a M6 earthquake in the near future.	Continuation. Continue representation of experiment to the public, the press, and to local, state, and federal agencies.	Parkfield	San Benito, Monterey, Kern, King, Fresno, San Luis Obispo, Santa Barbara
II.7, II.8	Tom Moses	USGS /Menlo /EGG	415-329-4870	OEVE Drilling Project	boreholes	Manage drilling projects for installation of borehole instrumentation.	Continuation. Complete East Bay Installations.	Bay Area	Alameda
II.7, II.8	Alan Linde, Selwyn Sacks	Carnegie Inst. of Washington, D.C.	202-686-4394 686-4388	Analysis of Borehole Strainmeter Data	boreholes, monitoring, deformation, Parkfield	Borehole strain data provides coseismic strain offset data and near-source deformation data, and a monitor of crustal strain changes that might preceed a damaging earthquake.	Continuation. Integrate observations with W. Stuart's models of stress changes, correlate strain observations with other observations of slow slip.	Parkfield	San Benito, Monterey, Kern,King, Fresno, San Luis Obispo, Santa Barbara
II.8 Develop and evaluate methods of short- and intermediate-term prediction of earthquake occurrence.									
II.8	Evelyn Roeloffs	USGS/ Vancouver/ EGG	206-696-7693	Influence of Rainfall on Fault Creep Observations	instrumentation, monitoring, strain, Parkfield	Creep may be useful for short-term earthquake prediction, but some creepmeter sites repond in a strong, unpredictable fashion to rainfall. Investigate the rainfall response using existing data from creepmeters, rain gauges, and soil moisture sensors.	New. Parkfield: determine if creep events occur during intense rainfall; study the seasonal signals to clarify the mechanism of the seasonal line-length changes on the 2-color geodimeter. San Juan Bautista: relate creep signals to storm intensity.	Parkfield	San Benito, Monterey, Kern, King, Fresno, San Luis Obispo, Santa Barbara
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	telluric, electrical, resistivity, monitoring, Parkfield	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 (since 1988). Maintain monitoring array and continue comparisons with other data. Analyze the possible precursor 1 month before the 1989 3.7 Parkfield earthquake also seen on the tensor strain array.	Parkfield	San Benito, Monterey, Kern,King, Fresno, San Luis Obispo, Santa Barbara

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II.8, II.7	Tom McEvilly	UC Berk	510-642-4494	High-resolution Controlled-source and Microearthquake Monitoring at Parkfield	Vibroseis, digital seismic network, microearthquakes, monitoring, 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.	Parkfield	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	Borehole, digital seismic network, microearthquakes, monitoring, Parkfield	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.	Parkfield	San Benito, Monterey, Kern,King, Fresno, San Luis Obispo, Santa Barbara
II.8, II.7	R. Helliwell, Tony Fraser-Smith	Stanford U	415-723-3684	Continuation of the Measurements and Analysis of Low-frequency Electromagnetic Fields at Parkfield, California	Electromagnetic, monitoring, Parkfield	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. Improve flexibility by replacing cables with radio links and install solar panels for power. Add a vertical ULF field component monitor at 1 site.	Parkfield	San Benito, Monterey, Kern,King, Fresno, San Luis Obispo, Santa Barbara
II.8	Bill Stuart	USGS /Menlo /EGG	415-329-4648	Simulation model for pre- and coseismic faulting at Parkfield	earthquake cycle, deformation, Parkfield	Develop full-cycle forward fault model for aseismic and seismic faulting at Parkfield. Fit model to past geodetic, fault creep, and main shock data. Compute future fault slip and crustal strain, including preseismic anomalies.	Continuation. Refine existing numerical model. Make simulations for a range of model parameters consistent with field and laboratory data. See if predicted preseismic anomalies could be detected in actual data.	Parkfield	San Benito, Monterey, Kern,King, Fresno, San Luis Obispo, Santa Barbara

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

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III.1	Paul Spudich	USGS/ Menlo/ SEIS	415-329-5654	Strong Motion Instrumentation for the SF Bay Region	strong motions, instrumentation	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.	Bay Area	Alameda, San Francisco, Napa, San Mateo, Santa Clara, Santa Cruz

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III.1	Jim Gibbs, Bill Joyner	USGS/ Menlo/ SEIS	415- 329-5631 329-5640	Near-surface Lithologic and Seismic Properties	strong motions, boreholes, site effects, geotechnical properties, hazard maps, Loma Prieta eqk.	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. Complete interpretation of downhole shear wave Q data from Gilroy site with lithology typical of Santa Clara valley. Continue to process data from 24 boreholes in the region where Loma Prieta strong motion data was recorded.	Bay Area	Alameda, San Francisco, Napa, San Mateo, Santa Clara, Santa Cruz
III.1	Hsi-Ping Liu	USGS /Menlo /SEIS	415- 329-5643	Borehole Instrumentation for Engineering and Earthquake Seismology	boreholes, instrumentation, digital seismic network, geotechnical properties, site effects, strong motions	Deployment of downhole arrays of to document effect of local geology and subsurface conditions on ground motions from earthquakes.	Continuation. Install borehole seismometers at Winfield Scott Sch. in Marina dist., design and construct a borehole shearwave generator, complete installations in the Lower Market dist. of SF.	Bay Area	San Francisco
III.1	Erdal Safak	USGS /Reston /NEGI	703- 648-6534	Analyses of Structural Response to Earthquakes	site effects, engineering, buildings, codes	Analysis of recorded response of structures, develop new methods to analyze structural data, study effects of the soil-structure interaction on seismic structural response, and evaluate current seismic design codes.	New. Ambient vibration testing of the Chevron Building in San Francisco.	Bay Area	San Francisco
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	boreholes, buildings, digital seismic network, geotechnical properties, instrumentation, lateral spreading, liquefaction, site effects, strong motions	Record comprehensive data on the response of soft soils and structures to strong motions. Borehole, surface, and structure instrumentation at Embarcadero/Justin Herman Plaza, Bessie Carmichael School, and Levi Strauss Plaza.	Continuation. Complete seismic and geologic logging of boreholes, complete installation of borehole sensors, install recording equipment, maintain array, and archive data.	Bay Area	San Francisco

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III.1	Ed Harp	USGS /Golden/ ELH	303-273-8641	Seismic Landslide Instrumentation Experiments	instrumentation, landslide	Instrument landslides to record simultaneously: 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; procure additional sensors and select a second landslide instrumentation site.	Bay Area	San Mateo
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	landslide, geotechnical properties, stratigraphy, strong motions, instrumentation, mapping	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.	Bay Area	San Mateo, Santa Cruz
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	liquefaction, Loma Prieta eqk., lateral spreading,site effects, geotechnical properties.	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.	Bay Area	Monterey, Santa Cruz
III.1	Sands Figuers	Rogers/ Pacific, Inc.	510-682-7601	Well Data Project	Database, wells, GIS	Collect data on properties of young or unconsolidated material in Alameda and Contra Costa counties to support strong-motion estimates for the rapidly-developing areas of Alameda and Contra Costa counties.	New. Gather and compile all types of existing drill hole information on Quaternary deposits in Alameda and Contra Costa counties.	Bay Area	Contra Costa, Alameda
III.1, II.7, II.8	Joe Fletcher, Paul Spudich	USGS /Menlo /SEIS	415-329-5628 329-5654	UPSAR, USGS Parkfield Dense Seismograph Array	buildings, digital seismic network, instrumentation, monitoring, site effects, strong motions, Parkfield	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.	Parkfield	San Benito, Monterey, Kern, King, Fresno, San Luis Obispo, Santa Barbara

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III.1, IV.1	Roger Borcherdt	USGS /Menlo /SEIS	415-329-5619	Analastic Wave Propagation, Ground response, and Predictive GIS Mapping Studies	GIS, hazard maps, codes, planning, site effects, strong motions	Study response of soils to strong ground shaking to understand amplification of strong shaking due to local site conditions. Develop methodologies for predictive GIS mapping of Alquist-Priolo zones.	Continuation. Complete GIS maps for "sheet 3/3" of the SF Bay Region, continue work on Integrated Market St. array in San Francisco, and continue analyses of weak- and strong-motion data to understand amplification process.	Bay Area	San Francisco, San Mateo, Santa Clara, Alameda
III.2 Predict strong ground shaking.									
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	strong motions, site effects, directivity, near field	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.	New. Use synthetic seismograms to extrapolate the existing data to augment the sparse data set close to the fault. Develop ground motion attenuation relations for 0.04-10sec periods at sites within 20 km of M6.5-7.5 strike-slip shocks.	Bay Area	Alameda, San Francisco, Napa, San Mateo, Santa Clara, Santa Cruz
III.2, I.2	Steve Hartzell	USGS /Golden/ ELH	303-273-8572	Improvements in Synthetic/Empirical Green's Function-Finite Fault Inversions; Application to the Loma Prieta Earthquake	Loma Prieta eqk., strong motions, site effects	Strong motion data from the Loma Prieta earthquake sequence provide a detaile picture of the earthquake source and also site effects at the distributed strong ground motion recording sites.	Continuation. Continue analyses of Loma Prieta main shock and aftershock strong motion data.	Bay Area	Santa Cruz, Santa Clara, San Mateo
III.2, III.1	Jack Boatwright	USGS /Menlo /SEIS	415-329-5609	Site Response for the Bay Area Estimated from Recordings of the Loma Prieta Mainshock and Aftershocks, and Correllated with Geology	site effects, strong motions, Loma Prieta eqk.	Predict strong ground motion parameters for the 4 scenario earthquakes in the Bay Area Probability Report (USGS Circ. 1053).	Continuation. Complete analyses of San Francisco recordings of Loma Prieta eqk., analyze site response in south bay, and complete deliberations of Working Group for Predictive Maps of Strong Ground Motion.	Bay Area	Alameda, San Francisco, Napa, San Mateo, Santa Clara, Santa Cruz
III.3 Predict ground failure.									
III.3	Tom Holzer, John Tinsley	USGS /Menlo /EGG, USGS /Menlo /WRG	415-329-5613 329-4928	Liquefaction research	liquefaction, hazard maps, lateral spreading, geotechnical properties, site effects, Loma Prieta eqk.	Refine methods to predict and map the likely occurrence of liquefaction and lateral spread ground failures.	Continuation. Deploy recorders between Watsonville and Salinas to measure acceleration vs. distance from Loma Prieta eqk. Study sites that failed in 1906 but not 1989. Install instrumentation purchased in FY91 in Marina district.	Bay Area	Monterey, Santa Cruz

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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	mapping, landslide, geotechnical properties, hazard maps, GIS, Loma Prieta eqk., strong motions	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.	Bay Area	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	geotechnical properties, liquefaction, Loma Prieta eqk., planning, transfer, site effects	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.	Bay Area	San Francisco
III.3, II.1	Dan Ponti	USGS /Menlo /EGG	415-329-5679	Quaternary Chronostratigraphy and Deformation History, LA Basin	landslide, Loma Prieta eqk.,	Edit ground rupture chapter of the Report to Congress on the 1989 Loma Prieta earthquake.	Continuation. Finish chapter.	Bay Area	Santa Cruz, Santa Clara
IV.1 Transfer hazard information and hazard-assessment methods to users.									
IV.1	Stan Silverman	USGS /Menlo /EGG	415-329-4862	Low Frequency Data Network/ Monitoring- Building 7 Lobby	transfer, Parkfield	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.	Bay Area, Parkfield, No. Calif.	San Benito, Monterey, Kern, King, Fresno, San Luis Obispo, Santa Barbara
IV.1	Bill Bakun	USGS /Menlo/ SES	415-329-4793	Bay Area Future Earthquakes Project	transfer, Parkfield	Effectiveness of the NEHRP programs is enhanced by cooperation and communication between USGS and other researchers. Preparation of pamphlets, videos, models, maps, etc. explaining program results increase risk reduction activities.	Continuation. Establish USGS EHRP contact (Susan Larsen, 415-329-4668). Produce video on New Madrid Seismic Zone. Hold EHRP Workshop.	Bay Area, Parkfield, No. Calif.	All

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Page Plan Elem.	Principals	Org.	Tele-phone #	Project Title	Comments (Key words)	Summary	FY93 Plans	Region	Affected Counties
IV.1	Jack Moehle	UC Berk. Earthq. Eng. Res. Cen.	510-231-9554	Data Archive for the 1989 Loma Prieta earthquake	database, Loma Prieta eqk.	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.	Bay Area	Alameda, San Francisco, Napa, San Mateo, Santa Clara, Santa Cruz, Monterey
IV.1	Martha Tyler, George Mader	Wm. Spangle & Assoc.	415-854-6001	Local Government Use of USGS Earthquake Hazard Information- Assessment of Practice in the San Francisco Bay Area	transfer, planning	Improve local government use of earthquake hazard informaion. How have local agencies, particularly planning agencies, used products to improve seismic safety and how might products be improved?	Continuation. Complete study and document results in a report to be published as a USGS Circular.	Bay Area	Alameda, San Francisco, Napa, San Mateo, Santa Clara, Santa Cruz, Monterey
IV.1	Chris Rojahn	Applied Tech. Coun.	415-595-1542	Program to Transfer USGS Engineering Seismology Research Results to Engineering Design Practice	Transfer, engineering, buildings, codes, design	Rapid and effective utilization of earth science information by design practitioners. Incorporation of earth science research into seismic design practices, codes, and standards.	New. Identify current design practice needs, identify major issues, and implement priority actions such as workshops on specific issues.	All	All
IV.1	Bob Brown	USGS /Menlo /EGG	415-329-5620	Northern San Andreas Fault System	mapping, regional framework	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. BAREPP Policy Advisory Committee and Engineering Criteria Review Board.	Bay Area	Marin, San Francisco, San Mateo
IV.1	Rich Bernknopf	USGS /Reston /OCG	703-648-6726	A Dynamic GIS to Forecast Economic Effects of Eqk. Policies and Regulations	GIS, hazard maps, landslides, liquefaction, strong motions	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, BAREPP, OES, CDMG, and FEMA.	Continution. 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.	Bay Area	Santa Clara