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

WORK IN PROGRESS IN THE PACIFIC NORTHWEST NATIONAL EARTHQUAKE HAZARDS REDUCTION PROGRAM FISCAL YEAR 1994

By

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PROGRAM HIGHLIGHTS IN FISCAL YEAR 1993

Earthquakes, faults and landslides made the last Federal fiscal year (from October 1, 1992 through September 30, 1993) very memorable in the Pacific Northwest. Oregon was rocked by three earthquakes greater than magnitude 5.5, crustal faults made the news in Portland and Seattle and the volume of a landslide on the northeast slope of Lassen Peak was correctly estimated using signals from standard seismic network stations. Other highlights included a meeting in Seattle of program participants working in the greater Puget Sound region, the completion of an agreement that incorporates the University of Alaska Geophysical Institute in Fairbanks as one of the external institutions in the cooperative regional seismic network program, and several new forms of public outreach. Relying in part on new understanding of the earthquake potential in the region, structural engineering groups revised the Uniform Building Code, putting all of western Washington and Oregon and Klamath county in eastern Oregon into seismic zone III.

First, the news from the earth. On March 25, 1993 a magnitude 5.7 earthquake occurred southeast of Portland near the small town of Scotts Mills. This event, although located along the Cascade foothills, did over $38 million in damage and was widely viewed as "Oregon's wake-up call". If after the Scotts Mills earthquake any residents of Oregon doubted the pressing need to upgrade buildings in light of our understanding that Oregon is truly earthquake country, that reluctance should have been swept away by the two events about 25 km northwest of Klamath Falls on September 21. The first event was of magnitude 5.9 and was followed about 3½ hours later by a second event of magnitude 6.0. Two people died as a result of the shaking effects; damage, largely in the downtown portion of Klamath Falls has been estimated at $7 million. Work will continue on both earthquakes in FY94.

Second, in both Seattle and Portland the threat of large magnitude (7+) crustal events became much better accepted. The Seattle fault was documented in a series of papers published in *Science (vol. 258, pp. 1611-1623, 1992).* The geological field evidence suggests that about 1000 years ago a magnitude 7 event occurred on the Seattle fault; the earthquake uplifted a marine terrace about 7 meters, caused a local tsunami in Puget Sound, sent parts of the shoreline around Lake Washington sliding into the lake, and initiated a number of rockslides in the Olympic Mountains. In Portland, aeromagnetic data, interpreted with previous geologic mapping, show a major, shallow crustal fault striking northwest through the city. The aeromagnetic data allowed details of the shallow crust masked either by urban development or poor surface geological exposures to be interpreted as a fault possibly long enough to produce a magnitude 7 event in the center of Portland. Currently, there are no paleoseismic data in the Portland area linked to the Portland Hills fault. Both features are continuing to be studied in FY94.

Third, a rock slide from the northeast section of Lassen Peak sent seismic signals jumping on September 7, 1993. This event is important because it demonstrated that routine landslide signals recorded on standard network stations can be used to estimate the mass involved in the landslide; such information could be extremely useful if search and rescue operations were needed as a result of the landslide. The success in interpreting the seismic signals from the Lassen Peak landslide showed that the work done on landslide signals at Mount Rainier and Mount St. Helens can be exported to other areas.

Fourth, a three-day meeting of program participants was held in Seattle on May 13 through May 15. Forty two talks were given (limited to 8 minutes each!) on all aspects of the National Earthquake Hazards Reduction Program (NEHRP) work in the greater Puget Sound area. All program investigators working in northwestern Washington attended; in addition several Canadian and private sector co-workers presented talks. The meeting was attended by members of the press and private citizens interested in earthquake issues and was incorporated into the University of Washington Quaternary Research Center's annual Spring Conference series.

Fifth, the USGS and the University of Alaska Fairbanks reached agreement on the continued operation of the southern Alaska seismic network. Under terms of the agreement, most of the operational and maintenance of the network will be transferred from Menlo Park to the university over the next two years. John Lahr moved from Menlo Park to Fairbanks during the summer and serves as the USGS on-site representative to coordinate many of the changes necessary to implement the new operating arrangements.

Sixth, new outreach efforts were initiated this year. In both Seattle and Portland, NEHRP sponsored press conferences to explain program results. In Seattle a press conference was organized to coincide with the publication of the group of papers on the Seattle fault and an earthquake about 1000 years ago in the central Puget Sound basin. The Portland press conference explained the significance of newly acquired aeromagnetic data that dramatically defined a strong gradient interpreted to be the Portland Hills fault, a previously recognized feature. This press conference helped establish new ties between the USGS NEHRP effort and the Portland Metro Council, an elected council with jurisdiction over landuse in the area.

In the Humboldt Bay region, a magazine insert, "On Shaky Ground" appeared in coastal newspapers. Many program participants throughout the Pacific Northwest responded to the Oregon earthquakes either in participating in the post-earthquake studies or ing providing information to the press and citizens of the northwest. And, a series of sometimes frank discussions continued between the USGS and members of the Oregon and Washington structural engineering groups on the need to revise the federal seismic zoning maps.

There were some changes in program management that should improve the total NEHRP efforts. The USGS named an overall NEHRP Coordinator, Dr. Randy Updike, separating this job from that of the Chief, Office of Earthquakes, Volcanoes, and Engineering (currently held by Dr. Rob Wesson). The USGS regional coordinators, including Craig Weaver in Seattle, Bill Bakun in the Bay Area, Jim Mori in Pasadena, and Buddy Schweig in Memphis, report to Updike. Combined with the new Deputy for External Research, John Sims, this group works with the USGS branch chiefs to coordinate the efforts of the earthquake program.

SUMMARY OF WORK FUNDED IN THE PACIFIC NORTHWEST FISCAL YEAR 1994

The Pacific Northwest region of the U.S. Geological Survey's part of the National Earthquake Hazards Reduction Program (NEHRP) includes both Cascadia (northern California, Oregon and Washington) and Alaska. Although this is a diverse geographical region, both Cascadia and Alaska share the hazards common to subduction zones: great thrust earthquakes, Benioff zone earthquakes, volcanic eruptions, and the possibilities of locally generated tsunamis. The program efforts include an internal part (funds spent within the USGS) and an external part (funds awarded through peer-review) to non-USGS investigators.

On the internal side first, where $2.40 million was available, 32 of 56 proposals received at least partial funding, including 10 investigators new to the region. The two cooperative seismic networks in the region, at the University of Washington and the University of Alaska Fairbanks, will receive $518.0K from NEHRP in FY94. On the external side, we received 65 proposals. After the reviews, we funded (sometimes at reduced levels) 28 of these proposals; the total funding available was $1.3 million. Of the 28 investigators, 13 were new to the Pacific Northwest.

Our efforts in the region are focused in five categories:

- Paleoseismic studies of uplift or subsidence along the coasts and in the Puget Sound region
- Regional geological, crustal and upper mantle structure, and tectonic investigations
- Regional seismic and deformation monitoring
- Shaking effects and modeling of potential strong ground motions
- Applications and outreach

One common theme from both the internal and external panels is a move from mud to modeling. Over the last few years the USGS has funded many paleoseismic studies that primarily examined late Holocene subsidence and uplift features, both along the outer coasts of Cascadia and Alaska as well as within Puget Sound.

Particularly with respect to the occurrence of Cascadia earthquakes, the success of these studies have raised questions about the extent of the rupture zone and the level of ground shaking in the urban areas, issues that must be addressed by modeling studies. We will have a combination of thermal and deformation modeling underway in FY 94 in an effort to test hypotheses related to the behavior of the Cascadia subduction zone. This work will be done by investigators from the Pacific Geoscience Centre, the University of Washington and Oregon State University.

Continuing the emphasis on modeling are a number of new efforts in strong ground motion modeling. USGS investigators will work to analyze the broad-band records written during the Scotts Mills earthquake sequence, whereas four awards to engineering firms have been made to examine aspects of strong ground shaking in the Portland and Seattle basins, estimating the effect of long durations, and using existing data to determine ground response in northwestern Washington and southern British Columbia and in northernmost California.

Some general seismicity work has been funded in conjunction with the Scotts Mills earthquake, including studying the seismic data collected by portable instruments installed in the epicentral region and analyzing the several thousand responses to the intensity questionnaire published in local newspapers after the earthquake. The University of Oregon, Oregon State University, the University of Washington and the USGS will be conducting these studies.

Finally, we are providing funds to Portland Metro for a demonstration project on developing landuse regulations in light of our increased understanding of earthquake risks. This project will attempt to translate our new understanding into legislative solutions firmly based on scientific results.

PROJECTS FUNDED IN THE PACIFIC NORTHWEST, FISCAL YEAR 1994

EXPLANATION

This is a compilation of efforts funded by the USGS in FY94 (October 1, 1993 through September 30, 1994) in the Pacific Northwest through the NEHRP. This listing is intended as a resource for identifying ongoing work and contacts knowledgeable about specific earthquake issues in the Pacific Northwest. For the purposes of USGS NEHRP efforts, the Pacific Northwest includes all of the Cascadia region and all of Alaska.

There are two major USGS earthquake investigations in the Pacific Northwest not funded through the regional program. The first is that portion of the northern California seismic network north of Cape Mendocino and Lassen Peak. Funds for these operations are provided by the northern California region of NEHRP. The second is the operation of seismic stations that are part of the several national seismic data collection efforts (National Seismic Network, the national strong motion network, global network). Funding for these operations come from the Earthquake Data and Information Services portion of NEHRP.

For convenience of most readers, work underway in the Pacific Northwest has been subdivided into the five general categories listed above rather than by elements listed in the NEHRP plan. These five categories are:

- Paleoseismic studies (uplift and subsidence) along the coasts and in Puget Sound (in the Pacific Northwest these studies are under NEHRP component II.5)
- Regional geologic, tectonic and structural studies (largely NEHRP components I.1, I.2, II.1, II.2, and II.5)
- Seismic network and geodetic studies (NEHRP components II.3 and II.4)
- Strong ground motions studies (NEHRP components III.2 and III.4)
- Applications and outreach (NEHRP components IV.1 and IV.2)

The listing includes projects conducted by the USGS directly, these projects are identified under the heading "INTERNAL" and are organized by the branch of the project chief. Work being done by non-USGS investigators is listed under the heading "EXTERNAL". Note that projects in the Pacific Northwest funded by other NEHRP agencies—the Federal Emergency Management Agency (FEMA), the National Science Foundation (NSF), and the National Institute of Standards and Technology (NIST) are not included.

Each listing contains the following information:

1. Project or grant title.
2. Project chief or principal investigator.
3. Address of project chief or principal investigator.
4. Telephone number (and for most investigators a fax number).
5. Study area.
6. Component (refers to NEHRP planning components listed on following page).
7. Objective of work (usually taken from proposal abstrasts or summaries).

OUTLINE OF USGS NEHRP ELEMENTS

General programmatic guidance for USGS NEHRP activities in the Pacific Northwest is contained in *U.S. Geological Survey Circulars 1067 and 1079,* published in 1991 and 1992, respectively. Program elements listed in here have been modified slightly to include a separate applications component (IV.1) in both the internal and external program announcements. Many of the projects listed above involve work in more than a single program component; the component listed under each project is where the majority of the effort is expected.

Element I. UNDERSTANDING THE EARTHQUAKE SOURCE

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

Component I.2: Develop quantitative models of the physics of earthquake processes.

Element II. EVALUATING EARTHQUAKE POTENTIAL

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

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

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

Component II.4: Characterize the earthquake potential of the United States on a regional and national basis.

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

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

Component II.7: Conduct intensified monitoring experiments in selected regions of high seismic potential.

Component II.8: Develop and evaluate short- and intermediate-term earthquake prediction methods.

Element III. PREDICTING THE EFFECTS OF EARTHQUAKES

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

Component III.2: Predict strong ground shaking.

Component III.3: Predict ground failure.

Component III.4: Evaluate earthquake hazards and losses.

Element IV. APPLICATIONS AND UTILIZING RESEARCH RESULTS

Component IV.1: Application of research results.

Component IV.2: Transfer hazards information and assessment methods to users.

PROJECT LIST

Category: Paleoseismic Studies (Uplift and Submergence)

INTERNAL

Branch: Alaska Geology

Project Title: Alaska Geologic Earthquake Hazards
Project Chief: George Plafker
Address: U.S. Geological Survey
MS 904
345 Middlefield Road
Menlo Park, CA 94025
Phone: 415-329-5689
Fax: 415-329-5134
Study Area: Southern Alaska
Component: II.5
Objective: Using geologic field investigations, this project will determine the characteristics and dates of past earthquakes as well as the nature and rates of long-term interseismic crustal deformation in the Yakataga area of southern Alaska. This work will take advantage of recent clear-cut logging in the Yakataga area.

Branch: Earthquake and Landslide Hazards

Project Title: Puget Sound Paleoseismology
Project Chief: Bob Bucknam
Address: U.S. Geological Survey
MS 966, Box 25046
Denver Federal Center
Denver, CO 80225
Phone: 303-273-8566
Fax: 303-273-8600
Component: II.5
Study Area: Northwestern Washington, primarily Puget Sound basin
Objective: The primary objective of this project is to document and characterize Holocene deformation in the Puget Sound, Washington, region and develop an understanding of the structural and tectonic origin of this deformation.

Project Title: Paleoseismology of Coastal Oregon
Project Chief: Alan Nelson
Address: U.S. Geological Survey
MS 966, Box 25046
Denver Federal Center
Denver, CO 80225
Phone: 303-273-8592
Fax: 303-273-8600
Component: II.5
Study Area: Coastal Oregon, primarily southern coast
Objective: The primary objective of this project is to determine the magnitude and recurrence

of great earthquakes of the past 4000 years in the Cascadia subduction zone. The work in FY94 is concentrating on determining if there are tsunami deposits from the event proposed about A.D. 1700.

Project Title: Paleoseismic Liquefaction Studies
Project Chief: Steve Obermeier
Address: U.S. Geological Survey
MS 922, National Center
Reston, VA 22092
Phone: 703-648-6791
Fax: 703-648-6908
Component: II.5
Study Area: Northwestern Oregon, focused on Portland and Columbia River.
Objective: The objective of this project is to search for paleoliquefaction evidence, primarily along the Columbia River from Portland to the coast, and use the distribution and type of features observed to infer the strength of shaking that produced the liquefaction.

Branch: Western Regional Geology

Project Title: Prehistoric Earthquakes in Western Washington State
Project Chief: Brian Atwater
Address: U.S. Geological Survey
University of Washington, AJ-20
Seattle, WA 98195
Phone: 206-553-2927
Fax: 206-553-8350
Component: II.5
Study Area: Western Washington, mostly along the coast
Objective: This project is attempting to hone our existing knowledge of Cascadia subduction zone earthquakes. The project continues to concentrate on three aspects of this problem: recurrence, magnitude, and intensity of shaking. For FY94 work will be expanded along the northern Washington coast and outreach efforts will be directed largely toward reducing tsunami risks along the Pacific coast of Washington.

EXTERNAL

Institution: Columbia University, Lamont-Doherty Earth Observatory

Project Title: Tree-Ring Dating of Coseismic Coastal Subsidence in the Pacific Northwest
Principal: Gordon Jacoby
Address: Lamont-Doherty Earth Observatory
Box 20, Low Memorial Library
New York, NY 10027
Phone: 914-365-8616
Fax: 914-365-3046
Component: II.5
Study Area: Selected Cascadia coastal areas
Objective: This project uses high-precision dating techniques to determine the year and even the season of damage or death to a tree. These techniques will be used to

determine if sample trees died by a sudden submergence event or died over many years; the former would suggest a seismic origin for the submergence whereas the latter suggests some gradual geologic or eustatic change. Crossdating techniques will be applied to living tree samples from the Columbia River and trees killed by the most recent Cascadia events to establish a calendar date for the tree death.

Institution: University of Connecticut

Project Title: Postglacial Offset along the Seattle Fault
Principal: Robert Thorson
Address: University of Connecticut
Department of Geology and Geophysics
(U-45) 354 Mansfield Avenue
Storrs, CT 06269
Phone: 203-486-5449
Fax: 203-486-1383
Component: II.5
Study Area: Northwestern Washington, central Puget Sound basin
Objective: The objective of this work is to examine glaciolacustrine strandline features formed during the withdrawal of the Cordilleran Ice Sheet to extend the record of uplift in the vicinity of the Seattle fault back about 14,000 years. These studies will provide a check on the validity of uplift reconstructions based on late Holocene wave-cut platforms and tidal marsh deposits and expand the understanding of neotectonic deformation in the Puget Sound basin.

Institution: University of Durham

Project Title: A Litho- and Biostratigraphic Evaluation of the Evidence for Coseismic Subsidence and Interseismic Strain Accumulation in the Washington and Oregon Part of the Cascadia Subduction Zone
Principal: Ian Shennan
Address: University of Durham
Environmental Research Centre Science Laboratories
South Road
Durham DH1 3LE
United Kingdom
Phone: 011-44-91-374-2484
Component: II.5
Study Area: Coastal Oregon and Washington
Objective: This project is examining the importance of local and regional processes reflected in the stratigraphic sequences at three sites along the coast. The work is attempting to test at three sites the validity of models of interseismic crustal movements through an analysis of the nature of paleoenvironmental vegetation succession and sedimentation. The work seeks to determine criteria that will allow coseismic peat/mud couplets to be distinguished from those unrelated to the seismic cycle.

Category: Regional Geologic, Tectonic and Structural Studies

INTERNAL

Branch: Alaska Geology

Project Title: Paleoseismicity of the Castle Mountain Fault System
Project Chief: Peter J. Haeussler
Address: U.S. Geological Survey
4200 University Drive
Anchorage, AK 99508
Phone: 907-786-7447
Fax: 907-786-7050
Component: II.5
Study Area: Southern Alaska, Anchorage area
Objective: The Castle Mountain fault is located near half of the population of Alaska, yet has had only preliminary reconnaissance-style investigations. This project will expand the reconnaissance and develop a plan for systematic mapping and trenching of critical areas.

Branch: Earthquake Geology and Geophysics

Project Title: Experimental Rock Mechanics
Project Chief: Steve Kirby
Address: U.S. Geological Survey
MS 977
345 Middlefield Rd.
Menlo Park, CA 94025
Phone: 415-329-4847
Fax: 415-329-5163
Component: I.1
Study Area: Cascadia Benioff Zone
Objective: This project focuses on the thermal and stress states for young, thermally-immature subducting plates such as the Juan de Fuca plate in Cascadia. The experimental results from this project offer constraints on modeling studies of Denlinger on the deformation of the subducting Juan de Fuca plate. The objective of this work is to understand the physical processes that control Benioff zone earthquakes (events like the 1949 magnitude 7.1 earthquake near Olympia, Washington) and provide a refined estimate of the hazards these events pose along the entire length of the Cascadia subduction zone.

Branch: Earthquake and Landslide Hazards

Project Title: Paleoseismicity of the Olympic-Wallowa lineament, northeastern Oregon and western Idaho
Project Chief: Steve Personius
Address: U.S. Geological Survey
MS 966, Box 25046
Denver Federal Center
Denver, CO 80225
Phone: 303-273-8611
Fax: 303-273-8600

Component: II.5
Study Area: Northeastern Oregon
Objective: This project is focusing on the paleoseismicity of the southeastern end of the Olympic-Wallowa lineament. This is a complex zone of strike-slip and normal faults; problems to be studied include the style, age, size and patterns of recurrence of surface-rupturing earthquakes on structures that show probable Quaternary or younger movement. The project is a collaboration with the National Geologic Mapping program.

Project Title: Geophysical Characteristics of the Seismically Active Puget Sound Region
Project Chief: Tom Pratt
Address: U.S. Geological Survey
MS 966, Box 25046
Denver Federal Center
Denver, CO 80225
Phone: 303-273-8606
Fax: 303-273-8600
Component: II.1
Study Area: Northwestern Washington, primarily Puget Sound basin
Objective: The project is using seismic reflection data purchased from industry sources to study seismically active structures in Puget Sound. For FY94 the emphasis will be on interpreting the newly acquired data and integrating these results with interpretations of potential field data and models of these data. The Seattle fault is the initial focus of the work.

Branch: Geophysics

Project Title: High-Resolution Geophysical Studies of the Portland Basin
Project Chief: Rick Blakely
Address: U.S. Geological Survey
MS 989
345 Middlefield Road
Menlo Park, CA 94025
Phone: 415-329-5316
Fax: 415-329-5133
Component: I.1
Study Area: Northwestern Oregon, primarily greater Portland area
Objective: This project will acquire low-altitude, high-resolution aeromagnetic data south of the Portland metropolitan area in order to study the upper crustal structure of the epicentral region of the March 25, 1993 Scotts Mills earthquake. Aeromagnetic surveys have proven to be dramatically successful in defining the Portland Hills fault (parallel to the Willamette River in downtown Portland); this project will examine the relation of aeromagnetically-defined structures near Scotts Mills to mapped faults in the region.

Project Title: Aeromagnetic and Gravity Characteristics of the Seismically Active Puget Sound Region
Project Chief: Carol Finn
Address: U.S. Geological Survey
MS 966, Box 25046
Denver Federal Center
Denver, CO 80225
Phone: 303-236-1345
Fax: 303-236-1425
Component: I.1
Study Area: Northwestern Washington, primarily Puget Sound
Objective: Gravity, magnetic and seismic-reflection data are being integrated to study selected structures and the regional tectonic setting in the Puget Sound area. Potential field data will be compiled and quantitatively analyzed and then compared with seismicity and areas of known Quaternary deformation.

Branch: Pacific Marine Geology

Project Title: Tectonic Framework and Seismic Potential of the Southern Cascade Subduction Zone
Project Chief: Sam Clarke
Address: U.S. Geological Survey
MS 999
345 Middlefield Road
Menlo Park, CA 94025
Phone: 415-354-3091
Fax: 415-354-3191
Component: II.1
Study Area: Southern Cascadia offshore
Objective: This project involves the collection and interpretation of a wide spectrum of marine geophysical data from the previously little-studied areas from the Cape Mendocino, California area northward along the Pacific coast to central Oregon. The two-fold objectives of this work are to enhance the understanding of the deformation processes related to the Mendocino triple junction and to determine the shallow-to-deep structure of the Gorda plate portion of Cascadia.

Branch: Sedimentary Processes

Project Title: Cenozoic Tectonic and Paleogeographic Evolution, Puget Lowland Seismic Zone, Washington
Project Chief: Sam Johnson
Address: U.S. Geological Survey
MS 939, Box 25046
Denver Federal Center
Denver, CO 80225
Phone: 303-236-1545
Fax: 303-236-0459
Component: II.5
Study Area: Northwestern Washington, primarily Puget Sound
Objective: This project seeks to define the Cenozoic geologic framework that influences the modern seismotectonic environment of northwestern Washington. Partly funded

by NEHRP, work in FY94 will be concentrated on completing a detailed analysis of the South Widbey Island fault zone and producing a geologic and geophysical transect through Puget Sound from the Canadian border to Olympia.

Branch: Seismology

Project Title: Crustal Velocity Structure and Ground Response in the Pacific Northwest–Coast Ranges through Cascades

Project Chief: James Luetgert
Address: U.S. Geological Survey
MS 977
345 Middlefield Road
Menlo Park, CA 94025
Phone: 415-329-4763
Fax: 415-329-5163

Component: II.2
Study Area: Western Oregon and Western Washington
Objective: This project collects and analyzes seismic refraction and wide-angle reflection data. These data, in consort with geological and geophysical potential field data will be developed into a model of the seismic velocity and attenuation structure of the crust and upper mantle in this region. Of particular interest is evidence for the breaking of Siletzia, a largely Eocene marine volcanic complex, into smaller blocks that influence contemporary seismotectonics.

Project Title: Wide-Angle Seismic Reflection/Refraction Recording at Cape Blanco, Southern Oregon

Project Chief: Tom Brocher
Address: U.S. Geological Survey
MS 977
345 Middlefield Road
Menlo Park, CA 94025
Phone: 415-329-4737
Fax: 415-329-5163

Component: II.1
Study Area: Southern Oregon
Objective: This project involves the collection and interpretation of wide-angle seismic data along lines near Cape Blanco, Oregon. These wide-angle seismic data are expected to image reflectors in the upper to lower crust of the North American plate, provide crustal and upper mantle refractions, and provide constraints on the geometry of the subducted Gorda plate along the seismic lines. Currently, there is no seismic data available to constrain the location of the Gorda plate near Cape Blanco.

Branch: Volcanic and Geothermal Processes

Project Title: Mechanics of Volcano-Tectonic Processes
Project Chief: Roger Denlinger
Address: U.S. Geological Survey
Hawaiian Volcano Observatory
PO Box 51
Hawaii National Park, HI 96718
Phone: 808-967-8825
Fax: 808-967-8890
Component: I.2
Study Area: Cascadia Benioff zone
Objective: This project is a collaboration with several laboratory projects to use results from these experiments on material properties of rocks found at depth to provide constraints on numerical models of the deformation of subducting slabs. Together, the laboratory and modeling work is attempting to explain the distribution of Benioff zone earthquakes observed in Cascadia.

Project Title: Regional Geologic Studies in the vicinity of Klamath Falls, Oregon
Project Chief: Dave Sherrod
Address: U.S. Geological Survey
5400 MacArthur Blvd.
Vancouver, WA 98661
Phone: 206-696-7995
Fax: 206-696-7866
Component: II.5
Study Area: Southern Oregon
Objective: This project is addressing the relation between mapped faults of Quaternary or younger age and the continuing seismicity initiated with the events of September 21, 1993, including earthquakes of magnitude 5.9 and 6.0. The earthquake sequence occurred about 25 km northwest of Klamath Falls in an area with many mapped faults.

Project Title: Geologic Map of the French Butte-Stonewall Ridge area, Southern Washington Cascades
Project Chief: Don Swanson
Address: U.S. Geological Survey
Department of Geological Sciences, AJ-20
University of Washington
Seattle, WA 98195
Phone: 206-553-5587
Fax: 206-553-5587
Component: II.5
Study Area: Southwestern Washington
Objective: This project addresses the geologic evidence for or against seismogenic faults within the Southern Washington Cascade Conductor (SWCC). Seismicity is well-recognized along the boundary of much of the SWCC, and models have been developed that treat the SWCC as a rigid body in the crust. The mapping and structural study in this project seeks to determine the strain history in the area above the SWCC.

Branch: Western Regional Geology

Project Title: Pacific Northwest Urban Corridor 100K Geologic Maps and Synthesis
Project Chief: Ray Wells
Address: U.S. Geological Survey
MS 975
345 Middlefield Rd.
Menlo Park, CA 94025
Phone: 415-329-4933
Fax: 415-329-4936
Component: II.5
Study Area: Western Oregon and Western Washington
Objective: This project is responsible for coordinating and producing a series of geologic maps in the urban corridor of Oregon and Washington; most of the funding is from the National Geologic Mapping program. Limited funds from NEHRP support some of these mapping products and allow the honing of a rotating seismotectonic block model for the Oregon and Washington convergent margin.

EXTERNAL

Institution: Harvard College

Project Title: Integrated Approach to Earthquake Hazard Assessment of a Subduction Segment: A Case Study of the Shumagin Islands Region, Alaska
Principal: James Rice
Address: Harvard College
Department of Earth and Planetary Science
Cambridge, MA 02138
Phone: 617-495-3445
Fax: 617-495-9837
Component: II.2
Study Area: Alaska (Shumagin Islands region)
Objective: This project is seeking to resolve seemingly contradictory evidence concerning the seismic potential of the Shumagin Islands segment of the Alaskan subduction zone. These differences arise from predictions stemming from seismic history that suggest a classic locked section of a subduction zone and from geodetic observations that have been interpreted to show a lack of stress accumulation. Modeling efforts in FY94 will examine alternative assumptions on the location of fault zone asperities, and attempt to compare model predictions with observations.

Institution: Oregon State University

Project Title: Thermal Modeling of the Cascadia Subduction Zone
Principal: John Chen
Address: Oregon State University
College of Oceanography
Corvallis, OR 97331
Phone: 503-737-0500
Fax: 503-737-2064
Component: I.2
Study Area: Cascadia, primarily Oregon margin

Objective: This study is developing a thermal model of the subducting Juan de Fuca plate system, emphasizing the effect that the thermal state may have on coupling with the overlying North American plate. A main objective is to estimate the strength along the contact zone between the subducting slab and the overriding plate and the extent of the locked zone consistent with the derived thermal model.

Project Title: Cascadia Subduction Zone: Neotectonics of the Continental Shelf off Oregon and Washington
Principal: LaVerne Kulm
Address: Oregon State University
College of Oceanography
Corvallis, OR 97331
Phone: 503-737-5211
Fax: 503-737-2064
Component: II.5
Study Area: Cascadia, Oregon and Washington margin
Objective: The objective of this study is to characterize and determine the timing of deformational events in the subducting Juan de Fuca plate, accretionary wedge, and forearc basins of the Cascadia convergence zone off Oregon and Washington. The study is investigating the shelf folds and faults to determine if these structures represent an independent seismic hazard to the coastal regions.

Project Title: Analysis of the Aftershock Sequence of the Mount Angel Earthquake
Principal: John Nabelek
Address: Oregon State University
College of Oceanography
Corvallis, OR 97331
Phone: 503-737-2757
Fax: 503-737-2064
Component: I.2
Study Area: Northwestern Oregon
Objective: This project, a collaborative effort with Doug Toomey at the University of Oregon, is studying the relationship of seismicity and source parameters of the aftershocks of the Scotts Mills earthquake to the location, geometry, and style of deformation of the Mount Angel fault. The Mount Angel fault is close to, but possibly separate, from the location of the aftershocks.

Project Title: Toward Routine Moment Tensor Determinations in the Pacific Northwest
Principal: John Nabelek
Address: Oregon State University
College of Oceanography
Corvallis, OR 97331
Phone: 503-737-2757
Fax: 503-737-2064
Component: I.2
Study Area: Western Oregon and Western Washington
Objective: The objective of this project is to develop a robust procedure for determining earthquake source parameters, including source mechanism (from moment tensors), seismic moment and source depth from the inversion of broadband

waveforms for all earthquakes within the region and of magnitude 3.5 or greater. An understanding of the effects of propagation paths, one of the major limitations in implementing moment tensor inversions, is a focus of study for FY94.

Project Title: Crustal Structure beneath the Northern Oregon Coast Range and Willamette Lowlands
Principal: Anne Trehu
Address: Oregon State University
College of Oceanography
Corvallis, OR 97331
Phone: 503-737-2655
Fax: 503-737-2064
Component: II.1
Study Area: Northwestern Oregon and Southwestern Washington
Objective: This project is determining the crustal structure of the Cascadia subduction zone in western Oregon. Previous work has shown that the crust is significantly different beneath western Oregon, with a very thick (at least 25 km) section of Eocene marine volcanics present, than beneath the well-studied Lithoprobe corridor across Vancouver Island. Work planned for FY94 will constrain the details of the lower crust.

Institution: Pacific Geoscience Centre

Project Title: The Megathrust Earthquake Potential of the Cascadia Margin: A Multidisciplinary Analysis
Principal: Roy Hyndman
Address: Pacific Geoscience Centre
P.O. Box 6000
Sidney, B.C. V8L 4B2
Canada
Phone: 604-363-6428
Fax: 604-363-6565
Component: I.2
Study Area: Cascadia subduction zone
Objective: This study will be using existing thermal data to model the thermal regime and the thermal constraints to the locked portion of the Cascadia subduction zone on a series of profiles across the margins of Washington and Oregon. These profiles will define spatial variations along the margin and provide for a comparison of extent of the locked zone determined from thermal data with that inferred from deformation data. To help calibrate the results in Cascadia, similar profiles will be constructed across the Nankai margin of Japan, where the additional constraint of estimates of the portion of the megathrust that failed during recorded earthquakes is available.

Firm: Shannon and Wilson, Inc.

Project Title: Quaternary Evidence for and Recurrence Interval of Movement on the Eastern Side of the Seattle Fault, Washington
Principal: Daniel Clayton
Address: Shannon and Wilson, Inc.
400 N. 34th St., Suite 100

Seattle, WA. 98109
Phone: 206-632-8020
Fax: 206-633-6777
Component: II.5
Study Area: Northwestern Washington, Puget Sound basin
Objective: This study is focused on the Seattle fault, a major crustal fault that strikes east-west through the highly urbanized central Puget Sound basin. The study will compile and analyze the extensive existing subsurface and surface data that exist in the vicinity of the fault. The main objective of these studies is to improve the existing understanding of the lateral extent of Quaternary deformation on the Seattle fault, determine if there is evidence of past surface rupture along the fault, and examine the recurrence of events on this structure.

Institution: University of California, Santa Cruz

Project Title: Seismological Investigations and Tectonic Interpretation of the April 1992 Cape Mendocino Earthquake Sequence
Principal: Susan Schwartz
Address: University of California
1156 High St.
Santa Cruz, CA 95064
Phone: 408-459-3133
Fax: 408-459-2127
Component: II.2
Study Area: Cape Mendocino, California
Objective: The objective of this work is to provide a better understanding of the complicated tectonics and earthquake hazard near the Cape Mendocino triple junction. The work will focus on analyzing a variety of records (long-period surface waves, teleseismic P and S waves, local strong motion) written by the main shock and two largest aftershocks in this sequence; source parameters for many hundreds of aftershocks will be calculated from both temporary and permanent stations that recorded the sequence. These results will be incorporated into a improved tectonic model.

Institution: University of Michigan

Project Title: Earthquake Source Process and Tsunami Generation in Aleutian-Alaska-Cascadia
Principal: Kenji Satake
Address: University of Michigan
Department of Geological Sciences
Ann Arbor, MI 48109
Phone: 313-763-9301
Component: I.1
Study Area: Alaska (including Aleutians) and Cascadia subduction zones
Objective: This work is using tsunami modeling to estimate the source areas for large earthquakes in the Alaskan and Aleutian subduction zones as well as for selected events near the Alaskan corner (Gulf of Alaska and St. Elias events) and along the Queen Charlotte fault. The results of these studies will be applied to Cascadia, where no data is available from large earthquakes, to estimate fault parameters for subduction zone events.

Institution: University of Nevada, Reno

Project Title: Paleoseismicity of the Puget Sound Area from Geological and Geophysical Studies of Lake Washington and Other Lakes in the Region
Principal: Robert Karlin
Address: University of Nevada, Reno
Geological Sciences
Mackay School of Mines/ 168
Reno, NV 89557
Phone: 702-784-1770
Fax: 702-784-1766
Component: II.5
Study Area: Northwestern Washington, central Puget Sound basin
Objective: This work is analyzing sediments in Lake Washington in an effort to use the history to determine if evidence exists that suggests strong shaking altered this history. Emphasis for FY94 is on honing the timing of the stratigraphy through collection of some additional lake cores and dating of these and some existing cores.

Institution: University of Oregon

Project Title: Analysis of the Aftershock Sequence of the Mount Angel Earthquake
Principal: Doug Toomey
Address: University of Oregon
Department of Geological Sciences
Eugene, OR 97403
Phone: 503-346-5576
Fax: 503-346-4692
Component: I.2
Study Area: Northwestern Oregon
Objective: This project, a collaborative effort with John Nabelek at Oregon State University, is studying the relationship of seismicity and source parameters of the aftershocks of the Scotts Mills earthquake to the location, geometry, and style of deformation of the Mount Angel fault. The Mount Angel fault is close to, but possibly distinct, from the location of the aftershocks.

Institution: University of Washington

Project Title: Earthquake Hazard Research in the Pacific Northwest using Washington Regional Seismic Data
Principal: Robert Crosson
Address: University of Washington
Geophysics Program AK-50
Seattle, WA 98195
Phone: 206-543-6505
Fax: 206-543-0479
Component: II.2
Study Area: Western Oregon and Western Washington
Objective: This objectives of this project are to provide a understanding of the structural and tectonic framework of the Cascadia subduction zone in order to increase the understanding of the origin and significance of earthquake hazards in this region. Work in this investigation for FY94 is focused on seismicity studies related to the

Scotts Mills, Oregon earthquake and its aftershock sequence and lithospheric structural studies using teleseismic, earthquakes, active experimental observations, and teleseismic receiver functions.

Project Title: Three Dimensional Modeling of Crustal Deformation in the Cascadia Subduction Zone
Principal: Mark Richards
Address: University of Washington
Geophysics Program AK-50
Seattle, WA 98195
Phone: 206-543-6674
Fax: 206-543-0479
Component: II.3
Study Area: Northern Cascadia
Objective: This project will develop 3-dimensional finite element models of deformation in the Cascadia subduction zone. The 3-d nature of these models will provide a much better representation of the geometrical complexities observed in the northern portion of Cascadia (from about central Oregon to Vancouver Island). The results from this modeling will provide insight into the effect of lateral variations in the strike of the deformation front or the dip of the subducting Juan de Fuca plate has on observed upper plate deformation.

Firm: Michael W. West & Associates, Inc.

Project Title: A "Pilot" Study of Quaternary Surface Deformation, Saddle Mountains Anticline, Northern Pasco Basin, Washington
Principal: Michael West
Address: Michael W. West & Associates, Inc..
290 Bank Western Building
8906 West Bowles Avenue
Littleton, CO 80123
Phone: 303-972-1537
Fax: 303-972-1549
Component: II.5
Study Area: Southeastern Washington, Pasco Basin
Objective: This study is designed to resolve existing controversy regarding the evidence for late Quaternary deformation along the north flank of the Saddle Mountains anticline. There are three major issues: 1) is late Quaternary deformation present, 2) if so, is the deformation tectonic (coseismic folding or faulting) or non-tectonic (landsliding), and, 3) if the deformation is tectonic what are the implications for seismic hazard and risk assessments in southeastern Washington. The proposed deformation features will be evaluated by a combination of surface geologic mapping and trenching.

Institution: Yakima Indian Nation

Project Title: Earthquake Study in the Vicinity of Toppenish Basin, South-Central Washington
Principal: Tom Ring
Address: Yakima Indian Nation
P.O. Box 151
Toppenish, WA. 98948

Phone: 509-877-6121
Fax: 509-877-6907
Component: II.5
Study Area: Southeastern Washington
Objective: The Toppenish Ridge scarps are part of a major fault system and previous work has shown that the structure has moved recently. The primary objective of this study is determine the timing and nature of the movement of the scarps on Toppenish Ridge fault system, to estimate if the system could produce a major (magnitude 7 or greater) shallow crustal earthquake, and to examine faulting on Ahtanum Ridge in light of findings on Toppenish Ridge.

Category: Seismic Network and Geodetic Studies

INTERNAL

Branch: Earthquake Geology and Geophysics

Project Title: Crustal Strain
Project Chief: Mike Lisowski
Address: U.S. Geological Survey
MS 977
345 Middlefield Rd.
Menlo Park, CA 94025
Phone: 415-329-4855
Fax: 415-326-4717
Component: II.3
Study Area: Entire Cascadia region
Objective: This project establishes, monitors, and analyzes geodetic data collected across all of Cascadia. In FY94 resurveys are planned in the Cape Mendocino region, the central Puget Sound basin, and northwestern Oregon. The existing network will be expanded across northernmost California from the Cape Mendocino area eastward to Mount Shasta and Lassen Peak. Modeling efforts will focus on distributed slip models of the 1992 Mendocino earthquake and on producing the first unified estimates of horizontal strain accumulation in southwestern Oregon.

Project Title: Coseismic and Long-Term Deformation of Southern Juan de Fuca Plate Subduction
Project Chief: Ross Stein
Address: U.S. Geological Survey
MS 977
345 Middlefield Rd.
Menlo Park, CA 94025
Phone: 415-329-4840
Fax: 415-329-5143
Component: II.3
Study Area: Cape Mendocino triple junction
Objective: This project is attempting to infer the fault geometry of the 1992 Cape Mendocino earthquake from geodetic and coastal-uplift observations. The study will use digital bathemetry to search for offshore faulting, folding, or slumping that could be associated with past events on this fault. Finally, the study hopes to determine a repeat time for characteristic earthquakes and to learn whether earthquakes in adjacent areas have contributed to the long-term deformation in this region.

Branch: Earthquake and Geomagnetic Information

Project Title: Use of Navy Hydrophone Data to Monitor Seismicity off the Coast of the Pacific Northwest
Project Chief: Eric Bergman
Address: U.S. Geological Survey
MS 967, Box 25046
Denver Federal Center
Denver, CO 80225

Phone: 303-273-8421
Fax: 303-273-8450
Component: II.2
Study Area: Offshore Cascadia
Objective: The U.S. Navy's SOSUS system, composed of fixed hydrophone arrays, is used to monitor seismicity off the coast of the Pacific Northwest. These data, formerly classified, are now being made available to researchers. This project will develop a pilot study to examine the usefulness of these data for studying the relation of offshore seismicity to known geological structures and for identifying seismically active structures not previously recognized.

Branch: Seismology

Project Title: Alaska Seismic Studies
Project Chief: John Lahr
Address: U.S. Geological Survey
Geophysical Institute
University of Alaska
Fairbanks, AK 99775
Phone: 907-474-7997
Fax: 907-474-5618
Component: II.2
Study Area: Southern and Central Alaska
Objective: The primary objective of this project is to build a sound seismological basis for assessing the long-term and intermediate-term earthquake potential of Alaska, primarily southern Alaska, through the collection and analysis of data from a sparse regional network. The operation of the regional seismic network involves a cooperative effort with the University of Alaska Geophysical Institute. Most of the research topics under study that use data from the Alaska network have analogs in Cascadia.

Project Title: Pacific Northwest Seismotectonics
Project Chief: Craig Weaver
Address: U.S. Geological Survey
Geophysics Program, AK-50
University of Washington
Seattle, WA 98195
Phone: 206-553-0627
Fax: 206-553-8350
Component: II.2
Study Area: Entire Cascadia region (focused in FY94 on Puget Sound, Mount Rainier, Klamath Falls, and northern California)
Objective: This project partly supports the Pacific Northwest Regional Seismic network operated by the University of Washington, and conducts research aimed at developing an understanding of the seismotectonic setting that help improve assessments of geologic hazards in the region. Research focus for FY94 is on completing a model of block tectonics for the forearc region of western Oregon and Washington (with Ray Wells), documenting the seismicity pattern from the Klamath Falls earthquake sequence (with Tony Qamar of UW), and completing a study of earthquake swarms and regional seismicity near Lassen Peak.

Branch: Volcanic and Geothermal Processes

Project Title: Physical Processes in Large Silicic Magma Systems
Project Chief: Dan Dzurisin
Address: U.S. Geological Survey
5400 MacArthur Blvd.
Vancouver, WA 98661
Phone: 206-696-7826
Fax: 206-696-7866
Component: II.3
Study Area: Northwestern Oregon and Southwestern Washington
Objective: This project collaborates with the Crustal Strain project of Lisowski and efforts of regional university groups to continue to expand and monitor the GPS network in the Pacific Northwest. In FY94 data collection in this project will concentrate on establishing additional GPS coverage in the Seattle-Mount Rainier area and re-surveying and linking together existing GPS networks in northwestern Oregon.

EXTERNAL

Institution: Columbia University, Lamont-Doherty Earth Observatory

Project Title: Crustal Deformation Measurements in the Shumagin Seismic Gap, Alaska
Principal: John Beavan
Address: Lamont-Doherty Earth Observatory
Box 20, Low Memorial Library
New York, NY 10027
Phone: 914-365-8882
Fax: 914-365-3046
Component: II.3
Study Area: Alaska, Shumagin Islands
Objective: This project provides a number of deformation measurements in the Shumagin Islands, located at the southwestern end of the Alaskan Peninsula. Available deformation data span 19 years; these data include geodetic leveling, GPS surveys, and sea level observations. The deformation data are being used to attempt to resolve the controversy surrounding the seismic hazard in this section of the Alaskan subduction zone. Some models explain the deformation data as compatible with aseismic slip on the subduction thrust surface, whereas other models with a locked interface are also claimed to fit the data. Continued analysis of existing data is the focus for FY94.

EXTERNAL (Regional Network Operations)

Institution: University of Alaska, Fairbanks

Title: Support for Southern Alaska Regional Seismic Network
Principal: Max Wyss
Address: University of Alaska, Fairbanks
Geophysical Institute
Fairbanks, AK 99775
Phone: 907-474-5529
Fax: 907-474-5618
Component: II.2

Study Area: Southern Alaska
Objective: This project will provide partial support to the joint University of Alaska, Fairbanks-USGS southern Alaska seismic network. The operational support from these funds provide partial support for field maintenance and replacement of existing stations, telemetry costs associated with transmitting the data to Fairbanks, routine analysis of the data, and publication of seismic catalogs. Additional internal NEHRP support for the operation of the southern Alaska seismic network is through Lahr's project.

Institution: University of Washington
Title: Washington Regional Seismic Network Operations
Principal: Steve Malone
Address: University of Washington
Geophysics Program AK-50
Seattle, WA 98195
Phone: 206-685-3811
Fax: 206-543-0489
Component: II.2
Study Area: Oregon and Washington
Objective: This project operates the regional seismic network in Oregon and Washington. About 130 short-period seismic stations, several 3-component short-period stations, and a five 3-component broadband stations are included in the network. The external portion of NEHRP provides a portion of the total operational costs (the US Department of Energy, the USGS Volcano program, and the USGS internal NEHRP efforts through Weaver's project are the other major funding sources). The operational support from these sources provide for field maintenance and replacement of existing stations, telemetry costs associated in transmitting the data to Seattle, routine analysis of the data, publication of seismic catalogs, and funding for a public spokesperson. A portion of the external NEHRP funds are passed through to the University of Oregon to support field maintenance of seismic stations in the central Cascades and southern Oregon.

Category: Strong Ground Motion Studies

INTERNAL

Branch: Earthquake and Landslide Hazards

Project Title: Earthquake Source Parameters, Site Response, and 3-D Basin Effects in the Portland Region
Project Chief: Art Frankel
Address: U.S. Geological Survey
MS 966, Box 25046
Denver Federal Center
Denver, CO 80225
Phone: 303-273-8556
Fax: 303-273-8600
Component: III.2
Study Area: Northwestern Oregon
Objective: This project is examining the seismograms of the Scotts Mills, Oregon earthquake. The strong motion data of the mainshock will be analyzed to determine source parameters (seismic moment, source dimension, stress drop) and propagation effects. These results will be used to characterize the site response and crustal attenuation for the Willamette Valley, parameters needed to predict future ground motions.

Project Title: Reassessment of Seismic Sources and their Earthquake Recurrence Rates for Use Probabilistic Ground Motion Mapping in the Pacific Northwest
Project Chief: David Perkins
Address: U.S. Geological Survey
MS 966, Box 25046
Denver Federal Center
Denver, CO 80225
Phone: 303-273-8554
Fax: 303-273-8600
Component: III.4
Study Area: Oregon and Washington
Objective: This project is using the current understanding of seismic source zones and source faults in Oregon and Washington to provide improved inputs to the national probabilistic ground motion hazard maps. Seismic recurrence rates will be estimated from historical seismicity or paleoseismic information when available.

Branch: Seismology

Project Title: Earthquake Source Parameters, Site Response, and 3-D Basin Effects in the Portland Region
Project Chief: Leif Wennerberg
Address: U.S. Geological Survey
MS 977
345 Middlefield Rd.
Menlo Park, CA 94025
Phone: 415-329-5659
Fax: 415-329-5163

Component: III.2
Study Area: Northwestern Oregon, primarily Portland and northern Willamette valley
Objective: This project is examining the seismograms of the Scotts Mills, Oregon earthquake. The strong motion data of the mainshock will be analyzed to determine source parameters (seismic moment, source dimension, stress drop) and propagation effects. These results will be used to characterize the site response and crustal attenuation for the Willamette Valley, parameters needed to predict future ground motions. This proposal is collaborative with that of Frankel.

EXTERNAL

Firm: Gail M. Atkinson

Project Title: Observed Ground Motion Characteristics of Earthquakes in the Pacific Northwest
Principal: Gail Atkinson
Address: Gail M. Atkinson
125 Dunbar Rd. S.
Waterloo, Ont. N2L 2E8
Canada
Phone: 519-741-0757
Fax: 519-741-0757
Component: III.2
Study Area: Northwestern Washington, Southwestern British Columbia
Objective: Using a collection of digital seismographic records from the Western Canada Telemetered Network, this study will investigate the average high-frequency stress drop of moderate magnitude earthquakes that have been recorded by stations on bedrock. Because these source parameters from smaller events are often used to construct estimates of ground motions from larger events, one of the expected results is a useful empirical base for future ground motion studies.

Firm: Maxwell Laboratories, S-CUBED Division

Project Title: Simulation of Strong Ground Motion from the Petrolia Earthquakes
Principal: Jeffery Stevens
Address: Maxwell Laboratories, S-CUBED Division
3398 Carmel Mountain Rd.
San Diego, CA 92121
Phone: 619-587-8442
Fax: 619-755-0474
Component: III.2
Study Area: Northern California (Cape Mendocino-Humboldt Bay area)
Objective: The excellent data set collected from the 1992 Petrolia earthquakes will be used to model these earthquakes and test how well methods employed in studying other earthquake sequences can be applied to the Petrolia events. These results will be used to estimate expected strong ground motion from a larger event in this area.

Firm: Risk Engineering

Project Title:	Effects of Long-Duration Motions from Subduction-Zone Earthquakes on Predicted Ground Motions
Principal:	Robert Sewell
Address:	Risk Engineering 4155 Darley Ave Suite 8 Boulder, CO. 80303
Phone:	303-499-3000
Fax:	303-499-4850
Component:	III.2
Study Area:	Cascadia forearc region
Objective:	This work is using an existing, extensive set of models and results to develop relations that predict, as a function of earthquake magnitude, distance, and soil type, the significant effects on motion characteristics of long-durations from subduction zone earthquakes. The study will offer suggestions as to how these results could be incorporated into seismic code provisions and seismic hazard assessments for the Pacific Northwest.

Firm: Woodward-Clyde Consultants

Project Title:	Simulating the 3-D Basin Response in the Portland and Puget Sound Regions from Large Subduction Zone Earthquakes
Principal:	Robert Graves
Address:	Woodward-Clyde Consultants Pasadena Office 566 El Dorado St. Pasadena, CA 91101
Phone:	818-449-7650
Fax:	818-449-3536
Component:	III.2
Study Area:	Northwestern Oregon (Portland area) and Northwestern Washington (Puget Sound)
Objective:	This project is investigating the effect of the presence of lateral variations in crustal structure on expected ground motions from subduction zone and crustal earthquakes. In the Pacific Northwest, the lateral variations of concern are the basins found in the Portland and Seattle urban areas. The project is honing seismic velocity models of these basins, developing different rupture scenarios, and testing the assumptions in these steps by using the strong motion data collected during Scotts Mills earthquake. Ground motion response and duration maps will be developed in the Portland and Puget Sound regions for each simulated event.

Category: Applications and Outreach

INTERNAL

Branch: Earthquake and Geomagnetic Information

Project Title: Earthquakes and Volcanoes
Project Chief: Dave Gordon
Address: U.S. Geological Survey
MS 967, Box 25046
Denver Federal Center
Denver, CO 80225
Phone: 303-273-8408
Fax: 303-273-8450
Component: IV.2
Study Area: National/International
Objective: The purpose of this project is to provide partial support for the publication of *Earthquakes and Volcanoes*. This publication appears bi-monthly and is intended to "...provide current information on earthquakes and seismology, volcanoes, and related natural hazards of interest to both generalized and specialized readers".

Branch: Earthquake and Landslide Hazards

Project Title: Drafting and Secretarial Support for Completion of Professional Paper 1560--Earthquake Hazards in the Pacific Northwest
Project Chief: Al Rogers
Address: U.S. Geological Survey
MS 966, Box 25046
Denver Federal Center
Denver, CO 80225
Phone: 303-273-8553
Fax: 303-273-8600
Component: IV.2
Study Area: Cascadia, although heavily focused on Portland and Seattle urban areas
Objective: The purpose of this project is to provide the necessary secretarial support needed to finish USGS Professional Paper 1560, *Assessing Earthquake Hazards and Reducing Risks in the Pacific Northwest*. The funding will be used to satisfy style requirements for USGS professional papers.

Project Title: Computer Graphics Laboratory
Project Chief: Art Tarr
Address: U.S. Geological Survey
MS 966, Box 25046
Denver Federal Center
Denver, CO 80225
Phone: 303-273-8570
Fax: 303-273-8600
Component: IV.1
Study Area: Northwestern Washington, primarily Puget Sound
Objective: This project provides direct graphics support to other researchers working in the Pacific Northwest; in addition to serving this function in FY94 this project will

produce a preliminary MF-map of seismic hazard and infrastructure at risk of parts of King County, Washington.

Branch: Seismology

Project Title: Earthquakes in America Film Project
Project Chief: Doug Prose
Address: U.S. Geological Survey
MS 977
345 Middlefield Rd.
Menlo Park, CA 94025
Phone: 415-329-5716
Fax: 415-329-5163
Component: IV.2
Study Area: National
Objective: This project will produce a one-hour, introductory-level, broadcast-quality "Educational Video Package" about earthquakes in America. The program will include the locations of major earthquake zones, causes for earthquakes and the hazards they pose, the risks to people and structures, and highlights of NEHRP risk reduction efforts.

Office: Earthquakes, Volcanoes, and Engineering

Project Title: Pacific Northwest Regional Coordination
Project Chief: Craig Weaver
Address: U.S. Geological Survey
Geophysics Program, AK-50
University of Washington
Seattle, WA 98195
Phone: 206-553-0627
Fax: 206-553-8350
Component: IV.2
Study Area: Cascadia, Alaska
Objective: This project provides funding to coordinate and direct NEHRP activities in the Pacific Northwest region (Cascadia and Alaska). Project funds are used to support projects and outreach efforts unanticipated during the normal proposal cycle. Outreach efforts planned for FY94 include a workshop on coastal tsunamis, a public meeting of all program investigators working in southwestern Washington, northwestern Oregon and along the Cascadia coast, and a discussion of the engineering implications of current liquefaction results and controversies.

EXTERNAL

Institution: Humboldt State University

Title: Regional Earthquake Hazard Maps for the Gorda Plate Section of the Cascadia Subduction Zone and Public Dissemination of Hazard Information
Principal: Lori Dengler
Address: Humboldt State University
Humboldt Earthquake Education Center
Arcata, CA 95521
Phone: 707-826-3115

Component: IV.2
Study Area: Northern California, Humboldt Bay area
Objective: This project plans to study the effectiveness of a newspaper insert, "On Shaky Ground", that was distributed in Sunday papers and by other means during May 1993. This study will give quantitative information on the effectiveness of this insert by comparing surveys taken before the magazine appeared with several taken at different intervals after the distribution of the insert. The post-distribution surveys will target the understanding of the simplified ground shaking map included in the center of the earthquake magazine.

Institution: Metro

Project Title: Model Land Use and Development Regulations for Mitigating Seismic Risks in the Portland Metropolitan Area
Principal: Gerald Uba
Address: Metro
600 NE Grand Avenue.
Portland, OR 97232
Phone: 503-797-1750
Fax: 503-797-1794
Component: IV.2
Study Area: Northwestern Oregon, Portland metropolitan area
Objective: This project is designed to result in proposed regulations, based on the relative earthquake hazard map of the Portland area being prepared by DOGAMI, that will guide land use development and redevelopment decisions in the Portland area. The project should also demonstrate how GIS can be used to enhance the application of geologic hazards maps by land use planners and other local officials.

Institution: Oregon Department of Geology and Mineral Industries

Project Title: Earthquake Intensity Maps, March 25, 1993, Scotts Mills Earthquake
Principal: Ian Madin
Address: DOGAMI
800 NE Oregon St.
Portland, OR 97232
Phone: 503-731-4100
Fax: 503-731-4066
Component: IV.1
Study Area: Northwestern Oregon and Southwestern Washington
Objective: This project will produce a detailed intensity map of the March 25, 1993 magnitude 5.7 Scotts Mills earthquake. Over 4000 intensity reports will be incorporated, and the data will be entered into a digital database. Isointensity maps will be produced at a 1:500,000 scale of the entire felt area of the earthquake and at a 1:100,000 scale of the Portland-Vancouver metropolitan area.

Institution: University of Washington

Title:	Urban Seismic Hazard Mapping Using Spatial Database Management Tools
Principal:	Earl Bell
Address:	University of Washington Department of Urban Design and Planning, JO-40 Seattle, WA 98195
Phone:	206-543-6641
Fax:	206-685-9597
Component:	IV.2
Study Area:	Northwestern Washington, Seattle
Objective:	The primary objective of this project is the production of an automated urban hazard mapping tool that incorporates observed Modified Mercalli intensities, mapped areas of potential liquefaction, observed faults, lifeline locations, population and building counts, that can be later extended to include detailed structural inventories and other spatial features pertinent to the hazard planning effort. The goal is to develop this tool using existing data for Seattle; presentation will be in the Windows desktop computing environment.

INFORMATION CONTACTS

Concerning the USGS NEHRP efforts in the Pacific Northwest:

Dr. Randy Updike
Coordinator, National Earthquake Hazards Reduction Program
Office of Earthquakes, Volcanoes and Engineering
U.S. Geological Survey
National Center, MS 905
Reston, Virginia 20092
703-648-6708

Dr. Craig Weaver
Regional Coordinator, Pacific Northwest
National Earthquake Hazards Reduction Program
U.S. Geological Survey
@ Geophysics Program AK-50
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