Fault Line Forum

Volume 14, Number 1 • 1998

Fault Studies Uncover More Utah Earthquakes

The Utah Geological Survey (UGS) studies active faults to determine the size and timing of past large earthquakes in Utah. The coming issue of UGS Survey Notes (v. 30, no. 3) contains summaries of several of these ongoing projects by Bill Black, Barry Solomon, and Bill Lund. Below are the highlights of the summaries. Please refer to the Survey Notes articles if you need more information.

West Cache fault zone

Three major active fault zones in and adjacent to Cache Valley pose a seismic risk to citizens living in Cache Valley and northern Utah. Studies to identify the size and timing of prehistoric earthquakes have been conducted for the Wasatch and East Cache fault zones. Now the UGS, with partial funding from the U.S. Geological Survey (USGS) National Earthquake Hazards Reduction Program (NEHRP), is conducting a study of the West Cache fault zone. The study will improve estimates of seismic hazard and risk in Cache Valley and northern Utah.

The West Cache fault zone (WCFZ) consists of the Clarkston, Junction Hills, and Wellsville faults (from north to south). The Clarkston fault is about 22 miles long (7 miles in Utah, 15 miles in Idaho). The UGS excavated a trench across the fault north of the mouth of Winter Canyon near Clarkston which exposed evidence for one surface-faulting earthquake. Radiocarbon results indicate the earthquake occurred around 4,500 years ago.

The Junction Hills fault is 16 miles long and is exposed near the southern end of a short scarp in a stream cut at Roundy Farm near Cache Junction, Utah. The north wall of the stream cut exposed direct evidence for one surface-faulting event and indirect evidence for at least one older earthquake. Radiocarbon results indicate the younger (most recent) earthquake occurred around 8,450 years ago.

The Wellsville fault, which is 12 miles long, was trenched north of the mouth of Deep Canyon east of Mendon and exposed evidence for two surface-faulting earthquakes which displaced sediments down to the east. Radiocarbon results indicate that a younger earthquake occurred around 3,700 years ago, and an older earthquake probably occurred sometime after 25,000 years ago.

Do these three faults rupture at the same time in one large earthquake, or do they behave independently? Radiocarbon age estimates for the most

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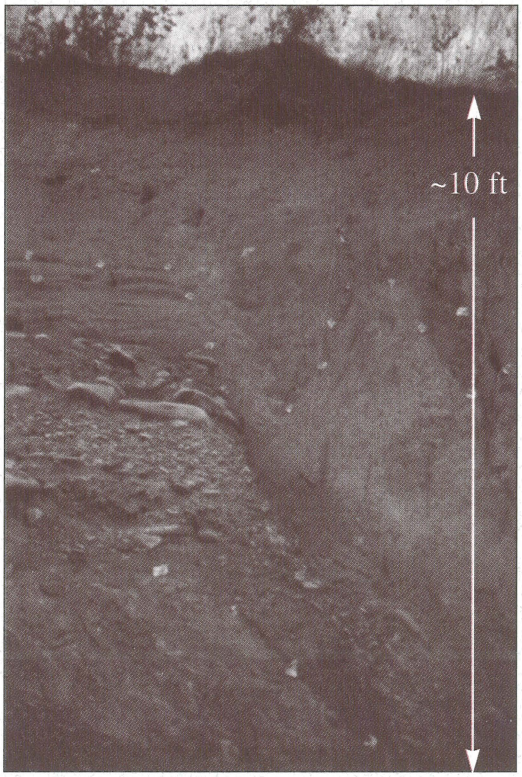
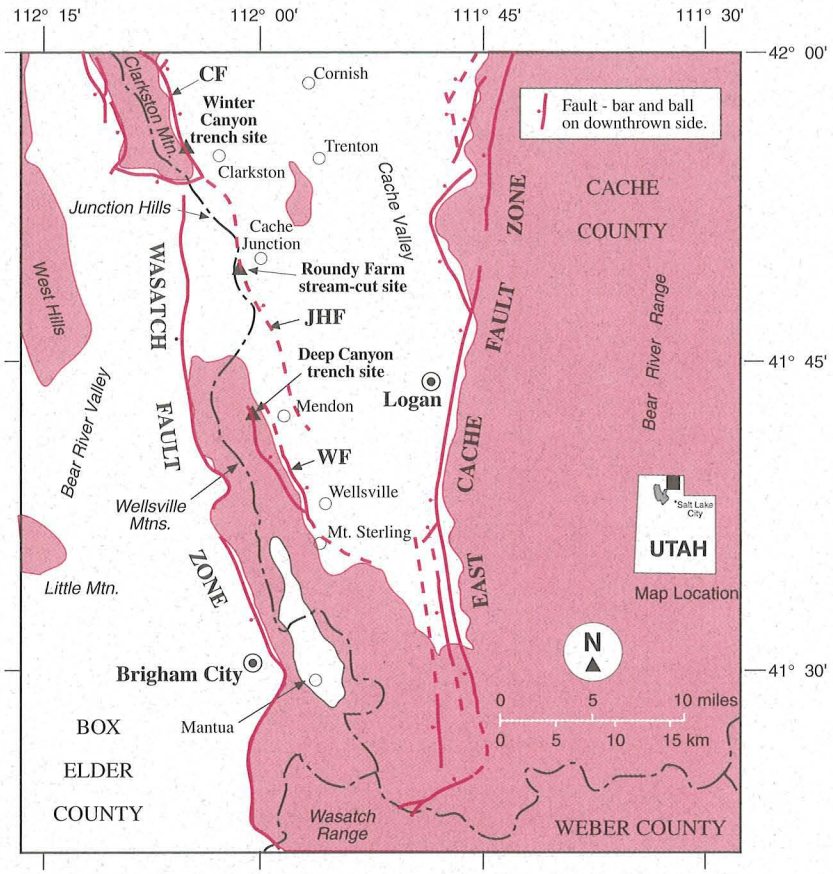
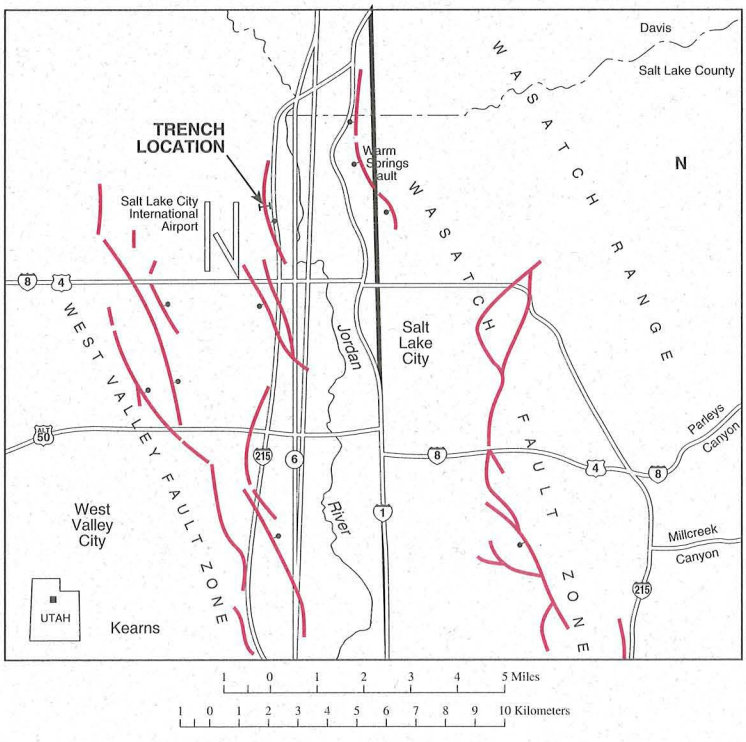


Junction Hills fault exposed in Roundy Farm stream-cut, Cache County, Utah. Flagging outlines geologic units in this view to the north.



Index map of Cache Valley showing locations of the active West Cache fault zone and investigation sites in the fault zone. CF - Clarkston fault, JHF - Junction Hills fault, WF - Wellsville fault.



Map showing the location of the fault trench excavated by AGRA Earth and Environmental, Inc. along the West Valley fault zone, Salt Lake County, Utah.

Fault Studies... *Continued from page 1*

recent surface-faulting earthquake on each of the three faults and a difference in Bonneville shoreline elevations across the Junction Hills and Clarkston faults both suggest that the three faults rupture independently.

West Valley Fault Zone

The West Valley fault zone (WVFZ), the western boundary of a fault-bounded basin in the center of the Salt Lake Valley, is in an urban area as close as three miles to downtown Salt Lake City. The eastern boundary of the basin is marked by the Wasatch fault zone (WFZ), the longest and most active fault in Utah. Studies of the WVFZ are few and its history is obscure. However, a new date was obtained from material collected from a fault exposure in a trench excavated in northern Salt Lake City by AGRA Earth and Environmental, Inc. AGRA informed the UGS of the exposure and samples were obtained from the trench for radiocarbon age dates. Analyses of the samples yielded the first estimate of the age of a specific earthquake along the WVFZ. The age obtained for the event is roughly 2,200 years. The timing of the event from this trench, compared to Great Salt Lake shoreline fluctuations and earthquakes along the Salt Lake City segment of the WFZ opposite this part of the WVFZ to the east, suggest that a surface-faulting earthquake occurred along this part of the WVFZ shortly after Great Salt Lake receded from its Holocene highstand (about 3,400 years ago) and at about the same time as the next-to-the-last surface-faulting earthquake along the Salt Lake segment of the WFZ (about 2,450 years ago). The new dates from the AGRA trench provide new information to help us evaluate the importance of the WVFZ for earthquake-hazard analysis along the Wasatch Front and its relation to the Salt Lake City segment of the WFZ.

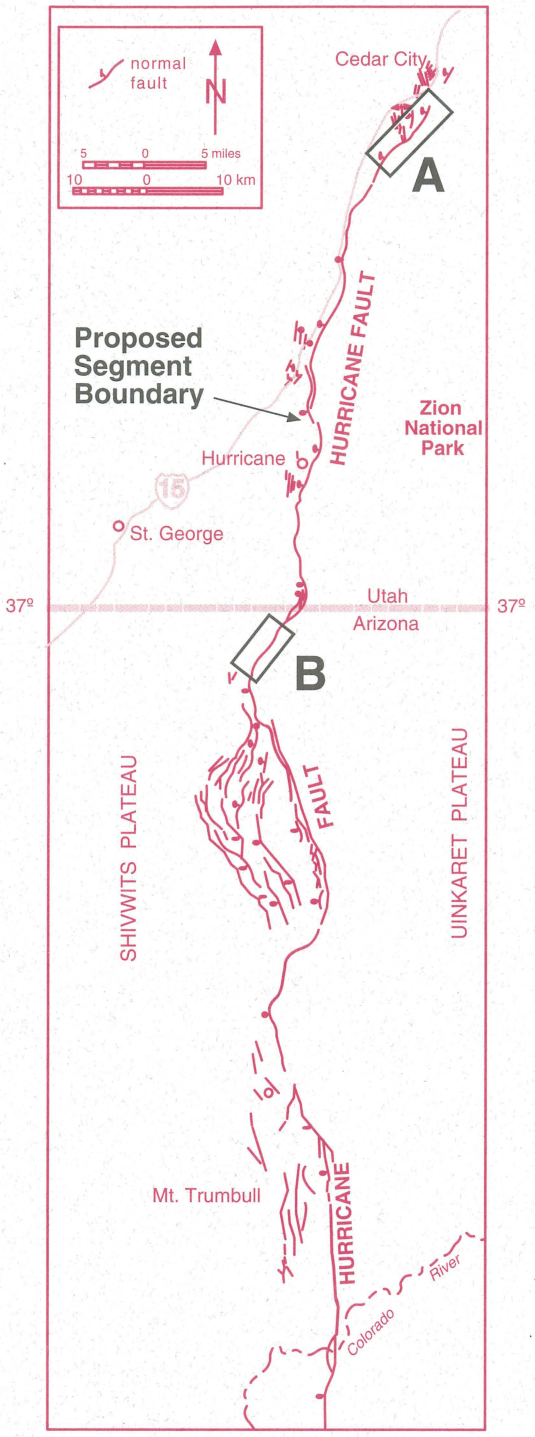
Hurricane Fault

The UGS and the Arizona Geological Survey (AGS) are cooperating in an investigation to evaluate the earthquake threat on the 156-mile-long Hurricane fault in southwestern Utah and northwestern Arizona. The active Hurricane fault extends from Cedar City, Utah to south of the Grand Canyon in Arizona. The presence of the fault and young fault scarps (formed during the past 10,000 years) implies a threat to lives and property, but little information exists about the size and frequency of large earthquakes on this fault. The region has experienced numerous earthquakes greater than magnitude (M) 4 this century. The largest and most damaging events were the M 6.3 Pine Valley earthquake in 1902 and the M 5.8 St. George earthquake in 1992. The St. George earthquake probably occurred on the

Hurricane fault.

The study is funded in part by the USGS NEHRP, and although not yet complete, has already produced new information about seismic hazard in southwestern Utah and northwestern Arizona. Scarps on unconsolidated deposits have long been recognized along the Hurricane fault in Arizona, but with the exception of the prominent fault scarp at Shurtz Creek near Cedar City developed on probable 80,000 to 120,000 year-old deposits, scarps on unconsolidated deposits were previously unknown on the Hurricane fault in Utah. Preliminary mapping indicates that probable early to middle Holocene (5,000 to 10,000 year old) deposits are faulted at Murie Creek, Cottonwood Canyon, and Honeymoon Trail, implying that at least one, and possibly two, large surface-faulting earthquakes have occurred on the Hurricane fault in the recent geologic past.

Surface displacements have been measured and samples collected for dating from the displaced surface at Shurtz Creek and from younger surfaces at Cottonwood Canyon. These data will allow the calculation of a slip rate (mm/yr) at these two locations for the past 100,000 to 200,000 years. In addition, geologists from the UGS Geologic Mapping Program have sampled a number of Quaternary lava flows displaced by the Hurricane fault. Once the lava flows are dated and the displacements accurately determined, the long term (possibly for the past 2 million years) slip rates can be calculated for the fault. In a later phase of the project, trenches at Murie Creek in Utah where probable Holocene-latest-Pleistocene-age deposits are displaced, should provide information on the size and timing of the more recent events. Comparing these young slip rates with those obtained from older displaced surfaces and lava flows will show how activity on the Hurricane fault has changed through time and give a better understanding of the long-term behavior of the fault.



Above: *Hurricane fault and subsidiary structures in southwestern Utah and northwestern Arizona. Box A = Shurtz Creek, Murie Creek, and two unnamed sites where the Hurricane Fault displaces unconsolidated deposits. Box B = Cottonwood Canyon and Honeymoon Trail sites.*

Left: *Fault scarp at Shurtz Creek (casting linear shadow) is 50 feet high and displacement is down to the west.*

Utah's Dramatic Growth—We Must Act Now to Ensure Earthquake Safety!

News of the January 9, 1998 Meeting

by Janine L. Jarva
Utah Geological Survey

Utah Seismic Safety Commission

The January 9, 1998, meeting of the Utah Seismic Safety Commission (USSC) began with an invited presentation by Natalie Gochnour of the Governor's Office of Planning and Budget on addressing quality growth issues in the Wasatch Front area. One of the USSC's best opportunities to ensure that earthquake safety issues be considered in future development in Utah is to become involved in the Envision Utah public private partnership efforts underway in the state (See Fault Line Forum, v. 13, no. 4, p. 3.). Ms. Gochnour's presentation detailed where that effort currently stands.

Quality Growth Issues, Natalie Gochnour

Governor Leavitt hosted a growth summit in December 1995 to address critical infrastructure challenges created by Utah's unparalleled growth. Utah's population reached the two million mark in 1996 with a growth rate twice the national average. In addition, Utah's population is younger, lives longer, has larger household sizes, and is more urban than the national average. The growth summit posed the question of how Utah will manage growth in a way that preserves and enhances our quality of life, particularly in the Greater Wasatch Area, which includes a 10-county region along the front and back of the Wasatch Range that can be considered the commutershed for the Salt Lake-Ogden and Provo-Orem metropolitan areas. The area includes 98 cities and 157 special-service districts. These multiple jurisdictions, along with state government and the Utah Transit Authority, share responsibility for providing infrastructure and services to 1.6 million residents. The steady and rapid population and economic growth within the region places increasing demands on these entities. This, in turn, makes the need for intergovernmental collaboration, information sharing, cooperative data development, and comprehensive growth modeling essential for informed decision-making and the efficient allocation of resources in Utah. In addition, Utah's unique physiographic character poses significant limitations on the type of development that can occur. In metropolitan Utah, the population resides along the valley floor, within a narrow area of developable land, surrounded by mountains and Great Salt Lake. The climate is arid and the risk of earthquakes is high. These physical limitations compound the growing problems of air quality, traffic congestion, water availability, hillside development, agricultural preservation, open space,

and other natural-resource/land-use related challenges.

In support of these issues, the Coalition for Utah's Future (the sponsor of Envision Utah) convinced the legislature to appropriate $250,000 toward the development, coordination, and implementation of Quality Growth Efficiency Tools (QGET) to expand and improve upon databases and planning tools currently available and utilized to understand the impacts of growth. To this end, the QGET Technical Committee was created to improve the technical and analytical tools used to plan for Utah's future. Their focus is to see that decision makers have growth-related information that is comprehensive, reliable, accessible, and consistent. Their first effort was to generate a baseline scenario to depict what current projections indicate regarding the demographic, economic, transportation, air quality, water, and land-use future of the Greater Wasatch Area. The purpose of the baseline is to provide a benchmark against which the effects of alternative future actions can be evaluated. It will be used by Envision Utah (formerly the Quality Growth Public/Private Partnership) to develop long-term, alternative growth scenarios for the Wasatch Front to be disseminated to the general public as part of a significant public-education campaign. Then QGET will facilitate the evaluation of these alternatives using an integrated land use and transportation model. Ideally, it will predict urban expansion at a regional scale. QGET published their baseline scenario in September 1997.

Other Business

Chairman Arabasz held a brainstorming meeting with all USSC Committee chairs on February 17, 1998, to identify critical growth-related issues and goals and to set strategies for action by the USSC in 1998. He hopes the USSC can provide seismic-safety input to QGET to help evaluate alternative scenarios.

Ron Dunn, Chairman of the Engineering and Architecture Committee, reported that his committee has been working with and gained the support of school district officials and the State Superintendent of Public Instruction's office to ensure earthquake safety in new school construction. They propose that a seismic review be performed by the structural engineering member of the value-engineering review team at the 90% design completion point for new school construction. Value-engineering analysis is performed for school projects over $30,000 or 30,000 square feet (a small elementary school averages 60-70,000 square feet, a large high school averages 250-275,000 square feet). With the support of school officials, this design quality control can be accomplished without legislation through administrative rulemaking by the Utah State Office of Education. Commissioner Bailey pointed out that their committee has so far only addressed this one issue and although it is a small step forward, they believe it to be a significant success. They will address the related issues of construction quality control and professional qualifications in future collaborative meetings.

Craig Nelson, Salt Lake County geologist, gave an invited presentation related to an investigative report in the Salt Lake Tribune (December 7, 1997) on the 'disappearing fault' in Salt Lake City. Salt Lake County published a geologic hazards map in 1989, showing known and suspected locations of the Wasatch fault. Special-study areas were designated around these locations such that any new development proposed within them requires that a surface-fault-rupture-hazard study be performed before the building is sited and designed. Such geotechnical studies must be submitted to the appropriate permitting authority before excavation or construction can begin. In February 1997, a new version of the county hazards map was issued. The revisions in the 1997 county hazards map were based on a 1992 U.S. Geological Survey map. On this map, the southern part of the Warm Springs branch of the Wasatch fault which trended through the downtown Salt Lake City had 'disappeared', even though a 1990 study of Washington Elementary School at 420 N. 200 W. accurately located the fault beneath the school's cafeteria and revealed 14-40 feet of offset, indicating that the fault had not 'disappeared' at this point. Despite the fact that the old map showed faults downtown and was in force at the time, the Salt Palace reconstruction in 1994 did not adequately study or address fault-rupture hazards and several other major downtown projects were approved by Salt Lake City without adequate fault-rupture-hazard studies.

To avoid future problems, Mr. Nelson is spearheading an effort to prepare a set of consistent development standards for Salt Lake County to ensure a minimum acceptable scope-of-work and independent review of the geotechnical consultant's reports prepared for developers. First, all consultants should be using the same map of faults and special-study zones. Until the new 1997 Salt Lake County map is revised as necessary to reflect new information, the old map will remain in force. As special studies are performed in support of development, Mr. Nelson proposes to create a geologic review board to consider and approve all changes to that map and to hear any appeals of the County geologist's recommendations. Further, the map will be made available to any interested party through Salt Lake County's web page. This should improve the quality of information used for development and ensure a consistent set of standards with respect to seismic safety are being met. Mr. Nelson is working with Wasatch Front city officials to gain

See **Dramatic Growth** *page 6*

Current projections... will be used to develop long-term alternative growth scenarios to be disseminated to the general public.

WSSPC Adopts Seismic Policy Recommendations

The Western States Seismic Policy Council (WSSPC) adopted four seismic policy recommendations at their November 7, 1997 annual business meeting. The recommendations grew out of the WSSPC-hosted Basin and Range Province (BRP) Seismic-Hazards Summit in Reno, Nevada, May 13-15, 1997, whose purpose was to review important technical issues in characterizing seismic hazards in the BRP and consider their public-policy implications. The summit focused on accurately and effectively characterizing seismic hazards in the BRP and identifying policies and means of communication that will effectively reduce the loss of life and property. Although the earthquake characteristics of the BRP are not necessarily unique, they have some distinctions that warrant seismic-policy considerations. Before the new measures became WSSPC Policy Recommendations, they were approved by the participants at the BRP Seismic-Hazards Summit, then by the WSSPC Board of Directors, and then by the full membership of WSSPC.

WSSPC PR97-1: Active Fault Definition Categories for the Basin and Range Province

WSSPC recommends that the following guidelines be used in defining active faults in the Basin and Range physiographic province. Active faults can be categorized as follows, recognizing that all degrees of fault activity exist and that it is the prerogative of the user to decide the degree of anticipated risk and what degree of fault activity is considered "dangerous":

Holocene Active Fault - a fault that has moved within the past 10,000 years.

Late Quaternary Active Fault - a fault that has moved within the past 130,000 years.

Quaternary Active Fault - a fault that has moved within the past 1,600,000 years.

It should be emphasized that more than half of the historic magnitude 6.5 or greater earthquakes in the Basin and Range Province have occurred on faults that did not have Holocene activity, furthermore, earthquakes in the province will occur on faults in all three categories.

WSSPC PR97-2: Developing Guidelines for Fault Trace Setbacks

WSSPC encourages individual state workshops to develop guidelines for local jurisdictions to establish consistent criteria for setbacks from surface traces of one or more

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Dramatic Growth...

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their cooperation and support in this endeavor. He will report on his progress at future USSC meetings.

At the October USSC meeting, Robert B. Smith (University of Utah) presented the results of his GPS monitoring and a proposal for developing a "unified master earthquake model" for Utah (see Fault Line Forum, v. 13, no. 4, p. 3). In response, Chairman Arabasz posed several questions to the USSC Geoscience Committee: (1) Do the high GPS rates warrant immediate action by the USSC? (2) Is this unified master model proposal technically applicable in Utah, and how should the USSC proceed? Gary Christenson, Geoscience Committee chair, presented the Committee's response to these questions. Regarding the high GPS strain rates, the Committee stated that the high rates do not necessarily indicate an increased earthquake hazard. In addition to measurement uncertainties, there are considerable uncertainties in interpreting the cause of the higher rates. One of the ways to reduce the measurement uncertainties in the GPS rates would be through permanent continuous-monitoring instruments. Dr. Smith is installing some now. The Committee believes that further scientific work and consensus building is necessary before recommending any USSC action. Regarding the master model proposal, the Committee needed more information before they could make a recommendation to the Commission. They proposed that a workshop be scheduled for the geoscience community to develop a strategic plan to consider Dr. Smith's proposal and other geoscience initiatives.

The Wednesday, April 8, 1998 meeting of the USSC was held in Brigham City, Utah, at the invitation of Representative Knudson, and focused on earthquake issues related to the Box Elder-Cache County area. This is the first time the USSC has held a meeting outside of Salt Lake City. The meeting included an information fair for local residents and a luncheon for local government officials. The next meeting of the USSC will be July 17 from 9 - 11 a.m., at the State Office Building. For further details please contact Janine Jarva, Utah Geological Survey, (801) 537-3386, fax: (801) 537-3400, e-mail: nrugs.jjarva@state.ut.us.

WSSPC...*Continued from page 6*

categories of active faults, such as those defined in WSSPC PR-1. In several western states, policy for the regulation of setbacks from active surface fault traces is established at the local level. WSSPC encourages individual jurisdictions that are traversed by the same active fault to have consistent setback requirements. Note that setbacks deal with surface fault ruptures from earthquakes, but do not address the broader, more significant hazards of ground shaking and other effects, such as ground-motion amplification, liquefaction, rock falls, and landslides.

WSSPC PR97-3: Development of National Earthquake-Hazard Risk Mitigation Priorities

WSSPC proposes to take the initiative to coordinate a process with the federal NEHRP agencies and regional earthquake consortia to establish national earthquake-hazard risk mitigation priorities. This may be accomplished by WSSPC facilitating dialog among the states and presentation of consensus to the federal government.

WSSPC PR97-4: Seismic Monitoring Networks

Because seismic monitoring networks are vital for earthquake-hazard characterization and because there is an insufficiency in available data, WSSPC advocates the continuation and expansion of seismic monitoring networks, including strong-motion instrumentation, by support from state and federal agencies. WSSPC further recommends existing networks be interconnected by compatible hardware and software.

Background of the Recommendations

Seismic-hazard characterization in the BRP poses several distinct challenges. This extensional, intraplate tectonic setting has hundreds to thousands of potentially active faults, most of which have average earthquake recurrence intervals ranging from thousands to hundreds of thousands of years. The long recurrence intervals can greatly complicate paleoseismic assessments and predictions of which faults are likely to generate strong earthquakes in the near future. Most potentially active faults in the province have predominantly normal slip or normal-slip components, which are believed by some to produce distinctly less bedrock ground motion than strike-slip or reverse faults. However, most communities within the province are located within alluviated basins, where issues for ground motion consideration include response of low-rigidity sediments to shaking and focusing of seismic waves due to basin geometry and/or other effects. Some historical earthquake sequences, such as the 1954 Rainbow Mountain-Fairview Peak-Dixie Valley sequence in Nevada, indicate that major earthquakes can be highly variable, with significant spatial and/or temporal clustering. A key question is whether this kind of earthquake behavior is a characteristic of the province that can be expected to be repeated or whether this was a chance happening.

WSSPC is a regional organization that includes the emergency management directors and state geologists or provincial or territorial lead geoscience-agency heads of thirteen states, three U.S. territories, one Canadian province, and one Canadian territory. WSSPC's mission is to provide a forum to advance earthquake-hazard reduction programs throughout the western United States; and to develop, recommend, and present seismic policies and programs through information exchange, research, and education. The BRP Seismic-Hazards Summit provided a vehicle by which WSSPC could advocate a firm scientific foundation for seismic policy. WSSPC had recently defined "seismic policy" as related to the concept of "government policy," which is the philosophical basis for laws and regulations adopted by government. Thus "seismic policy" is government policy that relates to earthquake hazards and earthquake mitigation. As examples, seismic policy encompasses such items as funding for research at the federal level, guidelines for evaluating and mitigating seismic hazards, and recommendations for changes in building codes adopted by local governments. WSSPC is presently preparing brief "white papers" giving the background and justification for the four seismic policy recommendations.

Adapted from Lund, W.R., editor, Introduction, Proceedings of the Basin and Range Seismic-Hazard Summit: Utah Geological Survey, Nevada Bureau of Mines and Geology, and Western States Seismic Policy Council, in press.

The recommendations grew out of the BRP Summit... which focused on accurately and effectively characterizing policies and means of communication that will effectively reduce the loss of life and property.

western united states
earthquake
insurance summit

june 24-26, 1998
the doubletree hotel
sacramento, california

Topics include:

Current Practice
Insurance Industry * Government Regulation * Public Policy * Earthquake Hazard Science

Estimating Risk
Risk Assessment Models

Reinsurance and Alternatives

Mitigating the Risk
Building Codes and Standards * Disaster Resistant Communities * Engineering and Construction * Insurance and Financial Incentives

Public Policy Analysis

The Summit is presented by Western States Seismic Policy Council & Council of State Governments-*WEST*

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Earthquake Activity in the Utah Region

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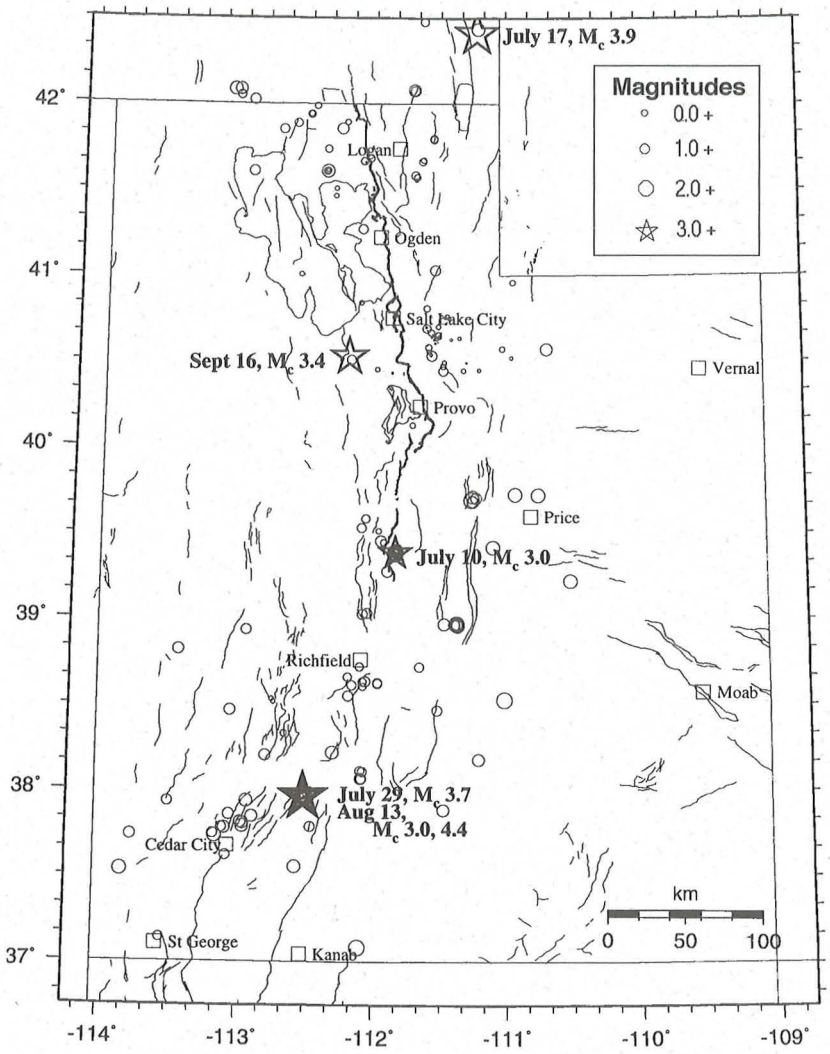


July 1 - September 30, 1997

During the three-month period July 1 through September 30, 1997, the University of Utah Seismograph Stations located 194 earthquakes within the Utah region (see accompanying epicenter map). The total includes one earthquake in the magnitude 4 range, five earthquakes in the magnitude 3 range, and 61 earthquakes in the magnitude 2 range. Earthquakes which have magnitudes of 3.0 or larger (plotted as stars and specifically labeled on the epicenter map) are described below. There were two earthquakes reported felt during the report period. (Note: Magnitudes listed are coda magnitude, M_C. All times indicated below are local time, which was Mountain Daylight Time during the report period.) Additional information on earthquakes within the Utah region is available from the University of Utah Seismograph Stations.

Significant Main Shocks and Clusters of Earthquakes

• **Eastern Wasatch Plateau-Book Cliffs Area near Price** (coal-mining related): Seismic events in this region (magnitude 1.9 to 2.8) make up only 9% of the shocks that occurred in the Utah region during the period. This represents a significant decrease in coal-mining related seismicity.

• **Significant central Utah earthquakes:** A swarm of 23 earthquakes, located near Levan (45 miles N of Richfield) occurred on July 10th and 11th. Earthquakes in this sequence ranged in magnitude from 0.9 to 3.0. Significant shocks include:

M_C 3.0	July 10	05:47 p.m.	12 miles SSE of Levan

• **Significant southwestern Utah earthquakes**: A cluster of 15 shocks ($1.6 \leq M_C \leq 4.4$), located about 10 miles NNW of Panguitch (35 miles NE of Cedar City) occurred principally from July 29 through August 13. Significant shocks include:

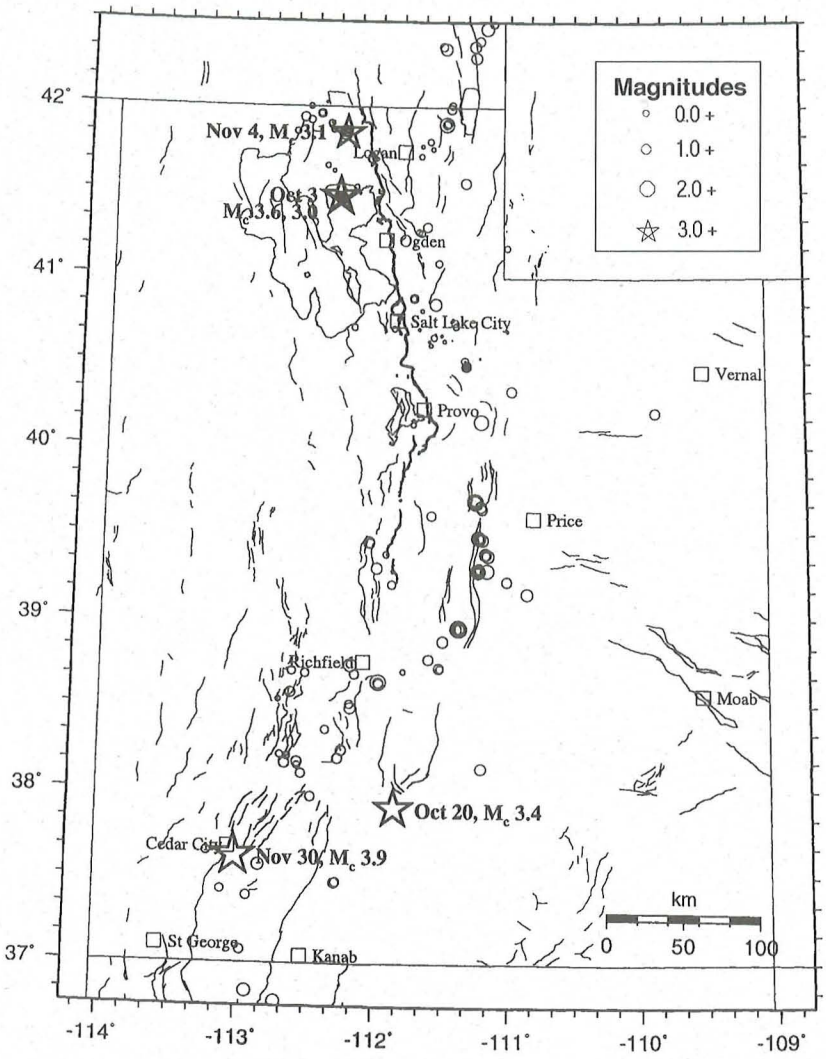
M_C 3.7	July 29	07:04 a.m.	11 miles NNW of Panguitch
M_C 3.0	August 13	06:29 a.m.	10 miles NNW of Panguitch
M_C 4.4	August 13	08:24 a.m.	11 miles NNW of Panguitch

• **Significant northern Utah/southeastern Idaho earthquakes:** A magnitude (M_C) 3.4 earthquake occurred on September 16th, located in the central Oquirrh Mountains (west of Salt Lake City) in the vicinity of the Kennecott Bingham Canyon Mine complex. Kennecott officials confirmed that this shock was not a mining-related blast or rock fall. Significant shocks include:

M_C 3.9	July 17	06:02 a.m.	7 miles NNE of Montpelier, ID. Felt in Montpelier, Georgetown, Bennington, and Geneva, Idaho. Also felt in Afton and Auburn, Wyoming.
M_C 3.4	September 16	06:38 p.m.	5 miles E of Tooele, Utah. Felt in Bingham Canyon, Lark, Copperton, Draper, and Tooele.

October 1 - December 31, 1997

During the three-month period October 1 through December 31, 1997, the University of Utah Seismograph Stations located 230 earthquakes within the Utah region (see accompanying epicenter map). The total includes five earthquakes in the magnitude 3 range, and 59 earthquakes in the magnitude 2 range. Earthquakes which have magnitudes of 3.0 or larger (plotted as stars and specifically labeled on the epicenter map) are described below. There was one earthquake reported felt during the report period. (Note: Magnitudes listed are coda magnitude, M_C. All times indicated below are local time, which was Mountain Daylight Time from October 1 to 26, and Mountain Standard Time during the remainder of the report period.) Additional information on earthquakes within the Utah region is available from the University of Utah Seismograph Stations.



Significant Main Shocks and Clusters of Earthquakes

• **Eastern Wasatch Plateau-Book Cliffs Area near Price** (coal-mining related): Seismic events in this region (magnitude 1.5 to 2.8) make up 26% of the shocks that occurred in the Utah region during the period.

• **Significant northern Utah earthquakes:** Two clusters of earthquakes occurred in northern Utah during the report period. One cluster of 8 shocks ($0.9 \leq M_C \leq 3.1$), located about 10 miles NW of Garland (~25 miles W of Logan), occurred from November 5th through 21st. The other cluster of 26 shocks ($0.4 \leq M_C \leq 3.6$), located about 12 miles SW of Corinne (~25 miles WNW of Logan), occurred principally from October 3 to 5. Significant shocks include:

M_C 3.6	October 3	8:52 a.m.	12 miles SW of Corinne
M_C 3.0	October 3	9:15 a.m.	12 miles SW of Corinne
M_C 3.1	November 4	5:51 p.m.	9 miles NW of Garland

• **Significant central Utah earthquakes:** A cluster of 26 earthquakes occurred about 5 miles SE of Heber City (~25 miles NE of Provo). The majority of earthquakes ($M_C \leq 1.7$) in this sequence occurred in November and December of this report period.

• **Significant southwestern Utah earthquakes:**

M_C 3.4	October 20	1:02 a.m.	16 miles WNW of Escalante
M_C 3.9	November 30	2:54 a.m.	4 miles SE of Cedar City. Felt in Cedar City.

Meetings and Conferences

- May 31 - June 4, 1998, **6NCEE - Sixth U.S. National Conference on Earthquake Engineering**, Seattle, Washington. Information: Earthquake Engineering Research Institute (EERI), 510-451-0905.
- June 24 - 26, **Western U.S. Earthquake Insurance Summit**, Sacramento. Sponsored by the Western States Seismic Policy Council (WSSPC) and the Council of State Governments-*WEST*. For more information, contact WSSPC, 121 Second Street, 4th Floor, San Francisco, CA 94105; (415) 974-6435; fax: (415) 974-1747, e-mail: wsspc@wsspc.org
- July 26 - 31, 1998, **"Gender in Disaster Research: Are the Experiences of Women Really Different?" XIV World Congress of Sociology--Session of the Research Committee on Disasters, International Sociological Association**, Montreal, Canada. For information contact Joseph Scanlon, 117 Aylmer Avenue, Ottawa, Ontario, Canada KIS 2X8; (613) 730-9239; fax (613) 730-1696; e-mail: jscanlon@ccs.carleton.ca

See **Meetings** *page 10*

Meetings...*Continued from page 9*

- August 3 - 6, 1998, **ASCE Geotechnical Earthquake Engineering and Soil Dynamics Conference**, Seattle. For information contact ASCE, (800) 548-2723 or (703) 295-6029; fax (703) 295-6144; e-mail: conf@asce.org
- September 15 - 18, 1998, **Western States Seismic Policy Council (WSSPC) 20th Annual Conference**, Pasadena. For information contact WSSPC, 121 Second Street, 4th Floor, San Francisco, CA 94105; (415) 974-6435; fax: (415) 974-1747, e-mail: wsspc@wsspc.org
- September 21 - 25, 1998, **8th Congress of the International Association of Engineering Geology**, Vancouver, British Columbia. Contact: Kim Meida, Secretariat, 8th Congress IAEG, (604) 528-2421, fax (604) 528-2558, e-mail: kim.meidal@bchydro.bc.ca; WWW: http://ewu.bchydro.bc.ca/IAEG/IAEG98.html
- September 22, 1998, **Earthquakes: Mean Business—Earthquake Conference 98**. University Park Hotel. Sponsored by the Association of Contingency Planners (ACP) and the Utah Seismic Safety Commission (USSC), the Symposium is part of Salt Lake City and salt Lake County's week-long "It's Our Fault" Earthquake Preparedness Week (September 21-26, 1998). For more information contact Mike Stever, (801) 535-6030, e-mail: mike stever@ci.slc.ut.us
- October 7 - 9, 1998, **Risk '98: First International Conference on Computer Simulation in Risk Analysis and Hazard Mitigation**, Valencia, Spain. Organizers: Wessex Institute of Technology and Universitat Jaume 1. Palau de Pineda. For information, contact C.A. Brebbia, Wessex Institute of Technology, Ashurst Lodge, Ashurst, Southampton SO40 7AA, U.K.; tel: 44 (0)1703 293223; fax 44 (0)1703 292853; e-mail: wit@wessex.ac.uk.
- October 11 - 14, **Dam Safety '98**, Las Vegas. Sponsored by the Association of State Dam Safety Officials. Information: (606) 257-5140; fax: (606) 323-1958; e-mail: damsafety@aol.com
- May 17 - 19, 1999, SEE-3, **Third International Conference on Seismology and Earthquake Engineering**, Tehran, I.R., Iran. Information: International Institute of Earthquake Engineering and Seismology, P.O. Box 19395/3913, Tehran, I.R., Iran; tel: (98 21) 229 5085, fax: (98 21) 229 9479; e-mail: SEE3@DENA.IIEES.AC.IR

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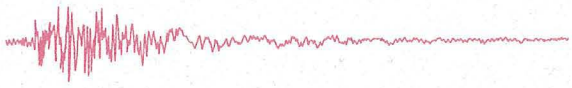

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