WASATCH FRONT FORUM

VOL. III
NO. 3-4

SPRING—SUMMER
1987

EARTHQUAKE HAZARDS PROGRAM

The Wasatch Front Forum is not to be quoted or cited as a publication because much of the material consists of reports of progress and research activities and may contain preliminary or incomplete data and tentative conclusions.

Information, contributions, questions, and suggestions concerning future issues may be sent to the Editor at the address listed below:

Janine Jarva, Editor, UGMS, 606 Black Hawk Way, Salt Lake City, Utah 84108, 801-581-6831.

Gary Christenson, Associate Editor, UGMS, 606 Black Hawk Way, Salt Lake City, Utah 84108, 801-581-6831.

Doug Sprinkel, Associate Editor, UGMS, 606 Black Hawk Way, Salt Lake City, Utah 84108, 801-581-6831.

Jim Tingey, Associate Editor, CEM, 1543 Sunnyside Avenue, Salt Lake City, Utah 84108, 801-533-5271.

Art Tarr, Associate Editor, USGS, MS 966, Federal Center, Denver, Colorado 80225, 303-236-1605, FTS 776-1605.

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FROM THE EDITOR . . .

In October of 1983, the Regional and Urban Hazards Evaluation Program was initiated as an element of the National Earthquake Hazards Reduction Program (NEHRP). Its purpose was to "develop the basic information and the partnerships needed for evaluating earthquake hazards and risk in broad geographic regions containing important urban areas and to provide a basis for loss-reduction measures that can be implemented by local governments. The goal is to provide an integrated program having comprehensive research goals and producing generic information that can be used to reduce earthquake losses in urban areas. The scientific emphasis is on developing fundamental physical understanding of the cause, frequency of occurrence, and the physical effects of earthquake ground shaking, surface faulting, ground failure, and tectonic deformation in various geographic regions."

In early 1984, in meetings of the then new "Regional and Urban Hazards Evaluation Program - Wasatch Front, Utah" research group, the need was expressed for a vehicle for timely dissemination of information to participants and interested persons affiliated with the Wasatch Front program. The "Wasatch Front Forum" became that vehicle, prepared as an informal newsletter from materials submitted by program personnel.

Now in 1987, the emphasis of priorities and allocation of program resources is shifting from scientific research activities that evaluate earthquake hazard to implementation activities that reduce earthquake risk. The Forum will reflect this change of emphasis. We are broadening our audience to include more members of the architectural, engineering, planning and zoning, and emergency management and response communities; members of real estate, banking, insurance, utility, transportation, and hospital organizations; and social scientists, urban planners, and public officials and policy makers at all levels of government. We think that it is more critical than ever that the Forum continue to bring together information producers and information users. In targeting the diverse community of end-users of translated geotechnical information, we also hope to serve as a network for communication between and through the members of this group.

The Forum will continue to inform our readers of new and ongoing scientific research, syntheses of data, and technical report summaries. The success to date of the Wasatch Front program has been built on a strong foundation of research to understand the earthquake hazard, achieved because of work supported by the NEHRP. The Forum will make an increasing effort to communicate work aimed at mitigating the consequences of a significant seismic event along the Wasatch Front by translating the results of scientific research into a format that has meaning for and can be implemented by public policy decision makers. This is the ultimate goal of the National Earthquake Hazards Reduction Act as discussed in the invited comment reprinted from the Natural Hazards Observer elsewhere in this issue.

Although the Wasatch Front Forum is entering its fourth year of publication, many readers may be seeing it for the first time with this issue. We would like to take this opportunity to welcome you and encourage you to become active contributors to our ongoing dialogue. After looking through this issue, please take a few moments to fill out the comment card attached to the back cover if you have any comments or suggestions. A future issue will include a more detailed Survey/Questionnaire of the Forum readership. Its purpose will be to clarify your needs, interests, and concerns so that the Forum can better serve you. If you are aware of anyone who would find the Forum useful and is not currently receiving it, please bring them to our attention or encourage them to contact us. With your enthusiasm and assistance, the Forum's value as an exchange place of information will be greatly enhanced. If you know of workshops, symposia, and meetings or publications that would be of value to our readers, tell us. Please contribute progress reports and summaries of projects related to the program. Comments and constructive criticism will always be welcomed.

Wendy Hassibe, now Chief of the U.S. Geological Survey Public Inquiries Office in Reston, Virginia, and Don Mabey, recently retired as Deputy Director of the Utah Geological and Mineral Survey, are owed a debt of gratitude by all who have read the Forum over the past three years. It has reached publication issue after issue largely because of their efforts and committment. I would also like to thank other previous Associate Editors Paula Gori, Bill Brown, and Art Tarr for their contributions. Gary Christenson, Doug Sprinkel, Jim Tingey, and Art Tarr have agreed to serve as the new Associate Editors, and my thanks to all of them for working so diligently to author and solicit most of the material comprising the issue. The numbering of this issue of the Forum and the one that is to follow, is different from the practice of the past. In an attempt to get back "on schedule", the editors have decided to publish two double issues. The Forum will subsequently return to its quarterly publication dates of March, June, September, and December. Don't forget, the deadline for the next issue is JANUARY 31, 1988!

Finally, a reminder. Everyone should plan to attend the workshop on "Continuing Actions to Reduce Potential Losses from Earthquakes Along the Wasatch Front, Utah" as its main focus will be the integration of the scientific research program with the mitigation/implementation program. It's not too late and it's free! See the related article in this issue for details.

IMPORTANT WASATCH FRONT MEETING!

WORKSHOP ON "CONTINUING ACTIONS TO REDUCE POTENTIAL LOSSES FROM EARTHQUAKES ALONG THE WASATCH FRONT, UTAH"

Marriott Hotel
Salt Lake City, Utah
December 1-2, 1987

WORKSHOP OBJECTIVE:

This meeting; the fourth annual gathering of Utah scientists, architects, engineers, social scientists, planners, emergency managers, and public officials who are either conducting research or fostering the process of implementation of earthquake loss-reduction measures along the Wasatch front, is designed to brief participants on the most important results of the integrated research and implementation program that started in 1983. A pre-publication set of the U.S. Geological Survey's professional paper will be available for participants to facilitate the communication and application of the rapidly growing base of knowledge and information. Other publications will also be provided to each participant.

Sponsors: The meeting is sponsored by the Utah Geological an Mineral Survey, Utah Division of Emergency Management, Federal Emergency Management Agency, and U.S. Geological Survey.

PRELIMINARY PROGRAM

TUESDAY, DECEMBER 1, 1987: Review of the Status of Current Research and Implementation Programs.

SESSION I: BRIEFING ON THE ACCOMPLISHMENTS OF THE RESEARCH AND IMPLEMENTATION PROGRAM ALONG THE WASATCH FRONT, UTAH

Objective: A panel will brief participants on: 1) significant research and implementation accomplishments, 2) why these accomplishments are important, and 3) the issues and problems that must be resolved in order to achieve overall research, translation, dissemination, preparedness, and mitigation goals in Utah.

SESSION II: REVIEW OF STUDIES OF THE WASATCH FAULT ZONE

Objective: A panel consisting of the segmentation and trenching "working teams" will brief participants on: 1) what they have learned, 2) products, and 3) implications of the results with respect to defining the earthquake potential, fault rupture characteristics, maximum magnitude, recurrence intervals, and other important parameters of the Wasatch fault zone.

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SESSION III: DELINEATION OF THE GROUND-SHAKING, GROUND-FAILURE, AND TECTONIC-DEFORMATION HAZARDS ALONG THE WASATCH FRONT

Objective: A panel will brief participants on results of studies to define the nature, spatial extent, and severity of potential ground shaking, ground failure, seiches, and tectonic deformation along the Wasatch Front, emphasizing: 1) what they have learned, 2) their products, and 3) the implications for earthquake-resistant design and construction, land use, and response and recovery planning in Utah.

WEDNESDAY, DECEMBER 2, 1987: Review of Knowledge and Experiences in Communication of Hazards and Risk Information

SESSION I: COMMUNICATING HAZARDS AND RISK INFORMATION

Objective: Two experts will review the knowledge base derived from the field of information, communication, and social sciences and the crucible of experience on the communication of short- and long-term hazards (characterization of the physical phenomena) and risk (characterization of the economic losses and societal impacts).

SESSION II: EXPERIENCES IN UTAH

Objective: A panel will brief participants on their experiences to foster the earthquake loss-reduction implementation process in Utah.

SESSION III: LEARNING FROM EXPERIENCES WITH OTHER NATURAL HAZARDS

Objective: Three experts will review perspectives gained from communicating volcanic-hazard and hurricane-hazard information.

SESSION IV: IMPROVING THE CAPABILITY TO COMMUNICATE EARTHQUAKE HAZARDS AND RISK INFORMATION IN UTAH

Objective: A panel will review current activities in Utah and some of the communication strategies to meet needs in Utah.

For more information contact:
Doug Sprinkel, Deputy Director,
Utah Geological and Mineral Survey,
606 Black Hawk Way, Salt Lake City,
Utah 84108-1280, 801-581-5831

(Reprinted from THE NATURAL HAZARDS OBSERVER, July 1986, Volume X, Number 6)

WHITHER THE NATIONAL EARTHQUAKE PROGRAM; PROPOSALS FOR THE SECOND DECADE -an invited comment by Robert A. Olsen, President, VSP Associates, Inc.

A deceptively simple question was recently posed to a conference panel: has the National Earthquake Hazards Reduction Program significantly increased seismic safety in the United States? This is the sort of question that legislative committees, top elected officials, program evaluators, budget analysts, and reporters like to pose. After the NEHRP's first decade, however, it is fair for us all to ask whether the program has made any difference. The words "hazard reduction" imply action, but how many fatalities and injuries have been prevented, and what is the value of property that has been protected from loss?

Around $550 million has been spent during the NEHRP's first decade. How many lives and buildings has that saved? Not many . . . yet. So far, the program has probably simply stopped things froom getting worse. Without it, there would be no national policy or federal support; without research support, knowledge would be limited and highly specialized; we would lack even the small appreciation of the risks that we now have; and the existing frail network of people and organizations concerned about earthquake safety would be absent. The national program has helped to draw the line against further disregard of earthquake risk, but it has only begun to affect the status quo.

The investment of the last decade has brought us to the threshold of implementation. In the second decade's work, we must cross it. A recent National Research Council report on landslides states:

> The greatest need...is not for new knowledge or new engineering methods but for more effective implementation of the capabilities we have today.

Today there is a better and wider understanding of the seismic and geologic forces that threaten many areas of the United States, and earthquake risk has been portrayed in ways that have encouraged at least some mitigation activities. The NEHRP has helped to create a broader community of researchers, practitioners, managers, and citizens who take seriously the earthquake problem. The program has fostered the development of materials, processes, and techniques to improve design and construction, strengthen or eliminate dangerous buildings, improve preparedness and response capabilities, and organize for recovery. Last, but certainly not least, the earthquake issue is now on the agendas of more elected bodies, corporate boards, and interest group committees.

However, to cross the threshold of implementation, we must change our emphasis from research to action. Let us accelerate activities by arbitrarily setting a cluster of dates around 2000 for the hypothetical recurrence of some significant historical earthquakes. These could include quakes in southern California, the San Francisco Bay area, the New Madrid fault zone, Charleston, the Puget Sound area, the Wasatch Front, Boston, and others. Let us then say that, given what we now know, we will not accept more than 5% of the deaths, 10% of the injuiries, or 20% of the property damage that would be caused by events of the magnitude or intensity of those historic disasters. Further, let us prepare sketch plans for the reconstruction of each area, and integrate those plans into long-term land use decisions that are being made right now. Finally, let us draw up an action plan for each area to insure that our promises are kept.

Those action plans should contain mitigation, preparedness, and recovery strategies for each area's particular needs; and they must specify the programs, techniques, responsibilities, public and private resources, and research needed to meet each area's goals. This will make us better able to measure our progress. Thus, when we are asked at the end of 1997 if the National Earthquake Hazards Reduction Program has increased earthquake safety, we can be ready with impressive answers. That would be a far stonger position than we are in today.

Words like "application," "implementation," "knowledge transfer," and "pilot project" all suggest one purpose: action to reduce dangers to life and property. With increasing frequency I hear from researchers, practitioners, and officials that they are concerned about, and frustrated with, the failure to use much of the first decade's research. The National Academy of Sciences has created a panel as part of its Committee on Earthquake Engineering

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to find ways to accelerate research applications. A FEMA official stated recently that 74% ($52 million) of the 1985 NEHRP appropriation is allocated to research. He noted that:

> ...it suggests an imbalance of resources and priorities in a program the Congressional intent of which is to implement activities to reduce earthquake risk. If research is not thoughtfully and effectively translated into results which can be implemented by municipal, state, and federal government agencies and the private sector, then it does not serve the goal of the Earthquake Hazards Reduction Act.

Whether this strategy means a reordering of priorities, a redistribution of funds, or a larger program is open to question. It is clear, however, that to achieve more action, concerted efforts must be made to influence public and private decision makers; they have to put earthquake safety on their agendas and keep it there. The national program must begin to reflect a better balance between research and application. Moreover, the user community must become better skilled at defining its needs so research can explore questions that contribute more directly to the solving of problems.

DEADLINE
for the
Fall-Winter 1987 issue
THE WASATCH FRONT FORUM
is January 31, 1988

UTAHNS NERVOUS ABOUT EARTHQUAKE RISK

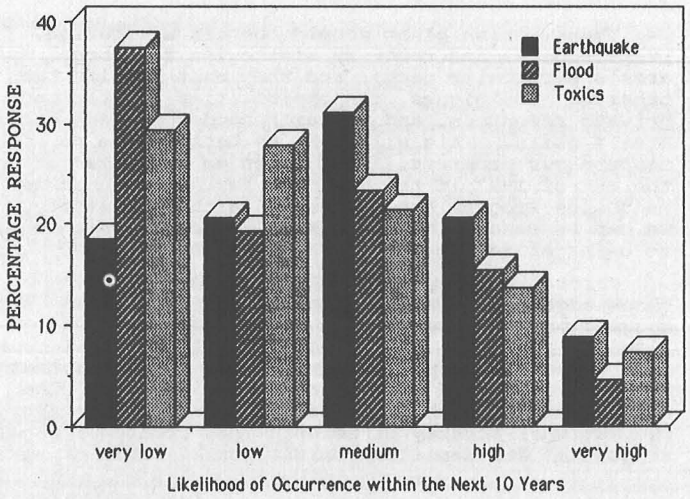
Survey Shows Support for Regulations

The University of Utah Survey Research Center Omnibus V Survey contained questions on perceptions of earthquake risks for residents of counties along the Wasatch Front. In light of the October 1, 1987, quake in the Los Angeles area, the responses of Utahns to questions posed during the July 1987 survey assume an even greater significance for county and municipal officials in the highly urbanized portions of Utah.

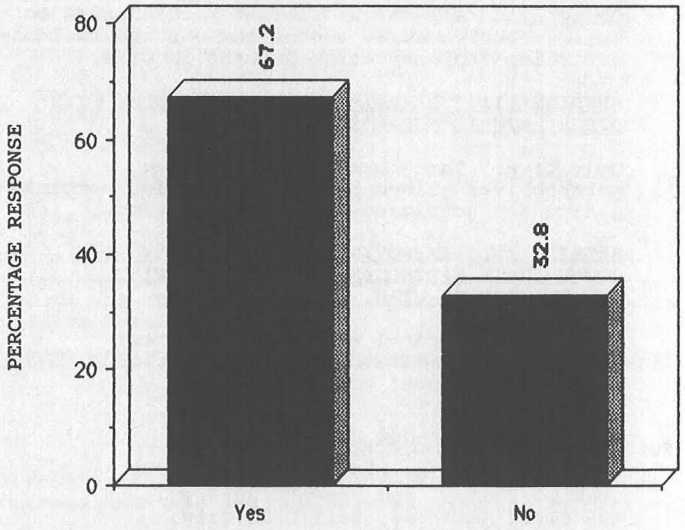
Seven hundred and six adults were surveyed for their views on the risks of various natural and man-made hazards, their sense of concern for what would happen in the event of a serious earthquake, and their support for regulations to reduce the risk of earthquake damage and loss. Survey results are 95% accurate to within 3.7 percentage points of reported results.

Subjective Perception of Risk:

Earthquakes, Floods and Toxic Chemicals



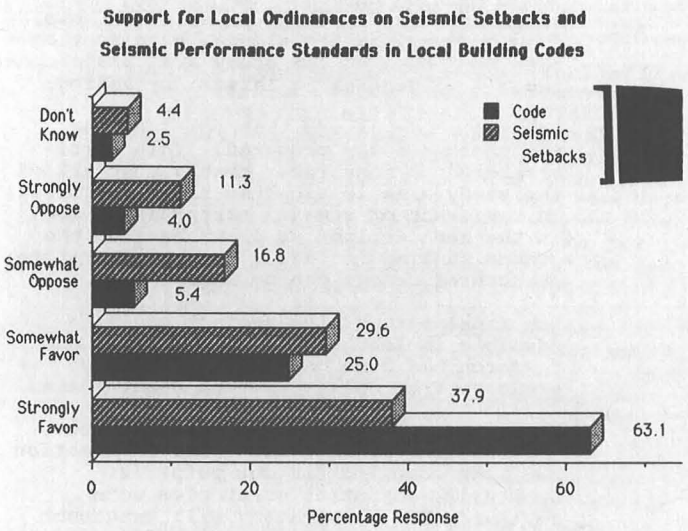
Earthquake Risk and the Regulation of Land Use and Building Construction



Is the Risk Serious Enough to Justify Regulation?

Respondents felt that, over the next ten years, the risk of an earthquake was greater than the risk of either a flood or exposure to toxic chemicals or hazardous waste. While three-eighths were "very concerned" about damage to homes and their contents, well over 50% were "very concerned" about injury to self or family members. Respondents also registered serious concern about aspects of local emergency response capability. Doubts about hospital capacity and the promptness of emergency medical services provoked the greatest degree of concern.

Two out of three respondents said that the risk of earthquake damage and loss was "serious enough to justify regulations" on land use and building construction. Thirty-eight percent "strongly favored" local regulations prohibiting the construction of homes close to earthquake faults. Another 30% "somewhat favored" such regulations. Over 63% "strongly favored" laws requiring new buildings in earthquake-prone areas to be built to minimize earthquake damage. An additional 25% "somewhat favored" such building code provisions.



Support for seismically oriented land use and building code regulations was stronger in Salt Lake County than in other Wasatch Front Counties. Support for regulations increased with education and income. Surprisingly, support for regulations did not vary across the spectrum of political outlook. Both liberals and conservatives were equally likely to support seismically oriented regulations.

The survey research was funded through a grant from the U.S. Geological Survey to the University of Utah, Department of Geography. The research is part of larger study on seismic risk assessment and hazard mitigation being directed by Professor Philip C. Emmi. Professor Emmi was quoted as saying, "The implications of these results are clear. They show the public is aware of the risks we face, concerned about the quality of our emergency response capability and demand regulations to lower our exposure to earthquake damage and loss." No doubt, this conclusion is stronger today than it was this past July.

Meeting held to discuss user needs for Implementation of Earthquake Hazards Information
January 8, 1987

Gary E. Christenson
Utah Geological and Mineral Survey

The UGMS held a meeting on January 8, 1987, at the Triad Center to bring together a variety of earthquake hazards information users to discuss the availability and use of this information for purposes of loss reduction. The meeting was conducted by Genevieve Atwood, Director of UGMS, and was attended by geologists, planners, civil and structural engineers, and emergency management personnel representing various academic, governmental, and private interests. The UGMS presented a status report indicating the availability and state of completion of various scientific and "translated" map products related to earthquake hazards, and then opened the meeting for a discussion of user needs and ways to achieve implementation.

Information needs varied depending on the specific discipline of the user. Based on discussions at the meeting and on a compilation of responses by attendees to a questionaire, needs can be grouped into six general categories: 1) large-scale "translated" maps depicting hazards, and technical assistance in their use; 2) educational materials describing hazards in non-technical terms; 3) model hazards regulations; 4) information dissemination programs to educate public officials and citizens; 5) information on economic impacts of hazards and cost-benefit analyses of mitigation techniques; and 6) better enforcement and updating of building codes.

The problem of achieving implementation was discussed, and it was brought out that a large gap exists between the production of hazards information and incorporation of this information into policy. A major information and training program to educate users, politicians, influential groups, government officials, and the public is generally required before any policy changes will take place. It was decided that more emphasis should be placed on projects aimed at educating policymakers and the public if full implementation is ultimately to be achieved. It was noted that users from the private sector, such as the banking, insurance, real estate, utility, construction, geotechnical consulting, and development industries, are another group that needs to be reached.

EMMY AWARDS

The Rocky Mountain Region of the National Academy of Television Arts and Sciences recently awarded Emmies to Ed Yeates (writer/producer) and Bob Greenwell (photographer/editor) of KSL Television in Salt Lake City for their special documentary entitled "Not If...But When". The documentary was produced in cooperation with the Utah Division of Comprehensive Emergency Management (CEM) and funded in part by a grant from the Federal Emergency Management Agency (FEMA). It was aired January 5, 1987.

The documentary dramatized the effects of a hypothetical 7.5 Richter magnitude earthquake centered on a segment of the Wasatch fault between Brigham City and Provo. A dramatic simulation of the effects on Utah's State Capitol Building was created using a model designed and constructed by Don and Dale Christensen and Mike Condie (ASSIST, Inc.). Wasatch Front scientists summarized the current state of knowledge regarding seismic hazards along the Wasatch Front. The aftermath of earthquakes in Mexico City (1985), Idaho (1983), California, and Japan was shown and discussed. The state of Utah's preparedness was discussed with Utah Emergency Management personnel. Some of the ways in which individuals can prepare and protect their homes and families were demonstrated. The documentary was a graphically effective plea for increased awareness and preparedness on the part of all Utahns who live in "earthquake country". Congratulations to everyone involved in this production!

Videotape copies are available from Jim Tingey, Utah Division of Comprehensive Emergency Management, 533-5271.

Summaries of USGS NEHRP-Funded Implementation Projects

The USGS is funding several multi-year projects directed toward facilitating the implementation of earthquake hazards information by local governments along the Wasatch Front. Summaries of the objectives, organization, scope of work, and preliminary findings are given below for three projects being performed/administered by West Valley City, the University of Utah Geography Department, and the UGMS.

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I. West Valley City Earthquake Hazards Reduction Program
Joseph L. Moore, West Valley City Community Development Department

Scope: To compile and analyze existing geologic/seismic data as part of a citywide effort to understand and hopefully mitigate some of the consequences of a significant seismic event in West Valley City, Utah. This study of a potentially catastrophic earthquake event will be utilized in the planning and emergency management functions within City government.

Specific Objectives:

1. Define the Study Area - Phase I researched the eastern half of the City, from about 4400 West to the Jordan River and from 2100 South to about 4700 South, encompassing 13 square miles. Many major critical facilities, lifelines and various land uses are found in the study area.

2. Inventory and Digitally Map Study Area Attributes - Initially a base map at 1" = 1000' scale was produced showing streets and lot lines. Then overlays of the available geologic/seismologic data were plotted utilizing a digital mapping system. These overlays included liquefaction, faults, ground shaking, soil types, water table, landslides, and tectonic subsidence. In addition, overlays of critical facilities were digitally produced.

3. The Digital Overlay Mapping of Study Area Attributes - Once the information for the maps identified in step 2 was complete, they were overlayed with the intent of identifying high risk multi-hazards areas.

4. Target High Risk Seismic Zones - This information led to defined areas of great seismic risk. A separate map was developed displaying the high risk areas.

5. Damage and Loss Potential - Critical facilities and lifelines that were considered structurally marginal have been identified for their importance in the urban environment and the consequences of their failure.

Findings: Our intent was not to generate new information but to compile and synthesize existing geologic/seismic data. On the whole adequate information exists except in the area of ground shaking and reaction of various soil types at various depths. Some gross information was compiled but it seems quite vague for our effort. It is hoped that during 1988 there will be a new, more detailed study of the ground shaking and soil reaction issue which can be incorporated into the Phase II report.

There are three major seismic hazards that are found within the City, namely, fault lines, potential ground shaking and a secondary hazard known as liquefaction. Numerous faults are scattered across the Valley floor, some of which bisect West Valley City. Also, the valley is somewhat similar to the area around Mexico City, in that large areas of lake-bottom materials, called unconsolidated sediments, exist which can amplify a shock wave from an earthquake anywhere in the area. During this shaking it is possible for the soils, if they are saturated, to liquefy and lose their bearing capabilities causing heavy structures to topple or cause soil flows, even on very shallow slopes, such as less than 5%. Much of the study area has slopes capable of generating lateral spreading.

For the study, a map that combines the major hazards was prepared. This multi-hazard map demonstrates that almost all of the study area is expected to have problems in the event of a major earthquake. Even in the area defined as "low" hazard, the ground shaking is fairly strong, therefore structural damage can be anticipated.

The final part of the project covers possible implementation strategies. Much research had been completed utilizing examples from California and other states.

Ordinances, building code modifications, Master Plan elements and other information has been compiled for our purposes. Generally, potential strategies were reviewed, but no strategy will make much sense until the whole City is addressed in Phase II.

II. Seismic Risks and Mitigation Policies: An Assessment of Problems and Possibilities in Salt Lake County, Utah
Philip C. Emmi, Department of Geography, University of Utah

Research Objectives: A serious earthquake affecting lives and property is a real possibility for residents of the Wasatch Front. Counties and municipalities are well advised to assess the risks and take appropriate action. The goal of this study is to compile and translate research on seismic and related geologic hazards in Salt Lake County into a form which has meaning for public decision makers. Objectives include integration of hazards maps into a computer-based map file; compilation of mapped data on structures, lifelines and critical facilities; assessment of seismic risk and evaluation of mitigation policy options. The value of the project depends, in large part, on the co-operation of Salt Lake City and County planning officials in the exploration of locally suitable policy options. The project began in February of 1986 and will continue until February of 1988.

Data and Findings. To date, over fifty-eight data and digital map files have been collected. These include boundary files, digital maps on seismic and related geologic hazards, digital maps and data files on current and projected (2005) population and land use, County Assessor's data on residential, commercial and industrial structures, and digital map and data files on lifelines and critical facilities. These are maintained on a computer-based geographic information system with digital cartographic overlay and analysis capabilities.

Our most significant results to date rely on earlier studies of probabilistic estimates on maximum bedrock velocities and bedrock-to-soil transfer functions to derive estimates of the intensity and spatial distribution of seismically induced ground shaking. The result is a set of estimates describing the effects of earthquakes of such magnitude as to have a 10% chance of occurring over a 10, 50 and 250 year period. Of course, quakes with a

10% chance of exceedence over a 50 year period are smaller than those with a 10% chance of exceedence over a 250 year period. Nonetheless, even such smaller events can be intense enough in certain parts of the County (Intensity VIII) to twist off chimneys and columns, partially collapse wood-frame houses, collapse brick veneer and overturn heavy furniture. A less probable 10% - 250 year event can have similar effects in areas least susceptible to ground-motion amplification. But the effects in areas of high amplification can approach those associated with a Modified Mercalli intensity XI - broad fissures, slumps and slides; destruction of all masonry, most wood-frame structures, well-built bridges and pipelines; damage to dams and dikes; seiche action on the lake and possible subsidence of land relative to lake levels with consequent lowland flooding.

Policy Implications. Detailed implications for local public policy will be developed during a later stage of the study. Yet the simple identification and mapping seismic intensities holds significant implications for policy.

The maps of Modified Mercalli intensity indicate the potential for very serious levels of damage. They also indicate considerable spatial variation in seismically related hazards. Together, these findings imply that seismic risk can be significantly reduced by matching the locations of structures and their seismic performance characteristics to the geography of seismic hazards. In short, potential loss can be greatly reduced by closely integrating seismology and local public policy.

For further information contact:
Philip C. Emmi, Department of Geography, University of Utah, Salt Lake City, Utah 84112 (801) 581-5562.

III. Wasatch Front County Hazards Geologist Program
Gary E. Christenson, UGMS

Objectives: The principal objective of this project is to provide in-house geologic expertise to local governments (cities and counties) along the Wasatch Front to aid in the implementation of geologic hazards information in land-use planning. This is being accomplished by placing geologists in county planning departments to work with planners on a day-to-day basis for a three-year trial period. Technical supervision of the geologists is provided by UGMS, but they are employees of the county under the supervision of the planning director. Beginning in June 1985, three geologists were placed in five counties: 1) Mike Lowe, Weber-Davis Counties; 2) Craig Nelson, Salt Lake County; and 3)) Robert Robison, Utah-Juab Counties. The goals of these geologists are to compile geologic hazards information, produce "translated" maps depicting hazards, provide advice regarding ordinances and implementation of hazards maps and information, review geotechnical reports, and provide other geologic expertise as needed. The federal funding will expire in June 1988 and it is hoped that counties will take over funding of the geologists at that time and maintain them as permanent members of the planning departments.

Accomplishments: The county geologists have assembled and catalogued information regarding geologic hazards in each county into a library housed in the planning department. This information is presently being used to compile basic-data (scientific) maps depicting geologic conditions and hazards from which "translated" maps for use by planners can be derived. Compilation of basic-data maps needed to derive translated hazard maps is nearing completion. In some cases, basic-data maps have already been prepared by others. This is true for geology, soils, and depth to shallow ground-water maps. Basic-data maps depicting Quaternary faults and earthquake ground shaking are in preparation by the USGS and hopefully will be available at least in preliminary form for the area during the period of this contract. The principal basic-data maps being compiled from original mapping by the county geologists are landslide, rock-fall, and debris-flow inventory maps. These maps are 75%-80% complete. Digital elevation model tapes will be used to computer-generate slope maps needed to derive slope failure susceptibility maps.

Services provided to cities and counties include aid in developing ordinances, reviews of engineering geologic reports, and memos to planners and developers indicating potential hazards at proposed developments requiring geologic investigations. Major special projects during the period June 1986 to June 1987 have included preparation of: 1) a gravel resource assessment for county property in Davis County, 2) a surface fault rupture hazard study for a proposed Provo City landfill in Utah County, 3) the geologic hazards portion of the master plan for the city of Washington Terrace in Weber County, 4) site investigation reports for two water tank sites for the city of North Salt Lake in Davis County, 5) a review of a proposed county fire station site along the Wasatch fault in Salt Lake County, 6) the engineering geologic section for the Pineview Reservoir Clean Lakes study to control development near the lakeshore to avoid contamination in Weber County, 7) maps showing seismic and slope failure hazards for the Utah County Comprehensive Hazard Mitigation Project, 8) a geologic hazards evaluation of property owned by Payson City proposed for development in Utah County, and 9) an engineering geologic report regarding geologic hazards, slope stability, and potential for ground-water contamination at the North Davis Refuse Dump and new burn plant in Davis County. The county geologists and UGMS have also given talks to various civic groups and governmental organizations, answered public inquiries, participated in radio talk shows, and been involved in a variety of technical and policy publications related to the program. (The program and its accomplishments are summarized in the newly released issue of Survey Notes, v. 21, no. 1, 1987, "Geologic Hazards and Land-Use Planning, Wasatch Front", available from UGMS.)

Final Products: Translated hazard maps planned during the third year of the program will depict areas subject to: 1) surface fault rupture (1:24,000), 2) ground shaking (1:250,000), 3) tectonic subsidence (1:100,000), 4) liquefaction (1:48,000), 5) dam failure inundation (1:24,000), 6) rock

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fall (1:24,000), 7) landsliding (1:24,000), 8) debris flows (1:24,000), 9) seismically induced slope failure (1:48,000), 10) shallow ground water (1:48,000),and 11) problem soils and subsidence (1:24,000). Maps 3), 4), 5), 9),and 10) are already completed by others and will be evaluated by the county geologists for adoption by the county. Other maps will be compiled during the coming year of the program. An explanatory text will be prepared to accompany all maps to discuss the nature of the hazard, its probability of occurrence, and possible consequences. Maps will be at a scale of 1:24,000 to 1:250,000 as listed above, depending on the scale of the basic-data maps used in the compilation. All of these products are designed for use by planning departments in evaluating where site-specific geologic reports are required.

THE UTAH COUNTY COMPREHENSIVE HAZARD MITIGATION PROJECT

Wes Desnup
Utah Division of Comprehensive Emergency Management

Utah County and the Division of Comprehensive Emergency Management (CEM) have been involved in a unique and significant hazards mitigation project for the past two years (1985-1987). Utah County contacted CEM about undertaking such a project in their area. The only stipulation for participation that made the project unique was that the County had to provide the funding for the project. Over the past two years of the project, Utah County has provided $51,300, the State Automated Geographic Reference Section provided $25,000, FEMA provided $22,000, Orem City provided $14,500, Provo City provided $14,500, and CEM provided $5,000, for a total of $132,300. The 30th of June 1987 marked the completion of the active involvement of the State in this project and the beginning of the project under County supervision.

The goals of the Utah County Comprehensive Hazards Mitigation Project are to utilize the resources of local government in the development of pre-disaster hazard mitigation strategies and activities that will reduce the potential for life loss, property loss and liability from multiple hazard events. The five major objectives of the project are: 1) achieve an appropriate mix and level of cooperation of federal, state, and local governments and the private sector with recognition of levels of authority and jurisdiction in dealing with hazard mitigation; 2) provide a usable compilation of the best available information concerning multiple hazards at a common scale and in a format that promotes continual updating as new information becomes available; 3) provide the information and tools necessary for decision makers to make appropriate policies for hazard mitigation as part of the day to day activities of government; 4) reduce the loss of life and property associated with the occurrence of natural disasters through implementation of appropriate mitigation measures; and 5) identify and reduce the liability of local governments through that implementation of mitigation activities.

The project was built on the efforts of the FEMA-funded Utah Multi-Hazard Project applied to the Weber County/Ogden City area, and used the model developed by that project with some modifications. There are three committees providing guidance and expertise to the project:

1. The Steering Committee, comprised of representatives of the County Commission, academic community, banking community, state government and federal government, charged with overall guidance of the project.

2 The Technical Review Committee, comprised of technical experts in the various field of concern, representing the federal, state and local levels of government, private sector and academic community, to assist in the development of the mapped and written data base and analysis of mitigation techniques.

3. The Administrative Review Committee, comprised of local elected officials, planners, engineers, emergency managers, business representatives and the legal community, responsible for selecting and developing mitigation strategies and activities based on a review of the technical information and an understanding of the political, economic and social needs of the area.

The project produced several reports, maps, and an organizational structure in the county that will allow them to proceed with a continual hazard mitigation effort as part of their day to day functions. The reports that were supplied include the "Hazard Mitigation Guidebook" which outlines technically feasible mitigation alternatives that are available to local governments; the "Map Supplement and Technical Report" that provides detailed information concerning the hazards discussed as part of the project and an explanation of the mapped information; and the "Administrative Review Committee Recommendations" which outline specific mitigation activities that will meet the needs of Utah County, Orem and Provo cities. In addition to the reports, the project provided hazard maps prepared by the Technical Review Committee which included maps addressing surface fault rupture; ground shaking; liquefaction; 100-year flooding; Utah Lake elevations; dam failure inundation; landslides; debris flows; rock falls; and population distribution. The study area included the cities of Orem and Provo in central Utah County and extended northeastward to include Deer Creek Dam on the Provo River. All maps were compiled from existing published and unpublished sources with no additional air photo interpretation or field checking. All hazard maps were digitized at the State Automated Geographic Reference Section (AGR) for presentation at a scale of 1:24,000 (1"=2,000'). Maps were compiled for parts of nine quadrangles covering the study area plus some of the outlying areas.

The seismic hazard maps (surface fault rupture, ground shaking, liquefaction) are taken from the most current and detailed information presently being produced under the U.S. Geological Survey's (USGS) NEHRP and were compiled by the Utah Geological and Mineral Survey (UGMS) and the Utah County Geologist. The 100-year flood plain information is derived from the Flood Insurance Rate Maps produced by the Federal Emergency Management Agency. The Utah Lake elevation information is provided by Utah County Public Works as part of their management efforts on the lake. The Deer Creek Dam failure inundation information is provided by the U.S. Bureau of Reclamation. Slope failure hazards maps (landslide, debris flow, rock fall) included recent information from NEHRP as well as earlier mapping dating back to 1952. The Provo Geologic Hazards Study information was provided for Provo City in 1984 by International Engineering Company, Inc. The population distribution information is provided by the Mountainlands Association of Governments. Some of the information used to compile the maps and report is preliminary, and will be updated as new information and mapping become available. Each map directs the user to seek more current information prior to making a decision

and identifies the most likely and appropriate sources for that information.

The committee approach of the project, involving multiple jurisdictions and functions, provides the necessary checks and balances to keep the project within the realms of reality. This coupled with the strong support of a respected county advocate has provided the leadership and direction to keep the project moving. The direct financial support of the project by the county commission and city councils helped strengthen the project by allowing it to focus on the local needs rather than state or federal needs that all to often override the local concerns.

Difficulty identified by the project was the lack of availability of technical data. There is a tremendous amount of hazard information that is not accessible in a short period of time. This resulted in the use of some data that, while better than ignoring the hazard, may have created some confusion without extensive interpretation. The project attempted to steer the cities and county into extensive use of the county geologist to overcome this problem, however, it remains a concern that must be understood by the users of the data. The data base is also constantly changing, making the mapped data obsolete very shortly after it is mapped. The data must be constantly updated to insure that the decisions based on the data will be appropriate. The use of the digital data base and the computer programs for mapping will keep the costs of a current data base in check.

The end of the direct participation of the State in this project through the project manager is a planned and desired element of the project. The design was to use the outside influence of the project manager to get the most out of the federal and state resources and to get the data and tools organized for efficient use by the Administrative Review Committee and the local government officials. The project has reached the point at which the county and cities can effectively and successfully manage and direct the implementation of the project recommendations as outlined by the Technical Review Committee and the Administrative Review Committee.

In summary, the project has been very successful in identifying hazards, creating tools to assist decision makers, organizing a core of trained, concerned public and private sector individuals, and preparing a set of recommendations that deal specifically with Utah County, Orem and Provo cities. The amount of money spent has provided products and services well in excess of the dollars spent.

ENERGY SYSTEMS AND DISRUPTION

Lorayne Frank
Director, Utah Division of
Comprehensive Emergency Management

A two-year federally-funded study, completed at the Utah Division of Comprehensive Emergency Management (CEM), Idaho State University (ISU), and Eastern Oregon State College (EOSC), examined the vulnerability of the Wasatch Front energy supply systems to disruption through a catastrophic event, such as an earthquake. Included was planning for energy emergency mitigation, preparedness, and response. The study was done by Drs. Fred May and Charles Pace, and several graduate research assistants and university interns. Some of the main ideas are highlighted below.

In a moderate earthquake, electrical supply systems tend to sustain damage. For example, the brittle nature of the electrical system supplying the San Fernando, California, area during a 1971 Richter Magnitude 6.5 earthquake has been demonstrated and is of concern to Utahns. That earthquake resulted in 65 deaths and $1 billion in damage. Each kind of major electrical component within that system was affected and the system shut down. The two-year CEM study demonstrates how the main Wasatch Front energy supply systems are interdependent, with the Achilles Heel being the electrical system. Several of our supplying oil fields operate on electricity, as do pipelines, refineries, product terminals, and gasoline service stations. Natural gas systems also run on electricity, but to a lesser extent, and appear to be less vulnerable.

One interesting insight into energy system impact caused by an electrical disruption was the statewide power outage of July 6, 1985, when a single bolt of lightning struck the Terminal Substation in west Salt Lake City (the cause could have been another kind of event, including earthquake). The resulting minor damage to the substation had far reaching effects, shutting down most of the Utah electrical supply system for several hours. Going relatively unnoticed, however, was the associated shut down of the crude oil and petroleum products supply system for both Utah and Idaho. Shutdowns were observed in pipeline pump stations, dispatch offices, refineries, products terminals, and gas stations. The damage to oil refineries, especially to catalytic crackers, took a few days to repair before full operation was again possible. The natural gas system continued to function, however, and the Mountain Fuel Supply insignia burned brightly over a darkened Salt Lake City, due to the company's cogeneration of power. A mitigation recommendation of the two-year energy study is that each major energy supplier have backup power.

Irregardless of the cause, the risk and loss could be surprisingly high and the recovery difficult. An MS Thesis prepared by David Zimmerman at ISU, and funded by the project, indicates that replacement of the 124,000 barrels-per-day of Utah-refined petroleum products could be as low as 50 percent. Although the estimated 50 percent figure is not well understood, still it is not difficult to estimate the number and availability of railroad tank cars and truck tankers needed to replace the lost product. The unknown factor in the formula is entrepreneurial ingenuity. The refineries in North Salt Lake supply two states, Utah and Idaho. Following a major earthquake, it is likely that transportation routes will be damaged as will the usual receiving and delivery facilities for petroleum products. The impact in the winter time, when more energy is required, could be substantially greater than in the summer. Winter power outages result in greater damage to pipelines, pump stations, refineries, substations, and other facilities. However, fires at refineries could cause the greater damage and be the overall limiting factor for the system.

A main objective of the two-year study was to develop generic types of planning for major energy emergency mitigation, preparedness, and response. The major responsibility to repair damaged energy systems and restore and maintain operation lies with the energy industries themselves. However, government has its responsibilities, separate from industry's. CEM plays a coordinative role for State government's responsibilities during major energy emergencies, working with the specialized State sister agencies to lessen overall impact on the

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public and public facilities. Ample credit must be given to the energy industries which have concentrated on developing their energy emergency plans due to their concern for citizens and to the belief that a major earthquake, or other catastrophe, could happen. Energy suppliers are surprisingly well prepared, maintaining staff that concentrate on developing and maintaining these plans.

Should a major earthquake occur there is no way to totally eliminate impact from damaged energy supply systems within our communities, streets, homes, schools, and work places. Risk comes with the expected way of life. The risk is lessened, however, through mitigation, preparedness, and response planning, not only in industry and government, but also by individuals. The weakest link lies in individual planning, but strides are being made here through the development of instructional programs, including video documentaries [see related news article on Emmy Awards - ed.], at the federal, state, and local levels. The key to saving lives and lessening damage from a major catastrophe lies in enhancing capabilities down to the individual level. Implementation objectives of this and other CEM projects are directed toward each level.

UGMS EARTHQUAKE EXERCISE

William F. Case
Utah Geological & Mineral Survey

On the morning of the last day of March, 1987, a hypothetical 7.5 M_L earthquake occurred along the Wasatch fault in south Salt Lake Valley, near Sandy, Utah. According to the scenario, the ground surface was ruptured over 25 km along the Salt Lake segment and was vertically displaced up to 3 m. Three aftershocks with magnitudes ranging from 4.7 to 5.3 M_L, occurred within a four-hour time span. Major transportation arteries, aqueducts, and communication lines were severed; hospitals and shopping malls had to be evacuated; the international airport was out of service for a few hours; large building facades collapsed; city streets were choked with debris; and the Emergency Broadcasting System was out. There were surface ruptures, seiching and hundreds of landslides and rock falls. Liquefaction and ground shaking damaged two dams, cracked foundations of hundreds of buildings, and started refinery fires. Waters from the Great Salt Lake encroached inland and flooded thousands of buildings due to tectonic ground subsidence as much as 1.5 m.

Miraculously, no fatalities occurred, in fact, no one was injured. The hypothetical event started two concurrent earthquake response exercises; a Division of Comprehensive Emergency Management (CEM) exercise which involved at least 15 governmental and emergency agencies; and a Utah Geological and Mineral Survey (UGMS) exercise which involved most of the UGMS staff and facilities. The UGMS exercise was funded by a grant from the Federal Emergency Management Agency.

Legislative mandates of the Utah Geological and Mineral Survey include: A) the assessment of public risk by geologic hazards, and B) the documentation of short-term and long-term geologic hazard phenomena. The UGMS Earthquake Response Plan defines the following personnel responsibilities to satisfy the mandates. Immediately after an event senior personnel will assume emergency response roles. Other staff members will check on the safety of their families and then report to the designated UGMS center for duty. A Geologic Advisory Group will be formed to assist the Governor and will consist of the UGMS director as chairman, and representatives of the University of Utah Seismograph Stations or Department of Geology and Geophysics, the United States Geological Survey, and the Senior Geologist for Applied Geology from UGMS. They will get support and advise from the section chief of UGMS Site Investigation Section who will receive information on geologic phenomena and requests for assistance. The Geologic Advisory Group will be located at the State Emergency Operations Center as established by CEM. The UGMS Deputy Director will remain at the UGMS center to deploy resources and investigative teams as directed by the Geologic Advisory Group. Investigative teams will consist of experienced people from the Applied Geology program to assess public risk and personnel from the Mapping program to map geologic hazards. Geologists from the Economic program and staff members with a geologic background will provide needed support.

Instructions given to William F. Case (UGMS), by senior members of the survey, were to design an earthquake exercise to occur in the morning within a designated four-week period, which would A) test the continuity and feasibility of the UGMS Earthquake Response Plan, B) give emergency response experience to UGMS staff members, and C) indicate what facilities, supplies, and equipment should be acquired by the UGMS. CEM provided facilities, radios, and resource personnel for the UGMS exercise. James P. McCalpin, Utah State University Geological Department, and T. Leslie Youd, Brigham Young University Department of Civil Engineering served as technical advisors for the project. McCalpin provided expertise on phenomena expected to occur along the Wasatch Range foothills and Wasatch fault scarps, and Youd covered liquefaction and ground response situations on the valley floor. All earthquake damage phenomena portrayed during the exercise took place at reasonable locations and at expectable magnitudes of damage, although it is not necessarily true that, during a major earthquake, all phenomena will be displayed at once. The selection of structures to fail in the exercise was not based on evidence that they would fail in an actual earthquake.

The UGMS earthquake exercise consisted of approximately 60 damage reports of phenomena such as liquefaction, ground shaking, surface rupture, seiche, structural failures, flooding, and landslides. Several areas of damage were "hot spots", i.e. they suffered different types of damage in a small area, some of which were reported by the investigative team after they had arrived at the site. Although most of the messages were legitimate, there was a sprinkling of messages with incomplete, sometimes misleading data, or incorrect addresses, to mimic real-world damage reports. Reports of damage were given to the communication person in the form of a list of messages of thirty words or less (the maximum message size accepted by the Emergency Operations Center during a real emergency) to be acted on in chronological sequence. Updates of disrupted transportation routes were passed on to the Deputy Director. Agencies participating in the CEM exercise and the Geologic Advisory Group were housed in a CEM classroom which served as the Emergency Operations Center. UGMS personnel at the Emergency Operations Center consisted of the UGMS Director, a communications person (UGMS Site Investigation Chief), and an advisor (UGMS Senior Geologist for Applied Geology). Communication to the Deputy Director at UGMS and to investigative teams was via handheld VHF radios on loan from CEM. Advisors had to interpret damage reports considering possible public risk, or decide if the phenomenon should be investigated, and how quickly. They would then ask the Deputy Director to send an appropriate investigative team to the site. The Deputy Director

had to mix and match available personnel, radios, and vehicles to form investigative teams as well as offer suggested routes to the site. The timing of transportation route disruptions required some investigative teams to return by a different route. During the exercise, the Deputy Director held a team in reserve anticipating future messages from suspect areas. Investigative teams were expected to serve as geologic observers as well as reporters. Some locations or routes to locations had geologic hazards other than those reported. Teams were expected to quickly sketch such hazards on topographic sheets, while enroute and at the site. Questions to be answered by the investigative teams at the site, along with a xerox copy of a picture, taken from textbooks or personal libraries, of the phenomena expected at the site, were listed in an Investigative Team Packet given to the team by the Deputy Director. The Emergency Operations Center received reports directly from the investigative teams by radio; in person, from teams with no radios; and by radio relay when one of the radios malfunctioned. UGMS Director/Geologic Advisory Group Chairman periodically gave synopses of damage reports and investigative team results and explained the meaning and extent of the geological phenomena to the other agencies at the Emergency Operations Center.

What was learned? The exercise brought together diverse geologic hazard phenomena, looked at sites in the Salt Lake Valley where they might occur, and estimated the risk if they did occur. Communication lessons were learned, from deciphering damage report messages; instructing and receiving reports from investigative teams; to discussing, within and outside the Emergency Operations Center, the implications of various geologic hazards. Learning how to communicate clearly and concisely over the radio was an important lesson of the exercise. All UGMS radio conversation included the message "This is an exercise." A communication link between Colorado and Utah was tested; the Earthquake Information Center announced the magnitude and location of the main shock and aftershocks by phoning FEMA Region 8 who then transmitted the data to CEM. The exercise also tested the facilities, equipment, and resources of UGMS. Communications radios have since been installed in all UGMS vehicles. One of the first things the Deputy Director did during the exercise was to assign staff to obtain pertinent copies of 1:24,000 scale topographic quadrangles from the USGS Public Inquiry Office (PIO). The PIO is maintaining a reserve of at least 50 copies of all Wasatch Front 1:24,000 scale maps for use in an actual emergency. The 1:24,000 scale maps that were needed for mapping purposes proved inadequate for locating sites and posting developments. Up-to-date street maps and 1:100,000 scale regional maps were also needed. Support people, particularly damage report recorders, factotums, and map plotters, were needed and should have been included in the UGMS Earthquake Response Plan. Hopefully the questions and observations completed by the investigative teams will help teach them what to look for in case of a future real event. UGMS decision-making muscles were flexed during the exercise; advisors had to determine the importance of messages concerning the type of damage and where it occurred, and quickly decide what action to take. All personnel involved considered the exercise important and acted professionally and seriously. The UGMS Earthquake Response Plan is being revised to reflect the experience gained in the exercise.

FEMA/CEM SPONSORED COURSES ON EARTHQUAKE HAZARD MITIGATION

Jim Tingey
Utah Division of Comprehensive Emergency Management

Two training courses on earthquake hazard mitigaytion were held in the months of June and July. The courses,"Nonstructural Earthquake Hazard Mitigation for Hospitals," and "Earthquake Hazard Mitigation for Utility Lifeline Systems" were cosponsored by the Federal Emergency Management Agency (FEMA) and the Utah Divison of Comprehensive Emergency Management (CEM).

These training sessions were designed to educate the target audience in the level of seismic risk and techniques to mitigate the risk from a moderate to large earthquake event. Heavy emphasis is placed on developing agency or company plans for response to such an event as well as measures which may be implemented to reduce injury and damage to these critical facilities.

The courses were developed by teams of experts through the National Emergency Training Center (NETC) in Emmitsburg, Maryland. Both courses were piloted at NETC and field tested in other locations before they were conducted in Utah.

CEM was responsible for contracting the faculty, logistics and generating a proper audience for both courses. Parts of the workshops which necessitated more detailed (Utah specific) instruction were conducted by CEM staff.

The principal faculty for the hospital course was Christopher Arnold of Building Systems Development Inc., San Mateo, California; Michael Durkin of Michael Durkin and Associates, Woodland Hills, California; and Bruce Baird of Safety Sciences Inc. Representatives of eighteen major health care facilities along the Wasatch Front were in attendance.

Instruction for the Utility Lifeline course was by Ronald Eguchi of Dames and Moore, Los Angles. His instruction team consisted of William Gates, Dames and Moore; C.B. Crouse, the Earth Technology Corporation, Long Beach, California; Peter McDonough, Mountain Fuel Supply Company; Lawrence Reaveley, Reaveley Engineering; and DeeEll Fitfield of CEM. Over fifty administrators, engineers and safety personnel representing twenty companies and public utility groups were in attendance.

Because of the success of these two field courses, it is probable that FEMA will offer other locally sponsored earthquake mitigation courses which will target other audiences in the high risk areas of the Wasatch Front.

A tentative listing of courses (with dates) offered at NETC which focus on earthquake related topics is below.

For information about attending these and other courses offered through the NETC contact Leo Kelland, or Jim Tingey at CEM (801) 533-5271.

Nonstructural Earthquake Hazard Mitigation for Hospitals and other Health Care Facilities
Jan 10-11, 1988

Multi-Hazard Planning Course
Dec 7-11, 1987
Feb 29-Mar 11,1988
May 2-13, 1988
May 6-17, 1988
Aug 8-19, 1988

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National Earthquake Hazard
Reduction Program - Seismic
Building Provisions
Jan 4-8,1988

Business Emergency Preparedness Seminar
Dec 14-18, 1987
Jun 14-17, 1988

Geobased Mapping Application
in Emergency Management
Mar 14-18, 1988
Apr 25-29, 1988
Aug 15-29, 1988

PLAN FOR FEDERAL RESPONSE TO A CATASTROPHIC EARTHQUAKE

Jim Tingey
Utah Division of Comprehensive Emergency Management

The Federal Government is in the process of coordinating and integrating a plan for their response to a major earthquake. This plan is based on the fundamental assumption that a catastrophic earthquake will overwhelm the capability of State and local governments to adequately respond. The principal purpose of the plan is to save lives and protect property through an organized response using Federal resources.

The plan is authorized under the provisions of Public Law 93-288, the Disaster Relief Act of 1974, and Public Law 95-124 the Earthquake Hazards Reduction Act of 1977. In the event of a major earthquake, the President of the United States will appoint a Federal Coordinating Officer (FCO) to coordinate response and delivery of Federal Assistance. Federal Officials from the many government agencies with response assignments will be under the management and direction of FCO.

Planning responsibility is assumed by the Subcommittee of Federal Earthquake Response Planning, which is an interagency organization for overall planning coordination and exercising. The subcommittee is chaired by the Federal Emergency Management Agency (FEMA) and includes representatives of each of the Federal departments identified in the plan.

This intensive planning effort was given great impetus by the 1985 Mexico earthquake, which showed the vulnerability of heavily populated areas to severe ground shaking. Although the plan is mainly directed toward response to a catastrophic earthquake, the plan stipulates that it may be used under other emergency conditions. The plan has been signed at the highest level by the following Federal Agency heads: Secretary of Agriculture; Assistant Secretary of Army; Executive Agent, Department of Defense; Secretary of Commerce; Secretary of Education; Secretary of Energy; Secretary of Health and Human Services; Secretary of Interior; Assistant Attorney General for Administration; Secretary of Labor; Under Secretary of State for Management; Secretary of Transportation; Assistant Secretary of the Treasury; President of the American Red Cross (not a Federal Agency); Assistant Secretary of the Army; Administrator of the Environmental Protection Agency; Managing Director of the Federal Communications Commission; Director of the Federal Emergency Management Agency; Administrator of the Federal Services Administration; Chairman of the Interstate Commerce Commission; Administrator of NASA; Manager of National Communications System; Chairman of the Nuclear Regulatory Commission; Director of the Office of Personnel Management; the Postmaster General; and the Administrator of the Veterans Administration.

This comprehensive representation ensures that all capabilities and resources may be accessed when needed. The high level auspices also gives regional and state planning the necessary channels for preparedness activities.

Each Federal agency has primary or secondary responsibilities under eleven Emergency Support Functions identified in the plan below.

Over the next several months it will be the responsibility of FEMA Region VIII (Headquarters in Denver, includes the states of North Dakota, South Dakota, Colorado, Wyoming, Montana and Utah), to integrate the plan with the Federal mandate and with states under their jurisdiction. The Wasatch Front area is the highest seismic risk area in Region VIII.

EMERGENCY SUPPORT FUNCTIONS

1. Transportation
2. Communications
3. Construction Management
4. Fire Fighting
5. Damage Information
6. Mass Care
7. Resources Support
8. Health and Medical Services
9. Urban Search and Rescue
10. Hazardous Materials
11. Food

ESF / ORG	1	2	3	4	5	6	7	8	9	10	11
USDA	S	S	S	P	S	S			S	S	P
DOC				S	S	S				S	
DOD	S	S	S	S	S	S	S	S	P	S	S
DOEd					S						
DOE			S		S		S			S	
DHHS					S	S	S	P	S	S	S
DOI	S	S	S	S	S	S			S	S	
DOJ							S			S	
DOL			S						S	S	
DOS										S	
DOT	P	S	S	S	S		S	S	S	S	S
ARC					S	P		S			S
USACE	S		P	S	S			S			
EPA			S	S	S					P	
FEMA	S	S	S	S	P	S	S	S	S	S	S
GSA	S	S	S	S	S	S	P		S		
ICC	S										S
NASA					S						
NCS		P			S		S				
NRC					S					S	
OPM							S				
USPS	S					S					
VA					S	S	S	S	S		

P - primary agency: responsible for management & coordination of ESF
S - secondary agency: responsible for supporting the primary agency
Note - in addition to the above organizations, the Federal Communication Commission and the Department of the Treasury participate as required.

The Utah Division of Comprehensive Emergency Management will be working closely with FEMA Region VIII planners to integrate their plan with Utah's State/Four County Earthquake Response Plan. Major planning steps yet to be worked out include the location in Utah of the Federal Response Command Center which will be staffed 24 hours a day during the disaster response, by over one thousand Federal and Regional personnel. Transport of equipment and personnel and reliable communications will also require detailed advance planning. The experience of FEMA Region IX, which contains California, will help in establishing the proper procedures for our area.

Major advantages for states and local governments are the basic planning assumptions which activate the plan at the Federal level. In the past, Federal response may have been delayed by procedures which require formal Disaster Declarations by counties, states and the President. The new plan states that it will be implemented immediately (without a formal request) and that Federal assistance will become available immediately under the Disaster Relief Act of 1974.

With this procedural assumption it then becomes a coordination problem at the state level to be able to manage judicially, the resources which will become available. The Utah Division of Comprehensive Emergency Management believes that although a major earthquake along the Wasatch Front will cause catastrophic damage, very soon after the event it may not be a matter of a lack of resources, but how best to use available resources to expedite the process of saving lives and property.

[A limited number of copies of "Plan for Federal Response to a Catastrophic Earthquake" are available and may be obtained by writing FEMA, P.O. Box 70274, Washington, DC 20024.]

NCEER Begins in New York

The National Center for Earthquake Engineering Research (NCEER) has started operations at SUNY-Buffalo. NCEER has started publishing a "Bulletin". The first issue (Vol. 1 No. 1) dated April 1987 describes the NCEER programs and describes how individuals, corporations and academic institutions can subscribe or become members at various levels. Also now available is the 1986-1987 Annual Report of the National Center for Earthquake Engineering Research, 32 pages. For copies of either publication or more information, write to: NCEER, State University of New York, 14214-9980, or call 716-636-3391.

PRELIMINARY RESULTS OF A PALEOSEISMIC INVESTIGATION ON THE SPANISH FORK SEGMENT OF THE WASATCH FAULT IN MAPLETON, UTAH

WILLIAM R. LUND, UGMS
and
DAVID P. SCHWARTZ, USGS

INTRODUCTION

In June, 1987, five trenches at two sites were excavated across the Wasatch fault, where it passes east of the town of Mapleton, Utah. The trenching was part of a cooperative UGMS/USGS study to investigate a part of the fault for which there was no information on timing of past earthquakes. The trench sites lie along the recently proposed Spanish Fork segment (Machette and others, 1986), which is approximately the southern 1/2 of the original Provo segment proposed by Schwartz and Coppersmith (1984). One of the eventual results of this study will be to help resolve uncertainties about segmentation of this part of the Wasatch fault.

SITE DESCRIPTIONS AND GEOLOGY

The two trench sites are located along the Wasatch fault within 0.8 km of each other in the southeast corner of Mapleton, Utah (see figure 1). Two trenches were excavated at the northern site (Mapleton north) and three at the southern site (Mapleton south).

Mapleton North

The Mapleton North site is at an elevation of about 1525 m, placing it approximately midway between the Bonneville and Provo shorelines of Pleistocene Lake Bonneville. At the site, the Wasatch fault consists of a single main trace that displaces Holocene alluvial-fan deposits at the mouth of Big Slide Canyon. The fan is beheaded, with the apex on the upthrown block. Total height of the scarp is 18 m. Scarp heights a few hundred meters to the south, where the fault displaces older Lake Bonneville sediments, are as high as 28-30 m. The fan surface on the downthrown block is back-tilted toward the east, and a graben associated with the most recent event (MRE) is almost completely filled by post MRE debris-flow deposits and colluvium.

Trench MN-1 was 56 m long and extended from the main fault zone west across the graben and all recognized antithetic faulting. Total width of the zone of deformation associated with the fault is 44 m. Trench MN-2 was 16 m long, and was excavated across the antithetic faults that form the west side of the graben. Stratigraphic units exposed in the trenches range in age from post-Lake Bonneville/pre-MRE alluvial-fan deposits in the footwall of the main fault, to a historical debris flow that buried various farm and cultural artifacts lying on the fan surface. The artifacts are thought to date from the 1920s or 30s. Debris-flow deposits were exposed in the trenches west of the main fault zone. Adjacent to the main fault, the graben-fill material consists of interbedded debris-flow deposits, well-sorted fluvial gravel, and colluvium derived from the fault scarp and mountain slope to the east. Distinctive within the trench stratigraphy is a gray, organic debris flow on which a black "A" horizon soil has developed. Buried everywhere in both trenches by younger deposits, this gray debris flow could be traced continuously from west of the graben into the main fault zone. In addition to serving as excellent marker horizons, both the debris flow and the associated soil contain abundant charcoal suitable for ^{14}C dating. A second charcoal-rich zone lies just above a weakly developed soil found in portions of the graben. The charcoal is associated with deposits younger than the gray debris flow, and clearly represents a burn layer resulting from a prehistoric range fire.

Mapleton South

The Mapleton South site is also located between the Bonneville and Provo shorelines of Pleistocene Lake Bonneville. It is at an elevation of about 1500 m at the mouth of an unnamed draw between Big Slide and Crowd Canyons (see figure). Trench MS-1 was 33 m long, and was excavated in a small alluvial fan formed by the ephemeral stream that drains the draw. The Wasatch fault, at the site, consists of an eastern main trace with a scarp more than 20 m high, that has been involved in repeated surface-faulting events since Bonneville time. A parallel

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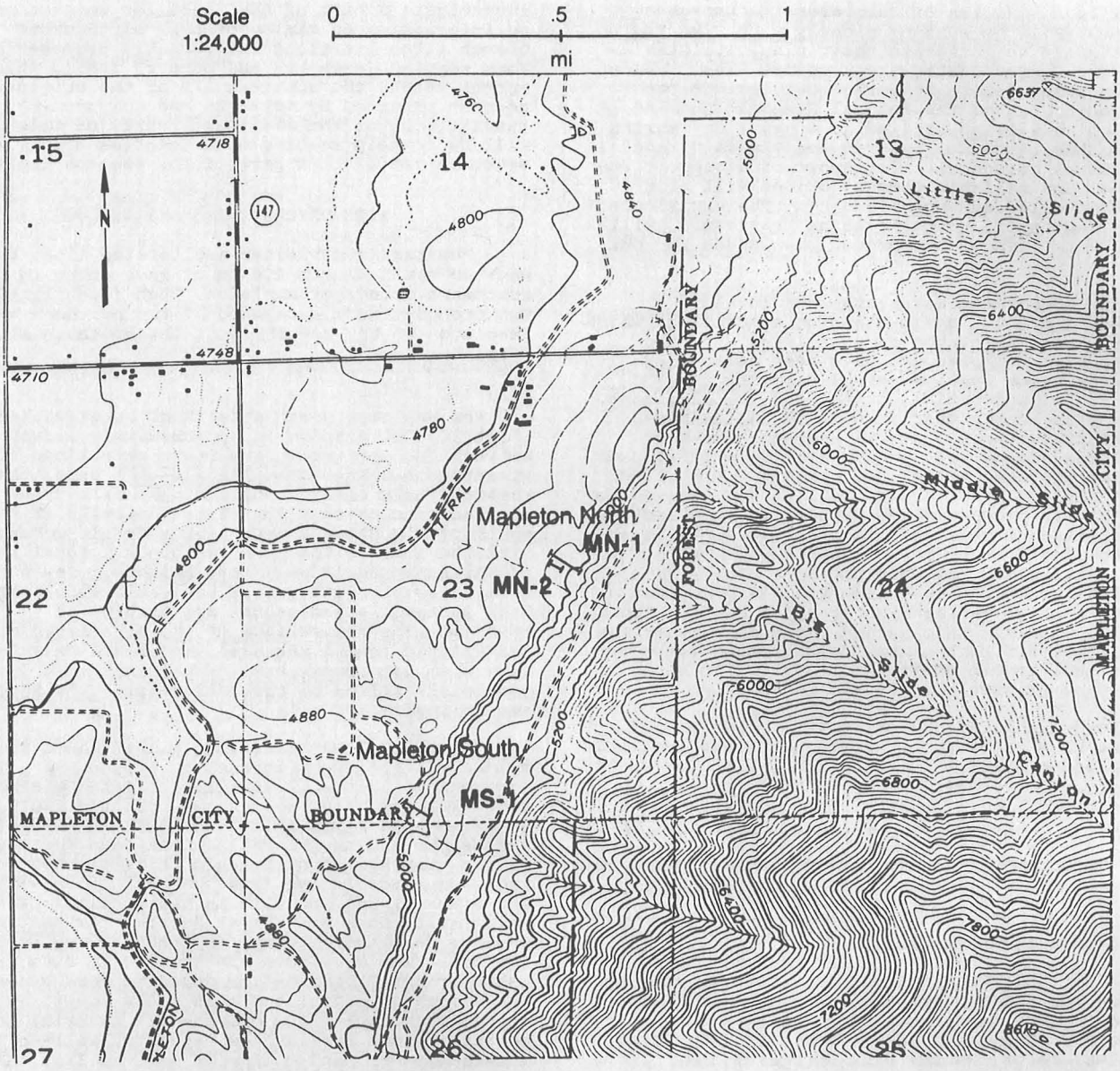

Figure 1. Map showing Mapleton exploration trench locations.

trace a few tens of meters to the west is expressed by a smaller, west-sloping scarp 5 m high. The faults which formed the western scarp were active only during the MRE. The fan surface between the two scarps is back-tilted to the east, highly faulted, and the location of graben formed during at least the last two surface-faulting events. The west-dipping faults that form the western scarp do not have an associated graben. The graben that developed adjacent to the main trace during the MRE is now nearly filled with post-event debris-flow and slope-wash deposits.

Stratigraphic units in the trench ranged from transgressive Lake Bonneville beach gravel and deeper water silty sand deposits in the footwall to slope colluvium postdating the MRE. As was the case with the Mapleton North site, debris-flow deposits made up the largest percentage of units exposed in the trench. They ranged from very coarse-grained flows containing numerous cobbles and boulders to much finer, matrix-supported units consisting chiefly of fine gravel, sand, and silt. Two distinctive paleosols were recognized, one developed on the oldest debris-flow (alluvial-fan) unit on the downthrown side of the fault, and a younger, less extensive soil that formed in the graben between the two scarps.

TIMING AND SIZE OF FAULTING EVENTS

Mapleton North

The Mapleton North trenches showed clear evidence for the MRE in both the main and antithetic fault zones. Evidence of a prior event exists only on one small antithetic fault exposed in trench MN-1. There, the amount of displacement in an older debris-flow deposit is greater than that in strata of younger age. A small colluvial wedge is also present adjacent to the twice-faulted older unit. Evidence of the prior event is lacking along the other faults because the older unit is downdropped below the bottom of the trench.

The abundance of charcoal at various stratigraphic levels in the Mapleton North trenches allows the timing of the MRE to be constrained with a greater degree of accuracy than has been possible

at other sites on the Wasatch fault. Charcoal was collected from the "A" horizon soil developed on the dark gray debris flow that serves as a stratigraphic marker in the trenches. The soil horizon is displaced by the MRE, but not by the prior event. The charcoal yielded a radiocarbon date of 770 (±100) ^{14}C yr B.P. which converts to a calendar age of 690 cal B.P. (years before 1950) or 1260 A.D. This is a maximum limiting date for the most recent surface-faulting event. Charcoal collected from the unfaulted burn layer that is younger than the MRE was dated at 445 (± 70) ^{14}C yr B.P. This converts to a calendar age of 510 cal B.P. or 1440 A.D. Taking into account the uncertainty of each radiocarbon date, the period during which the MRE could have occurred is 1170 A.D. to 1480 A.D. The preferred range, however, for the timing of the MRE at this point on the fault is a 175 yr time window beginning 1265 A.D. and ending 1440 A.D.

Formation of a 2 m deep graben and back-tilting at the main fault during the MRE produced a 5 to 6 m high main scarp. However, preliminary results of scarp profiling indicate that the actual net vertical slip at Mapleton North during this event was between 2 and 3.5 m.

Mapleton South

The trench at Mapleton South exposed evidence for the two most recent surface-faulting events on this segment of the fault. Numerous high angle, west and east dipping faults were present in the trench, particularly in the area between the two scarps. Evidence for two events was provided by the extent to which individual faults displaced stratigraphic units of different ages, and the presence of two colluvial wedge deposits, the older of which is faulted, associated with the main fault zone. Some faults were active only during the older event, others only during the most recent event, and a few during both.

The timing of the MRE at Mapleton South cannot be constrained by radiocarbon because of an absence of charcoal. However, based on its proximity (0.8 km) to Mapleton North it is likely that the same event occurred at both locations. Determination of the timing of the older event at Mapleton South awaits the results of age date analyses on various types of samples submitted for testing. Because charcoal is not abundant at Mapleton South, the dating of surface-faulting events must rely on a combination of accelerator radiocarbon dates, mean residence time analyses of bulk soil samples, and thermoluminescence dating. At present, only a preliminary thermoluminescence date is available for the soil developed on the debris-flow deposit faulted by the older event. It gives a date of 5000 ± 1000 years, and represents a preliminary maximum limiting date for the older event. Charcoal and bulk soil samples have been submitted from the soil horizon for dating. Additional charcoal and soil samples collected from stratigraphic units deposited during the time interval between the two events are scheduled for analysis. They will provide a minimum date for the occurrence of the older event.

SUMMARY

Well constrained radiocarbon dates obtained from charcoal collected from exploration trenches excavated across the Wasatch fault where it passes near Mapleton, Utah show that the MRE at this location occurred sometime between 1265 A.D. and 1440 A.D. A preliminary thermoluminescence date indicates that one other surface faulting event occurred on this segment within the past 5000 ± 1000 years. Additional samples collected for dating should allow the timing of the older event to be more closely determined, thus giving a measurable interval between surface-faulting events during the mid to late Holocene. Preliminary results of scarp profiling indicate that the net tectonic displacement during the MRE at this location was in the range of 2-3.5 m.

The results of this and other paleoseismic investigations along the Wasatch fault increase our understanding of the pattern of the fault's past behavior. Hopefully, this will eventually allow us to forecast where and when the next large earthquake is most likely to occur on the Wasatch fault zone.

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FAULT TRENCH STUDIES ON THE WASATCH FAULT ZONE

Douglas A. Sprinkel
Utah Geological and Mineral Survey

The Utah Geological and Mineral Survey (UGMS) and the U.S. Geological Survey (USGS) are currently engaged in a joint effort to further understand the paleoseismicity of the Wasatch fault zone. These studies, which are funded through the "Regional Earthquake Hazards Assessment: Wasatch Front Area" element of the National Earthquake Hazards Reduction Program, include investigations of several trench sites excavated across mapped fault traces of the Wasatch fault zone. Today's efforts are the continuation of USGS work that began in 1983 with detailed mapping of fault traces and Quaternary geology along the Wasatch Front urban corridor. That led to the first of several UGMS-USGS trench excavations commencing in 1985 where UGMS and USGS scientists worked together collecting data to determine number of events, amount of displacement per event, recurrence intervals, slip rates, and time of last event for major earthquakes. Current and future paleoseismic studies will add to the present data base and provide critical information that will further characterize fault behavior for each fault segment and increase our understanding of the extent of earthquake effects along the Wasatch fault zone. Ultimately, the information derived from these studies will be used for more precise earthquake hazard assessment and loss estimation models along the Wasatch Front urban corridor.

The Wasatch fault zone extends 320 km from near Malad City, Idaho, southward to near Fayette, Utah. It has been divided into at least 6 fault segments suggested by Schwartz and Coppersmith (1984) and as many as 10 to 12 segments (Fig. 1) suggested by Machette and others (in press). In 1985, the Dry Creek site became the first of these cooperative studies along the Wasatch fault zone (Fig. 1). It

was followed in 1986 with sites at Brigham City, East Ogden, and American Fork Canyon. In 1987, sites were opened at Mapleton, Red Creek, and Skinner Peak.

The Dry Creek site is between South Fork Dry Creek and Dry Gulch, south of Little Cottonwood Canyon on the Salt Lake City segment. It consisted of four trenches excavated across multiple faults scarps that form a 300 m-wide zone (984 ft) and was investigated by William R. Lund (UGMS) and David P. Schwartz (USGS). The Brigham City site is in the eastern part of Brigham City, north of Box Elder Canyon on the Brigham City segment. Three trenches were excavated, one near the mouth of Bott Canyon and the other two at the mouth of Bowden Canyon. This site was investigated by Stephen F. Personius (USGS) and Harold E. Gill (formerly UGMS). The East Ogden site is just north of Ogden Canyon and east of Harrison Blvd. at the east end of 9th street. This site is on the Weber segment, consisted of five trenches across multiple scarps, and was investigated by Alan R. Nelson (USGS) and Robert H. Klauk (UGMS). The final site excavated in 1986 was immediately south of American Fork Canyon on the American Fork segment. Three large trenches were excavated at the American Fork Canyon site and they were investigated by Michael N. Machette (USGS) and William R. Lund (UGMS).

Work on the three newest sites began on June 1, 1987, and were closed in early October 1987. Mapleton, which is the largest of the three sites, is on the Spanish Fork segment near the town of Mapleton. It consists of three trenches being investigated by William R. Lund (UGMS) and David P. Schwartz (USGS) (see article by Lund and Schwartz, this issue). The Red Creek site is near the mouth of Red Canyon just northeast of Nephi and Interstate I-15, on the Nephi segment. The Skinner Peak site is about 20 miles south of Levan near the mouth of a small canyon just north of Skinner Peak, on the Levan segment. The latter two sites (Red Creek and Skinner Peak) consist of one trench each and are part of a UGMS-USGS-University of Colorado cooperative study being investigated by Mike Jackson, University of Colorado, Boulder.

Initial paleoseismic studies on the Wasatch fault zone were conducted by Woodward-Clyde Consultants in 1977 with trench investigations at Kaysville, Little Cottonwood Canyon, Hobble Creek, North Creek, and on the East Cache Fault at Logan (Fig. 1). The Deep Creek site on the Wasatch fault zone near Levan was an arroyo exposure and not trenched as were the other sites. Each of the sites were on different fault segments. Information on the Kaysville, Little Cottonwood Canyon, Hobble Creek, North Creek, and Deep Creek sites are summarized by Schwartz and Coppersmith (1984) and Schwartz and others (1983). Information on the recent trench studies are found in the Geological Society of America 1987 Abstracts with Programs, Rocky Mountain Section, by Machette and Lund; Machette; Lund and Schwartz; Nelson and Klauk; Personius and Gill; and McCalpin. A new report by Machette and others (1987) summarizes current information on all trench investigations along the Wasatch fault zone.

Information derived from the trench excavation studies yield evidence that most Quaternary fault scarps along the Wasatch fault zone are sites of multiple surface rupture events that displace the ground surface about 2 m (6.5 ft), but can be as much as 4.75 m (15 ft). Also, each segment behaves independently producing a unique faulting history with its own recurrence interval, number of events, and slip rate. Machette and others (1987) suggest large surface rupturing events tend to occur more frequently on medial segments (Brigham, Weber, Salt Lake, American Fork, Provo, Spanish Fork, Nephi) and less frequently on distal segments (Malad Range, Clarkston Mountain, Collinston, Levan, and Fayette). Preliminary ^{14}C dates from the most recent trench excavations have led researchers (Lund, Machette, and Schwartz) to consider the time of last surface rupture event along the Wasatch fault zone to be about 600-700 years ago. Machette and others (1987) also suggest, on the basis of preliminary ^{14}C dates and detailed Quaternary mapping, that the average recurrence interval for an earthquake to occur somewhere along the Wasatch fault zone is 250-280 years. This is a significant change from the previously thought average recurrence interval of 444 years proposed by Schwartz and Coppersmith (1984). The average recurrence interval for the Wasatch fault zone will undoubtedly be refined with additional dates and continued trenching.

Paleoseismic studies in Utah include investigations both on and off the Wasatch fault zone. Although many of these studies are conducted on the Wasatch fault zone, investigations off the Wasatch fault zone are just as important because earthquakes generated from these nearby fault systems can have an affect on the Wasatch urban corridor. These include investigations northwest of the Wasatch Front in Hansel Valley, northeast of the Wasatch Front in Cache Valley on the East Cache Fault zone, the West Valley fault zone, and in the back valley areas east of the Wasatch Front.

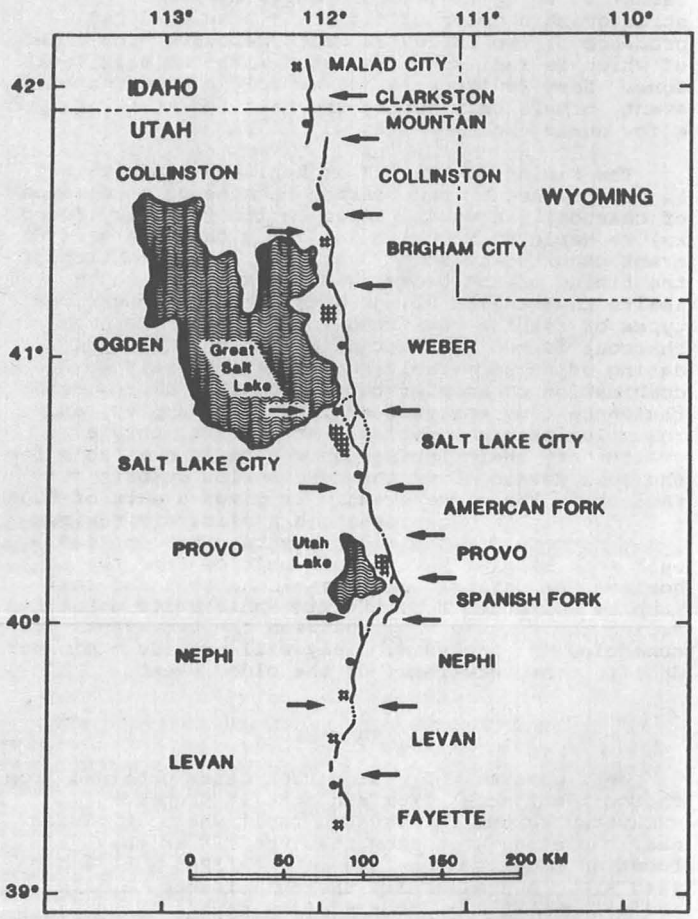

Figure 1. Segmentation of the Wasatch fault zone as proposed by Schwartz and Coppersmith (1984; left column) and by Machette and others (1987; right column). Arrows indicate segment boundaries; major towns shown by hachures.

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CONFERENCES YOU MAY HAVE MISSED

23rd Annual Symposium on Engineering Geology and Soils Engineering

The 23rd Annual Symposium on Engineering Geology and Soils Engineering was held at Utah State University April 6-8, 1987. The symposium featured many papers of interest to those involved in hazards research and the implementation of hazards information for land-use planning. Earthquake hazards and related topics addressed in papers included: 1) liquefaction, 2) regional deformation (tectonic subsidence and related flooding), 3) surface faulting, 4) seismic slope stability, and 5) local government policy and procedural steps in implementing earthquake hazards planning. A 521 page proceedings volume is now published and available at a cost of $18.00 from Engineering Geology Symposium, Idaho Department of Transportation, Attention Robert M. Smith, P.O. Box 7129, Boise, Idaho, 83707.

- From Gary Christenson

Twelfth Annual Hazards Research Workshop

Hazard management has been greatly enriched over the last decade by new and creative approaches to hazard mitigation and disaster recovery. These were the main topics of discussion at the Twelfth Annual Hazards Research Workshop, held in Boulder, Colorado, July 19-22, 1987. The workshop was attended by 238 public and private sector professionals involved in hazard mitigation and disaster response and recovery in the United States, Australia, Canada, Japan, Italy and elsewhere. The meeting provided a forum for talking about innovative programs in government and private business; methods for disseminating up-to-the-minute information among practitioners, policy makers, and researchers; and ways to overcome the social, economic, and political constraints upon hazard mitigation. Highlighted at the conference were exciting programs that reflect newly forged partnerships between researchers and practitioners, cooperative efforts in government and the private sector, and new benefits offered by advanced technology. Materials provided to workshop participants, as well as summaries of each of the concurrent sessions, can be obtained from the Information Center. Abstracts are of three kinds: descriptions of new research projects, reviews of completed research projects and their applications; and reports on projects and programs to improve hazard mitigation, public response and involvement, and disaster recovery in the United States and abroad. All abstracts include the name and address of a person to contact for further information. A maximum of six individual abstracts or session summaries can be ordered for no cost, six to 12 abstracts or session summaries cost $3, and complete workshop packet (all abstracts and summaries, a program, and a participant list) cost $10. All orders must be prepaid and should be directed to the Publication Clerk, Natural Hazards Observer, Box 482, University of Colorado, Boulder, Colorado, 80309.

- From Natural Hazards Observer

2nd International Earthquake Conference

From April 6 through 10, 1987, the City of Los Angeles hosted more than 500 participants from 30 countries at its 2nd International Earthquake Conference, held at the Universal City Sheraton. Organized by the office of Councilman Hal Bernson, the Conference had support from a wide spectrum of the business, education, public, and scientific communities. According to Robert Olson, EERI Vice President, this Conference differed widely from the more common professional meeting of specialists, in that it offered the opportunity for private and public sector leaders to learn the realities of earthquake hazard mitigation needs and to exchange ideas with those who work to mitigate these hazards. Many EERI members

took part in or moderated panels on special subject areas. Features of the five-day Conference included workshops on data management maintenance during an earthquake crisis; protection of records and artifacts; urban search and rescue; and public education through a network of media resources. Earthquake simulations and disaster management exercises were carried out with the assistance of highly trained volunteer groups and telecast for wide distribution. Paul Flores, of the Southern California Earthquake Preparedness Program (SCEPP), who served on the Advisory Board of Conference organizers, expressed the opinion that the Conference has opened up new channels to private sector awareness and involvement in earthquake preparedness, as well as in international networking of information. He noted the enthusiastic participation of the delegation from the People's Republic of China, whose spokesperson made an appeal for the exchange of information with U.S. and international experts. Flores also pointed out that the Conference session on the maintenance of computerized business systems during a disaster marked a new concern in the private sector for contingency planning. Two of the major outcomes hoped for by Conference organizers, according to Councilman Bernson's office, are to encourage private involvement and individual responsibility for health and human welfare disaster, and to promote self-help neighborhood groups trained to take action in the early post-disaster period before professional assistance can be mobilized. Several such groups took part in the disaster management simulations, and among the conference participants were teams of rescue and first-aid workers from several countries.

- From EERI Newsletter

Technical Briefing, The Whittier Narrows, California Earthquake, October, 1987

November 6, 1987, San Francisco, California. The Whittier Narrows Earthquake of October 1 was a 6.1 magnitude earthquake affecting the Los Angeles region. It was the most damaging earthquake to occur in California since the 1971 San Fernando Earthquake. The briefing described the earthquake's impacts and discussed its implications for practice. One clear message of this earthquake was that modest earthquakes can cause substantial damage and pose special engineering problems. The briefing covered the following issues: seismology and geology, engineering seismology, strong ground motion, performance of engineered structures, performance of residential structures, performance of equipment and building contents, and emergency response and management issues. The briefing was organized and presented by the Continuing Education Committee of the Earthquake Engineering Research Institute with the assistance of and co-sponsorship by the Southern California Earthquake Preparedness Project, Structural Engineers Association of California, California Seismic Safety Commission, California Division of Mines and Geology, Applied Technology Council, United States Geological Survey, and National Research Council. A special issue on the earthquake in the journal Earthquake Spectra is under preparation. Those who did not attend may obtain a copy for $15 sending advance payment to Editor, Earthquake Spectra, EERI, 6431 Fairmount Avenue, Suite 7, El Cerrito, California, 94530. Note: registrants, members of EERI and subscribers to Earthquake Spectra will automatically receive this issue.

- From EERI Newsletter

Annual Conference, Western States Seismic Policy Council

November 3-6, 1987, Lakewood, Colorado. The Western States Seismic Policy Council is comprised of representatives from 14 western states committed to improved understanding of earthquake dynamics and risk, and interested in formulating policy to mitigate earthquake impacts. The Council is managed by these representatives and supported by the Federal Emergency Management Agency. The program is aimed at local and state emergency managers, planners and building officials, federal and state policy makers, and all others who are responsible for protecting the public safety. This year's program offered discussions of the National Earthquake Response Plan, earthquake risk assessment, and earthquake prediction, and showcased some of the earthquake mitigation activities currently underway in various western states. The conference included a trip to the National Earthquake Information Center in Golden, Colorado. For additional information, contact Sarah Cline-Lebsack, Colorado Division of Disaster Emergency Services, Camp George West, Golden, Colorado, 80401, 303-273-1776.

- From Natural Hazards Observer

Building Seismic Safety Council Seismic Workshop At NIBS Annual Conference

November 3-5, 1987, Columbus, Ohio. For additional information, contact NIBS Annual Conference, 1015 15th Street, N.W., Suite 700, Washington, D.C., 20005, 202-347-5710

- From EERI Newsletter

Second U.S.-Mexico Program On 1985 Mexico Earthquake Research

November 5-7, 1987, Chapultepec, Mexico City. Sponsored by NSF. The Workshop participants reviewed and discussed progress made by the Program's U.S. researchers and their Mexican colleagues since last year, and assessed research directions, needs, and goals. For more information, contact Nancy Segal, Project Coordinator, at the EERI office at 415-525-3668, for details.

- From EERI Newsletter

UPCOMING CONFERENCES

December 14-18, 1987. U.S.-Asia Conference on Engineering for Mitigating Natural Hazards Damage. National Science Foundation, University of Hawaii, and Asian Institute of Technology, Bangkok, Thailand. The purpose of this conference is to bring together researchers and practitioners from the United States and Asia to exchange information and to formulate specific hazard mitigation projects that could be pursued on a bilateral or regional cooperative basis. Wind, flood, earthquake, and ground failure hazards will be the focus. The program will include a keynote speech, eight theme lectures on the four hazard areas, the presentation of shorter papers on regional or local hazards problems and their solutions, and numerous group discussions. There will also be

a field trip and other informal get-togethers. It is anticipated that there will be about 80 participants from the United States and various Asian countries. Participants should be persons actively involved in engineering practice or research on hazards mitigation who are willing to continue their involvement by submitting proposals for joint research projects. Obtain more information form Arthur N.L. Chiu, Department of Civil Engineering, University of Hawaii, Manoa, 2540 Dole Street, Honolulu, Hawaii, 96822, 808-948-7170.
- From Natural Hazards Observer

February 24-26, 1988. Eastern U.S. Conference: Earthquake Hazards and the Design of Constructed Facilities in the Eastern United States. The New York Academy of Sciences, the National Center for Earthquake Engineering Research, and the Earthquake Engineering Research Institute, New York City. The objectives of this conference are to review the scientific basis for assessing earthquake hazards in the eastern U.S., to develop a realistic estimate of the extent of such hazards, and to assess alternative policies for the engineering design community and related regulatory agencies in response to these risks. Seismologists, earth scientists, design engineers, and representatives of various private and public organizations will meet to present relevant data and discuss scientific policies. For program and registration information, contact the Conference Department, New York Academy of Sciences, 2 East 63rd Street, New York, New York, 10021, 212-838-0230.
- From Natural Hazards Observer

February 25-26, 1988. 1988 Los Angeles Conference on Tall Buildings: Development, Planning and Systems in the Wind and Seismic Environment. Held at Los Angeles Hilton, Los Angeles, California. Sponsored by the Council on Tall Buildings and Urban Habitat. Several major themes include the following: wind and seismic concerns in the high-rise environment; stiffness vs. flexibility; damping systems; motion perception; to warn or not to warn. For additional information, contact Mr. Nabih Youssef, Director of Structural Engineering, Albert C. Martin and Associates, 811 West Seventh Street, Los Angeles, California, 90017, 213-683-1900.
- From EERI Newsletter

May 10-13, 1988. International Symposium on Earthquake Countermeasures (ISEC). State Seismological Bureau, Ministry of Urban and Rural Construction and Environmental Protection, Ministry of Civil Administration, and several other agencies, People's Republic of China, Beijing, China. Recognizing that increased population and urbanization have resulted in a greatly increased threat to human beings due to destructive earthquakes, several agencies of the Chinese government have organized this meeting to promote the study of earthquake hazard mitigation so that seismic damage and losses can by reduced to a minimum. Major themes to be examined include: earthquake prediction, earthquake hazard mitigation and disaster prevention, earthquake mitigation in large cities, technological disasters and large earthquakes, seismo-sociology and legislation of earthquake mitigation measures, medical intervention following earthquake disasters, and news dissemination and communication. Persons interested in participating should contact ISEC"s Secretariat, c/o State Seismological Bureau, No. 63 Fuxing Avenue, Beijing, People's Republic of China. Telex: 22349 SSTCC CN, SSB; telephone 811928.
- From Natural Hazards Observer

June 27-30, 1988. Earthquake Engineering and Soil Dynamics II - Recent Advances in Ground Motion Evaluation. Held at Park City, Utah. Sponsored by the Geotechnical Engineering Division of the American Society of Civil Engineering. Contributed papers are solicited from engineers and earth scientists on the following topics: recent advances in development of design ground motions including evaluation methods, case histories, and verification techniques; field and laboratory methods and experience for site characterization and specification of dynamic soil properties; geological and seismological considerations for evaluation of earthquake potential and earthquake characteristics; regional and local variations in ground motion; use of strong motion data sets from recent earthquakes and synthetic seismograms for estimating ground motions; analytical and empirical techniques for evaluating ground motions and ground deformations during large earthquakes. All contributed papers will be published in the conference proceedings and presented by the authors at evening poster sessions during the conference. December 1, 1987, is the deadline for submission of draft papers for conference review. Finished papers will be submitted at a later date. Send papers to Dr. Larry Von Thun, Publications Chairman, U.S. Bureau of Reclamation, 820 South Estes Street, Lakewood, CO 80226. For further information contact the Specialty Conference Chairman, Dr. T. Leslie Youd, Department of Civil Engineering, Brigham Young University, Provo, Utah 84602.
- From EERI Newsletter

August 2-9, 1988. Ninth World Conference on Earthquake Engineering. Held in Tokyo/Kyoto, Japan. For information, contact Dr. Hajime Umemura, President of IAEE, c/o Japan Convention Services, Inc., Nippon Press Center Building; 2-1, 2-chome, Uchisaiwai-cho; Chiyoda-Ku, Tokyo 100; Japan.
- From EERI Newsletter

RECENT PUBLICATIONS

New UGMS Publications

Circular 79, Suggested approach to geologic hazards ordinances in Utah, by G.E. Christenson, 1987, 16 pages. Free while supply lasts.

Miscellaneous Publication M, Guidelines for preparing engineering geologic reports in Utah, by the Utah Section of the Association of Engineering Geologists, 2 pages. Free.

Miscellaneous Publication N, Guidelines for evaluating surface fault rupture hazards in Utah, by the Utah Section of the Association of Engineering Geologists, 2 pages. Free.

In a continuing effort to aid local governments and the private sector in using geologic hazards information to reduce losses and risks, the UGMS has recently published Circular 79 and Miscellaneous Publications M and N listed above. Circular 79 summarizes how local governments in Utah presently address geologic hazards in local government ordinances and also discusses approaches used in other states. Ordinances will vary depending on the availability of geologic hazards information, and the report outlines the recommended steps to be taken to adequately address geologic hazards for various levels of available information. This report does not present model ordinances or land-use regulations, but recommends sources where these may be obtained. The purpose of the report was to

present the general steps needed to insure adequate consideration of geologic hazards so that local governments could adapt these to fit best into their present land-use regulations and ordinances.

Miscellaneous Publications M and N by the Utah Section of the Association of Engineering Geologists are directed toward the geotechnical consulting community as well as local governments. They list guidelines for performing and reviewing reports addressing geologic hazards, and are based on similar guidelines developed in California over the past 14 years. It is hoped that these will clarify what is expected of site-specific geotechnical reports, both for the consultant preparing the report and the local government geologist that must review them.

Also from UGMS:

A reissue of an old favorite. Earthquake Studies in Utah, 1850-1978, edited by Walter J. Arabasz, Robert B. Smith, and William D. Richins, 1979, 552 pages, spiral bound, $28. This is the catalog for the University of Utah Seismograph Stations as well as several earthquake-related papers and has been out of print for several years.

Geologic Hazards and Land-Use Planning, Wasatch Front, by Gary E. Christenson, Mike V. Lowe, Craig V. Nelson, and Robert M. Robison, in Survey Notes, v. 21, no. 1, p. 3-7, 10-14. Free while supply lasts. This article discusses the use of hazards information in planning and summarizes efforts to facilitate implementation through the UGMS-sponsored County Hazards Geologist Program.

Open-File Report 109, Utah's Geologic Hazards: A Review for Realtors, by Gary E. Christenson and Don R. Mabey, 1987, 7 pages, $1. This introduction to hazards and information for realtors-in-training also serves as a good laymen's preface to destruction prevention from Utah's varied hazards.

All of the above publications can be obtained from the Publications Clerk, Utah Geological and Mineral Survey, 606 Black Hawk Way, Salt Lake City, Utah, 84108-1280, 801-581-6831.

From the U.S. Geological Survey

THE FOLLOWING U.S. GEOLOGICAL SURVEY PUBLICATIONS ARE AVAILABLE FROM THE PUBLIC INQUIRIES OFFICE, USGS, 8105 FEDERAL BUILDING, 125 SOUTH STATE STREET, SALT LAKE CITY, UTAH 84138-1177, 801-524-5652, FTS 588-5652

Bulletin 1698
United States Earthquakes, 1983, edited by C.W. Stover, U.S. Geological Survey, 1987, 196 p. $10.

OPEN-FILE REPORTS CAN BE ORDERED THROUGH THE PUBLIC INQUIRIES OFFICE, OR DIRECTLY FROM USGS, OPEN-FILE SERVICES SECTION, FEDERAL CENTER, BOX 25425, DENVER, COLORADO 80225.

OF 87-008
Proceedings of a Workshop on "Assessment of Geologic Hazards and Risk in Puerto Rico". Walter W. Hays and Paula L. Gori, Editors, Geological Survey, 397 pages. $62.75 paper; $4.00 microfiche.

From the Bay Area Regional Earthquake Preparedness Project and Association of Bay Area Governments

EARTHQUAKE PREPAREDNESS CHECKLIST: BUSINESS AND INDUSTRY, 1986, a one-page flyer summarizing the major points a business or industrial concern should cover in an earthquake preparedness plan. CORPORATE COMPREHENSIVE EARTHQUAKE PREPAREDNESS PLANNING GUIDELINES, 1985, a 57 page booklet designed to help companies develop a comprehensive, systematic plan to respond to a major earthquake. EARTHQUAKE PREPAREDNESS: A KEY TO SMALL BUSINESS SURVIVAL, prepared by Michael E. Durkin and Associates, 1985, an 8 page brochure that discusses the vulnerability of small business to earthquakes and suggests ways of mitigating the effects. BAREPP's CHECKLIST OF NONSTRUCTURAL EARTHQUAKE HAZARDS, 1986.

All the BAREPP publications are free. For information on additional publications or to order the ones mentioned above, contact The Bay Area Regional Earthquake Preparedness Project, Metro Center, 101 8th Street, Suite 152, Oakland, California, 94607, 415-540-2713.

THE SAN FRANCISCO BAY AREA--ON SHAKEY GROUND, 1987, 35 pages that describes the ground-shaking hazard in the Bay Area and lists twelve strategies that could be used to mitigate the risk. Although this information is specific to the Bay Area, the list of possible mitigation strategies is not. The discussion of those suggestions--which range from land use controls to disclosure requirements and public education--should be enlightening for planners and officials in other seismically active areas of the the country. The publication costs $8.00 plus $2.00 postage and handling, and can be ordered from the Association of Bay Area Governments, P.O. Box 2050, Oakland, California, 94604-2050, 415-464-7900.

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Continued on Page 23

UTAH EARTHQUAKE ACTIVITY

By Ethan D. Brown

UNIVERSITY OF UTAH SEISMOGRAPH STATIONS
DEPARTMENT OF GEOLOGY AND GEOPHYSICS

THE University of Utah Seismograph Stations records an 81-station seismic network designed for local earthquake monitoring within Utah, southeast Idaho, and western Wyoming. During January 1 to March 31, 1987, 152 earthquakes were located within the Utah region, including 57 greater than magnitude 2.0. The epicenters in figure 1 show earthquake activity scattered throughout Utah's main seismic region with significant localized clustering. The largest earthquakes during this time period, M_L 3.7, occurred on February 25, and March 5, and were located respectively 32 km WNW of Logan in northern Utah and 90 km east of Vernal in eastern Utah. The northern earthquake was reported felt in Tremonton, Utah, and other areas of Box Elder county. Three felt earthquakes of about the same magnitude originated in the same source area during the last report period. The March 5 earthquake was felt in areas in and about Duchesne within the Uinta basin. Two small earthquakes, M_L 2.7 and 2.9, occurred on March 11 about 3 km south of Manti (50 km NE of Richfield), and were felt by numerous people in Manti.

About half (75 out of 152) of the earthquakes recorded during the study period occurred in four spatial clusters labeled in figure 1. The largest (1) is WNW of Logan and includes 43 earthquakes ($M_L \leq 3.7$) that occurred chiefly during February and March. This cluster represents a continuation of activity that began in September of 1986 which has produced six felt events with magnitudes in the mid-three range. A joint seismological-geological study of this area (at the north end of the Blue Spring Hills) is currently being carried out by the University of Utah Seismograph Stations and the Utah Geological and Mineral Survey. Further west, north of the Great Salt Lake, a smaller cluster (2) of 12 events ($M_L \leq 3.4$) occurred in mid-March. To the south, two small clusters of 11 (3) and 9 (4) earthquakes ($M_L \leq 2.8$ and 2.3, respectively) were located 40 km SW of Price and 50 km NE of Richfield.

During April 1 to June 1, 1987, 98 earthquakes were located within the Utah region, including 39 greater than magnitude 2.0. The epicenters in figure 2 show earthquake activity scattered throughout Utah's main seismic region with two localized clusterings north of the Great Salt Lake. The largest earthquake during this time period, M_L 3.6, occurred on April 1, and was located 35 km WNW of Logan in the easternmost cluster north of the Lake. This earthquake was reported felt in Tremonton, Utah, and other areas of Box Elder County. Prior to the shock, six felt earthquakes of about the same magnitude had originated in the same source area since September 1986. In southwestern Utah, 5 km east of Cedar City, an earthquake occurred on April 3 at 11:24 pm and was strongly felt in Cedar City.

Of the two clusters located north of the Great Salt Lake, the larger includes the felt earthquake WNW of Logan mentioned above, and 21 earthquakes ($M_L \leq 3.6$) that occurred cheifly during the first week of April. This cluster represents a continuation of activity that began in September of 1986. The second cluster 45 km to the west includes 15 events ($M_L \leq 3.4$) that occurred in the last half of April.

Additional information on earthquakes within Utah is available from the University of Utah Seismograph Stations, Salt Lake City, Utah 84112; telephone (801) 581-6274. ■

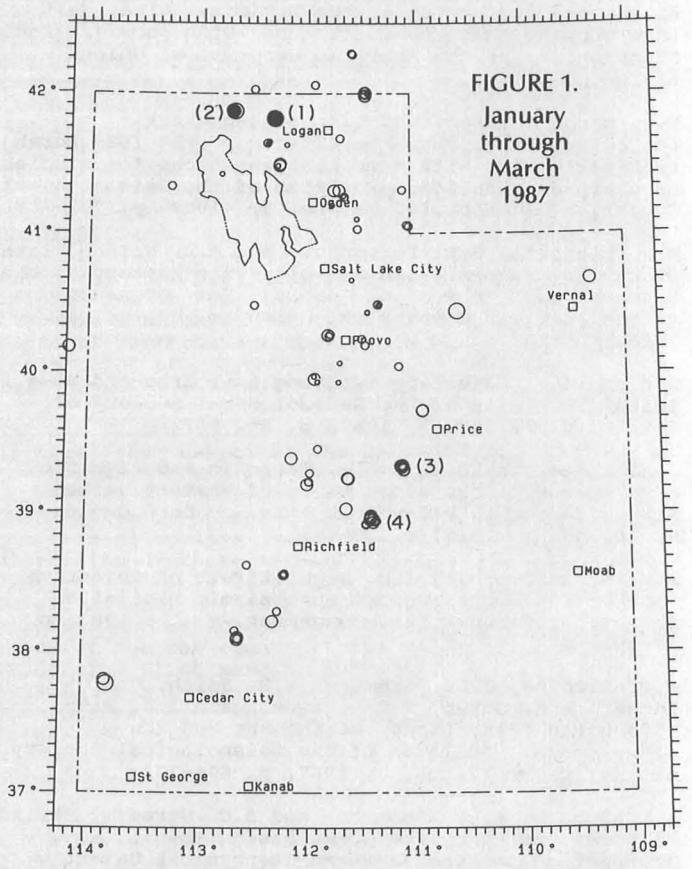

FIGURE 1. January through March 1987

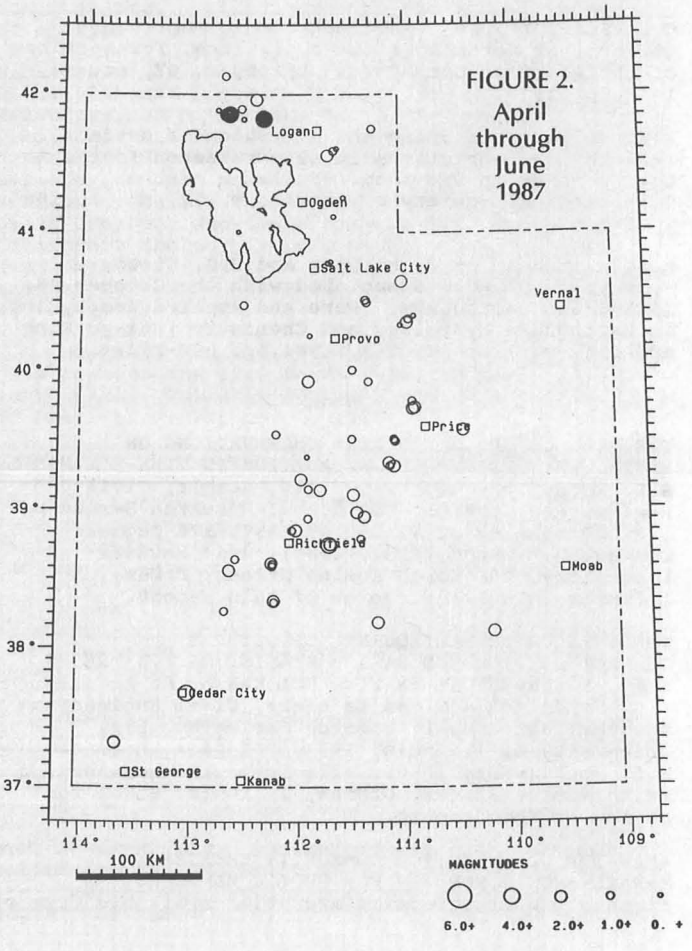

FIGURE 2. April through June 1987

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Four books containing edited papers selected from those presented at the 3rd International Conference on Soil Dynamics and Earthquake Engineering, held at Princeton University, Princeton, New Jersey, June 22-24, 1987, are for sale from Computational Mechanics (Ashurst Lodge, Ashurst, Southampton, S04 2AA, UK, or 25 Bridge St., Billerica, MA 01821, USA, or Suite 265, 17744 Skypark Circle, Irvine, CA 92714, USA). SOIL DYNAMICS AND LIQUEFACTION, $80; STRUCTURES AND STOCHASTIC METHODS, $86; GROUND MOTION AND ENGINEERING SEISMOLOGY, $96; and SOIL-STRUCTURE INTERACTION, $67; or all four for $269.

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