EARTHQUAKE HAZARDS PROGRAM

WASATCH FRONT FORUM

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FROM THE EDITOR

The comments and contributions that have been sent are greatly appreciated - and still more are needed! The deadlines for submitting material have changed somewhat. Information and inquiries may be directed to those listed below.

- SPRING ISSUE.....April 30,1985
- SUMMER ISSUE.....July 31, 1985
- FALL ISSUE.....October 31,1985
- WINTER ISSUE.....January 31,1986

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HAZARDS GEOLOGISTS FOR WASATCH FRONT COUNTIES

The U.S. Geological Survey (USGS) and the Utah Geological and Mineral Survey (UGMS) announced on January 25, 1985, a new cooperative program to provide funding and technical assistance to counties so they can employ geologists to work on geologic hazards in the five most populous Wasatch Front counties.

Officials expect that the geologists will be on board before the 1985 landslide and flood season. Annual costs of these hazards in the past two years have exceeded $250 million.

The three-year effort is part of the Wasatch Front Earthquake Hazards Reduction Program and is designed to aid the counties and cities in obtaining information on geologic hazards within their jurisdictions and to provide improved access to geologic expertise on problems involving geologic hazards. The program was developed by the USGS, UGMS and county planning departments and endorsed by the county commissions.

Genevieve Atwood, State Geologist and Director of the UGMS said "Both the U.S. Geological Survey and the Utah Geological and Mineral Survey recognize that the success of any program to reduce the risks from earthquakes or other geologic hazards depends on actions by county and city governments because they have the primary responsibility for protecting life and property. We concluded that the best method for encouraging and aiding these local governments to take actions on geologic hazards was to make the services of a hazards geologist directly available to them."

She added "In the last two years, the landslides, mudflows, rise of Great Salt Lake and Utah Lake, problems related to shallow ground water, and the major earthquake in Idaho have created an awareness of geologic hazards on the part of local officials and the public in general. There is an interest in taking actions that will provide protection from geologic hazards, and providing the services of a hazards geologist to the local governments will significantly improve the ability to develop and implement hazard reduction plans. This is an outstanding example of successful County-State-Federal cooperation."

(continued)

(Hazards Geologists - UGMS - continued)

A geologist will be employed by Weber County to work in Weber and Davis counties. A geologist employed by Utah County will work in Utah and eastern Juab counties and the third geologist will be employed by Salt Lake County. Each geologist will be part of the county planning department and the geologist's services will be available to other county departments and to the cities within the counties.

Funding of all salaries and benefits will be paid initially by a grant of $92,500 from the USGS to the UGMS. The total grant over the three-year period will approach $300.000. The UGMS will provide technical assistance, technical supervision, and specialized equipment. The counties will provide office space, vehicles, and secretarial support. The County Hazards Geologists will compile information on geologic hazards and pull together in a single location all the hazard-related investigations already completed for each county. An end product of the three-year program will be maps and reports describing the geologic hazards in the counties. These final products will be published by the UGMS.

The UGMS provides assistance to local governments in assessing geologic hazards and siting of critical facilities. This support will continue to be available to all local governments and state agencies. The UGMS is compiling State-wide hazards information and the work of county geologists will be an important part of this program.

Although the County Geologists are funded as part of the Wasatch Front Earthquake Hazards Reduction Program, they will be concerned with all geologic hazards. The State of Utah's earthquake hazards program is coordinated by Don Mabey, UGMS Senior Geologist for Applied Geology. Gary Christenson, UGMS Geologist, will be directing the County Geologist Program.

For more information, contact Don Mabey, UGMS, 801-581-6831 or Walt Hays, USGS, 703-860-6471.

FROM WALT HAYS
COORDINATOR
REGIONAL EARTHQUAKE HAZARDS ASSESSMENT PROGRAM

A series of workshops, ranging in length from half a day to 5 days, are being scheduled from April through September 1985 and planned for 1986. The workshops will be convened at various locations in Utah. U.S. Geological Survey, Federal Emergency Management Agency, Utah Geological and Mineral Survey, Utah Division of Comprehensive Emergency Management, and others will sponsor the workshops which are intended to increase the capability of groups in Utah to carry out their responsibilities to reduce losses from earthquake hazards and other geologic hazards.

✓STRATEGY

These workshops will continue the planning process begun in FY-84 at the workshop on "Evaluation of Regional and Urban Earthquake Hazards and Risk in Utah" held in Salt Lake City on August 14-16, 1984, and replace the large conference originally planned to take place in 1985, i.e. there will not be a major conference in 1985. The workshops will address the special needs of the Governor, the Utah Legislature, Utah Geological and Mineral Survey, Utah Division of Comprehensive Emergency Management, scientists, engineers, county geologists, county emergency managers, county planners, building inspectors, and others.

Each "target group" will be invited by a steering committee to identify their agenda of critical needs. The steering committee will differ for each "target group"; however, some members will be common for all "target groups". After an agenda is defined by the "target group", a resource team will be provided to assist them in achieving the goals represented by their agenda. The schedule of all the workshops will be coordinated to ensure an orderly progression in the development of capability in Utah to reduce earthquake hazards.

✓PROGRAM

The agenda for each "target group" will vary as a function of the problems of the "target group". For example, an agenda may address the following types of problems:

1) TECHNICAL - how to identify active faults, how to characterize earthquakes in terms of other natural hazards, the fundamentals of probabilistic hazards and risk assessment, the multihazards mitigation scenario, the multihazards response scenario, and others.

2) COMMUNICATION WITH THE PUBLIC SECTOR - how to devise basic information systems that can be utilized to communicate information of seismic hazards and risk more effectively.

3) USE OF PRODUCTS - how to increase understanding about the advantages and disadvantages of various maps drawn at various scales, how they should be used, and what their limitations are.

4) TRANSFER OF TECHNOLOGY - how to take advantage of technology developed in other parts of the United States - such as SCEPP.

5) PLANNING - identification of short-and-long-term goals and the resources (staff, computers, word processors, information systems, library and visual aid materials, etc.) that are needed to achieve them.

6) DEVELOPMENT OF PARTNERSHIPS - how to increase understanding of the roles and needs of other agencies or groups and to devise a process that will energize local/State/Federal Government interests and give everyone a stake in the total solution to the earthquake hazards problem which requires research, mitigation, response and recovery activities.

7) POLITICAL - how to communicate effectively with public officials and gain their support for legislative initiatives.

✓PROCEDURES

The number of participants for each workshop will vary. An effort will be made to keep the number of participants small so that efficient interaction can be realized. The resource teams will be small; the mix of capabilities will vary as a function of the agenda of the "target group". Although some members of the resource team may be common for all workshops, the team will generally be different for each "target group" which will also have representatives on the resource team.

The workshop will be organized to achieve an effective exchange of information to provide answers to the problems and needs of the "target group". The forum may include field trips as well as discussion sessions. A publication will be created to document each workshop. The publication will be a USGS open-file report.

FEATURE ARTICLE

THE BORAH PEAK, IDAHO EARTHQUAKE: AN ANALOG OF FUTURE WASATCH FRONT EARTHQUAKES?

by
Anthony J. Crone
U.S.Geological Survey, Denver, Colorado

* * * * * * * * *

At 8:06 a.m. on October 28, 1983, the Borah Park earthquake transformed a peaceful Friday morning in east-central Idaho into a turbulent day that few inhabitants will forget. On that morning, the first major earthquake since the August, 1959, Hebgen Lake, Montana earthquake jolted the intermountain west and abruptly reminded everyone (scientists and the general population alike) that damaging earthquakes can strike in unexpected places. Fortunately, the Borah Peak earthquake was located in a relatively remote part of Idaho, causing only about $12.5 million in damage and relatively few injuries; however the earthquake should remind us that a similar event in a more densely populated area would have far more serious consequences.

There are several important similarities between the Borah Peak earthquake and the geologic and seismologic setting of major earthquakes that might occur along the Wasatch Front. To date, few of these similarities have been discussed, and yet, just a few hundred miles from Salt Lake City, we have the unusual opportunity to study the effects of a major earthquake that may well be a perfect example of the "typical" major Wasatch Front earthquake. My intent here is to briefly note some of the similarities, to bring them to the attention of researchers studying the earthquake hazards of the Wasatch Front, and to encourage those researchers to utilize the natural laboratory that exists in the Borah Peak area.

The Borah Peak earthquake had a surface-wave magnitude(M_S) of 7.3. Trenching studies and reconnaissance mapping of Quaternary and Holocene fault scarps in the region both suggest that surface faulting in the eastern Great Basin and along the Wasatch Front are probably associated with magnitude 7 or greater earthquakes. The tectonic displacement produced by the Borah Peak earthquake was 1.5-2.5 m along much of the zone of surface faulting. These displacements are essentially the same as those estimated for individual prehistoric earthquakes along the Wasatch fault zone. Thus the geologic effects of the Borah Peak earthquake provide some insight into the multitude of potentially damaging natural phenomena that will likely accompany a similar size earthquake along the Wasatch Front. In addition to the extensive ground breakage that occurred in the vicinity of the fault zone, the Borah Peak earthquake generated several major landslides and debris flows, produced liquefaction on some areas, and caused local flooding by greatly increasing the flow of groundwater onto the surface. Clearly, all of these phenomena could threaten life and property in urbanized areas of the Wasatch Front.

Surface faulting, although restricted to the vicinity of the fault zone, could pose a substantial hazard along the Wasatch Front. It is important to note that the zone of surface faulting associated with the Borah Peak earthquake is locally more than 100 m wide and that the displacement is not confined to a single scarp. Within the zone, there are numerous en echelon scarps, and in places, the ground is shattered into tilted blocks several meters across. The largest scarps are nearly 5 m high. Structures located within the zone of surface faulting would have undoubtedly suffered significant damage. Along parts of the Wasatch Front, many homes and developments are located at the base of the range-front where the location offers scenic views of the nearby valleys and the adjacent ranges. Unfortunately, this desirable location is where the surface faulting hazard is the greatest. Most, but not all, of the surface faulting at Borah Peak occurred along prominent, preexisting upper Pleistocene and Holocene fault scarps. Thus careful mapping of the fault scarps along the Wasatch Front can, in most cases, accurately define the areas where surface faulting hazards are high. This valuable information can then be used by interested individuals and agencies.

The Borah Peak earthquake generated about 36 km of surface faulting and ground ruptures mainly along the Lost River fault, the range-front fault of the Lost River Range. The Lost River fault extends tens of kilometers beyond both ends of the 1983 surface faulting and has upper Pleistocene and Holocene fault scarps along most of its length. Only a small part of the Lost River fault ruptured during the earthquake, suggesting that the fault zone is probably divided into segments that are separated by structural barriers. The concept of fault zone segmentation, recently proposed by David Schwartz and Kevin Coppersmith is, in large part, an outgrowth of studies along the Wasatch fault zone. Geologic and seismologic data from Borah Peak support the validity of the concept. Studies of the geologic structure in the Borah Peak area could provide valuable information on the nature of the structural barriers and how they influence a propagating rupture. Such information will improve our knowledge of the mechanics of fault rupture that can be expected along the Wasatch Front.

The largest amount of tectonic displacement during the 1983 earthquake occurred along the topographically highest part of the range near the western base of Borah Peak, the highest point in Idaho. Schwartz and Coppersmith also note that topographic relief along the Wasatch Front might be an indicator of the long-term activity rate for the various segments of the range-front faults. The topography of the Lost River Range and the location of 1983 surface faulting seem to be consistent with this observation. On this basis, portions of the Wasatch Front where the range crest towers over the valley are more likely to experience major earthquakes (on a geologic time scale) than the portions with less topographic relief.

The general geologic history and setting of the Borah Peak area is similar to the Wasatch Front. Precambrian, Paleozoic, and Mesozoic rocks in both areas were thrust westward during the late Mesozoic and early Tertiary. The thrust sheets were subsequently broken into basins and ranges by normal faults starting in the middle Tertiary and continuing to the present. A better understanding of the structural evolution of the two areas may provide some additional insight into the origin and characteristics of the structural barriers that appear to divide the fault zones into discrete segments.

Seismicity along the Wasatch fault zone has been monitored by a relatively dense network of seismographs for more than two decades. In spite of the geologic evidence that indicates high levels of activity, the seismologic data shows surprisingly low levels of seismicity along the fault zone. A similar situation existed at Borah Peak. Although the seismograph coverage in Idaho is far less dense, instrumental data for twenty-years prior to the Borah Peak earthquake shows that the area within 25km of the 1983 epicenter was aseismic (at a threshold level of magnitude 3.5 or greater). By analogy, this suggests that the lack of earthquakes associated with the Wasatch fault zone is evidence of a temporal seismic gap rather than evidence that the fault zone has suddenly become inactive.

It is important to be cautious when extrapolating geologic and seismologic observations from one location to another. However, the striking similarities between the Borah Peak area and the Wasatch Front strongly indicate that we may have an excellent model of typical major earthquakes in the urban parts of Utah. The Borah Peak earthquake presents an opportunity that all researchers should fully utilize.

FURTHER READING:

Crone, A.J. and Machette,M.N.1984, Surface faulting accompanying the Borah Peak earthquake, central Idaho. GEOLOGY, v.12, 664-667.

WASATCH FRONT HAZARDS AND THE CURRENT WET CYCLE

by
Don R. Mabey
Utah Geological and Mineral Survey

In the fall of 1982, the surface of Great Salt Lake was at an elevation of about 4200 feet above sea level, the same elevation as when the first Mormons arrived in Utah in 1847. In the intervening 135 years the lake rose about 12 feet to the historic high in 1873 and then declined about 20 feet to the historic low in 1963. In September 1982, precipitation at the Salt Lake City airport broke the record for any month and marked the beginning of a wet cycle that in 22 months produced a rise in the lake level of over 9 feet with the lake cresting at 4209.25 feet on July 1, 1984. Breaching the Southern Pacific causeway on August 1, 1984 combined with the seasonal decline lowered the level to 4207.85 feet on October 1. Since then the lake has risen gradually and by next summer will likely be within 1.5 feet of the historic high. Because the rising lake waters are causing hundreds of millions of dollars in damage and severely restricting activities on and around the lake, several techniques of controlling the lake level have been investigated, and industry and all levels of government are investing large sums of money to cope with the rising lake. In Utah Valley, Utah Lake has also risen to near record levels. As Great Salt Lake and Utah Lakes rise, the unconfined water table is also rising in several areas along the Wasatch Front flooding basements and septic systems.

The rising lakes and ground water have intensified several earthquake hazards. The area threatened by deformation induced inundation described by Smith and Richins increases as the lakes rise, as does the area threatened by seiches. The higher ground water would likely intensify the effect of ground water problems associated with ground shaking.

Two years of much above normal precipitation have raised the moisture content of the soils in the mountains east of the Wasatch Front to much above normal (248 percent of normal in November 1984). This has resulted in many unstable slopes that might fail if subjected to intense ground shaking. Stream flows are generally above normal and the level of water in storage reservoirs is above normal. Thus the hazard of earthquake related flooding is increased.

Actions to cope with the wet cycle are adding to the earthquake hazard. Several debris basins have been constructed in areas in or immediately adjacent to the Wasatch fault zone. Dikes to restrain the water of Great Salt Lake from inundating developed areas are being built in zones of high liquefaction potential. A study for the State of Utah proposes a dike system to protect parts of Tooele, Salt Lake, Davis, Weber and Box Elder Counties from Great Salt Lake. One alternative plan proposes dikes to provide protection to a lake level of 4217 feet above sea level. At this elevation the lake would be as much as 7 feet higher than areas being protected. Most of the dike system is in areas of high liquefaction potential, and there is danger that the dikes might fail during intense ground shaking.

One question facing those of us concerned with seismic safety along the Wasatch Front is how long will the wet cycle continue, and at what level will the Great Salt Lake crest or stabilize. When the lake elevation reaches 4217 feet above sea level it will have extended west into the Great Salt Lake Desert and increased its surface area about 40 percent above what it is now. Apparently the lake rose to this level and stabilized about 300 years ago. No consensus exists on the long-term outlook for the climate in the Great Salt Lake basin and thus what the lake level is likely to be in the future. However, there is no reason to conclude that the lake could not reach the 4217 foot level in the next few years, and the UGMS has suggested this as a planning elevation. Earthquake hazard reduction plans should allow for periodic rises of the lake to this level as well as for other effects of wet cycles.

REPORT OF ACTIVITIES

STATE-FOUR COUNTY EARTHQUAKE PLAN

Jim Tingey, Earthquake Preparedness Planner
State of Utah
Division of Comprehensive Emergency Management

The State-Four County Earthquake Response Plan was developed as part of Utah's Five Year Earthquake Preparedness Program and under the auspices of the Federal Earthquake Hazards Reduction Act of 1977 and the Federal Emergency Management Agency which presently funds on-going planning activities. The plan concentrates on response to a major destructive earthquake affecting the Wasatch Front metropolitan areas of Weber, Davis, Salt Lake, and Utah counties, to reduce risks to populations, resources, and lifeline systems.

Goals and activities for 1985 include integration and coordination of the plan with county and state officials and agencies which have roles in disaster response; excercises designed to test the plan, response capability and expose necessary modifications; and cooperative agreements between counties and public and private agencies. As it becomes available, technical information such as microzonation studies, generated by the UGMS, USGS and others will be integrated in the plan to help city, county and state officials in their mitigation and response planning efforts. With the cooperation and support of County Commissioners, County Emergency Directors and state agencies, Utah has the opportunity to become an innovator in the field of earthquake mitigation and response as Federal attention focuses on the Wasatch Front area.

For information regarding the response plan, please contact Jim Tingey (801) 533-5271 or write to the Division of Comprehensive Emergency Management, 1543 Sunnyside Ave., Salt Lake City, Utah 84108-0100.

PROGRESS REPORTS

Art Tarr, USGS, Denver

The following information was abstracted from Semi-Annual Technical Reports prepared at the completion of Fiscal Year 1984 for projects funded in the Branch of Engineering Geology and Tectonics. Complete reports will appear in a USGS Open-File Report to be published in mid-1985

Although earthquakes along the eastern margin of the Great Basin are the principal concern for evaluating the seismic hazard of the Wasatch Front, large earthquakes in the adjacent Intermountain Seismic Belt could produce strong shaking in the Wasatch Front area. A USGS field investigations group monitored aftershocks of the widely-felt, ML=5.5 Laramie Mountains, Wyoming earthquake of October 18, 1984. Charley Langer reports that hundreds of aftershocks were recorded by 23 portable seismographs systems deployed in and around the aftershock zone. Preliminary locations of six events indicate that the center of the aftershock zone is near Mule Creek Mountain 8 km ENE of Marshall, Wyoming. Depths range from 20-27 km and a preliminary focal mechanism indicates right-lateral, strike-slip motion in response to east-west stress.

The MS = 7.3 Borah Peak, Idaho earthquake of October 28, 1983 was and continues to be studied by many investigators including field teams from the USGS and the University of Utah. Charley Langer reports that aftershocks recorded by USGS field systems following the Borah Peak mainshock are distributed in a zone approximately 75 km long and 15 km wide, aligned roughly parallel with and 5-10 km southwest of the surface rupture. Aftershocks heavily cluster near the westward splay of the rupture in the Willow Pass area. The distribution with depth shows the majority of aftershock activity occurring between 5 and 11 km; south of the splay, the distribution of hypocenters in a cross-section perpendicular to the surface rupture suggests that the fault dips southwestward at about 60 degrees.

Ken King reports that the six-station, strong-motion network in Salt Lake City urban areas will be supplemented with 14 seismoscopes. The seismoscope sites were selected by a USGS/UGMS committee. Ken also reports that tests of new Mini-Sosie high-resolution reflection equipment continue along the Wasatch Front and in Kansas where there is a well-defined standard section. These experiments include the use of shear-wave generation and reflection to study shallow structure in the upper 100 meters.

Al Rogers has been studying the effects of site geology on ground motion in the Wasatch Front urban area. Response spectra were determined from horizontal seismograms recording distant explosions and an earthquake. The spectral ratios of alluvium-to-rock were divided into two period bands (0.2 to 0.7 sec and 0.7 to 1.0 sec) and three general lithologic categories: silt to clay, sand and gravel, and rubble. In the short-period band, the mean spectral ratios range from 2.7 (rubble) to 6.2 (silt and clay); in the mean long-period band, the spectral ratios range from 3.2 (rubble) to 7.2 (silt and clay) (Figure 1).

Art Tarr reports that spectral analyses of digital seismic data recorded at Jackass Flats on the Nevada Test Site have been completed. The study required the assembly of appropriate data analysis computer programs into a streamlined software package. The Seismic Data Analysis Package (SDAP) will be used in several Wasatch Front projects to analyze digital data recorded by a variety of seismic systems for different purposes: earthquake and blast monitoring, reflection and refraction profiling, and ground amplification. Seismic moment and stress drop were determined from spectral parameters of eleven earthquakes located on or near the NTS. The determination of ML from the spectra provided independent validation of a new coda-length magnitude scale used in southern Nevada. The results also indicate that the southern NTS is under conditions of low ambient stress, at least compared with similar activity in California. Extension of spectral methods into other seismic areas of Nevada and Utah will be needed to determine the extent of variation of ambient stress in southern and eastern Great Basin.

Ernie Anderson reports several significant results from his and his colleagues' studies in the eastern Great Basin. Ernie and Ted Barnhard have been collecting fault-slip data along major faults in the transition zone between the Colorado Plateaus province and eastern Great Basin province. They find geological evidence for strike-slip faulting in the Sevier River valley, consistent with focal mechanisms determined from seismicity, showing that faults in the area are capable of strike-slip motion as well as the expected dip-slip motion.

Mike Machette and Steve Personius have been studying slip rates along two segments of the Wasatch Fault zone and they find that the slip rate varied significantly during the Quaternary, culminating in latest Pleistocene time, during rapid growth and subsequent contraction of Lake Bonneville. Their results are summarized in the following table:

TABLE 1. Cumulative slip rates(m/ka) recorded in offset Quaternary deposits (age in ka) along the Wasatch Fault Zone

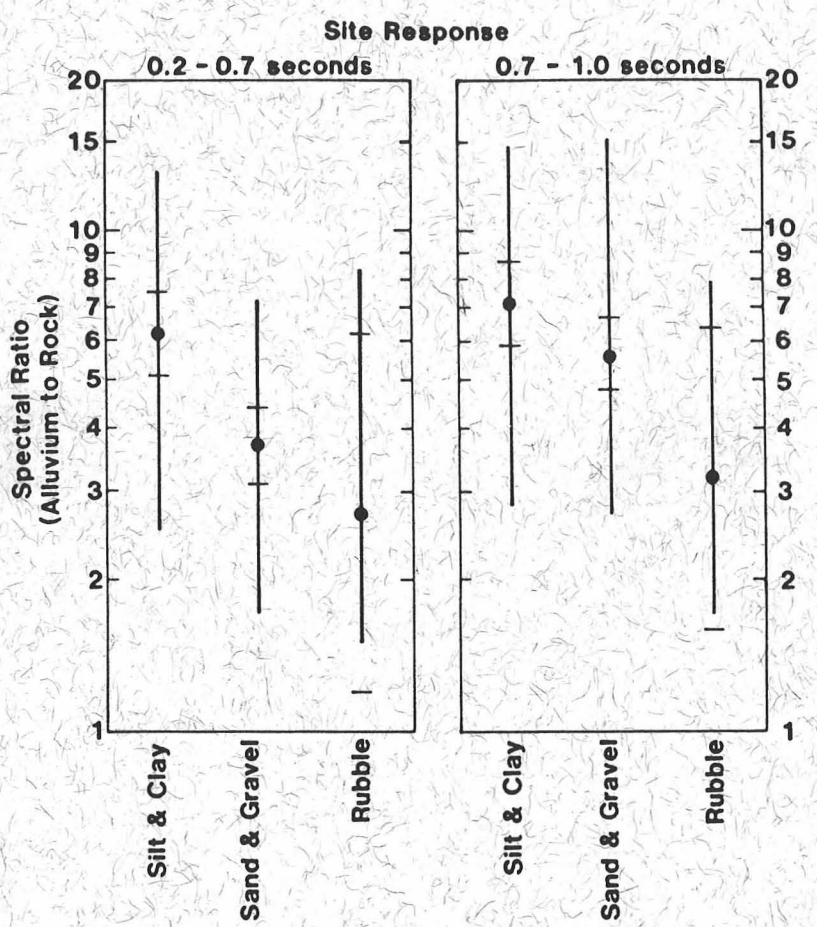
Time interval	Jim May Canyon (Personius)	Hobble Creek	North Creek	Gardner Creek (Machette)
Mid(?) Holocene (5 ka)	0.30 (6 ka)	[1] 1.3 (4.5 ka)	[2] 1.3	0.78
Early (?) Holocene (10 ka)	0.50			
Post-Provo (13.5 ka)	1.0 (13.5 ka)	[1] 0.85-1.0	n.d.	n.d.
Post-Bonneville	n.d.	[3] <1.8	[4] n.d.	n.d.
Pre-Bonneville (200 ka)	0.15	n.d. (250 ka)	0.20 (250 ka)	0.12
Late Cenozoic	0.4 for the central Wasatch Fault Zone [5]			

1 Data from Swan and others (1980).
2 Data from Schwartz and others (1983).
3 Most likely rate of Swan and others (1980); range is <1.7 to <3.3 m/ka.
4 Calculated from ratio of pre-Bonneville to mid-Holocene slip rates at Gardner Creek times mid-Holocene slip rate at North Creek
5 Data from Naeser and others (1983).

(USGS Progress Reports continued)

Tony Crone, in studying the detailed morphology of the scarps of the 1983 Borah Peak earthquake, has found that the new scarps and surface ruptures closely followed the pre-1983 surface ruptures, primarily along the Lost River fault. The morphology of the scarps depends on many factors including sorting, grain size, and water saturation of the faulted material; these data should help in understanding how the various morphologies will degrade in the future. Tony also reports that several sets of slickensides, freshly exposed on a bedrock face on Dickey Peak, show dominant dip-slip with both right and left-lateral components; the slickensides predate the Borah Peak earthquake. (see additional information under "Feature Article", this issue)

FIGURE 1 -- Response relative to bedrock of sites underlain by three categories of surface deposit: silt and clay, sand and gravel, and rubble. Solid dots indicate the log-normal mean of the spectral ratio for each category. Vertical bars indicate the range of individual sites' spectral ratios in the category. Horizontal bars show the 90-percent intervals for each category.



UTAH EARTHQUAKE ACTIVITY
October through December 1984

William D. Richins
University of Utah Seismograph Stations
Department of Geology and Geophysics

The University of Utah Seismograph Stations records a 75-station seismic network designed for local earthquake monitoring within Utah, southeast Idaho and western Wyoming. During October 1 to December 31, 1984, 149 earthquakes were located within the Utah region (see Figure 1).

The largest earthquake during this time period occurred on October 15, 1984, 22 km northwest of Tremonton. This earthquake had a magnitude of 3.4 and was felt in Howell and Portage. Two other earthquakes reported felt in the Utah region during this time period were shocks of magnitude 2.1 and 2.0 on November 25, 1984, located near, and felt at, St. George, Utah. Other significant aspects of earthquake activity during the report period shown in Figure 1 include (from north to south):

1) clustered earthquakes (mag.$\leq$2.3) in southeastern Idaho northeast of Logan and 40 km north of the Utah-Idaho border;

2) clustered earthquakes (mag.$\leq$3.4) in the Utah-Idaho border area north of the Great Salt Lake;

3) small-magnitude earthquakes (mag.$\leq$1.8) southwest of Logan in the vicinity of the Wellsville Mts. during November and December;

4) a magnitude 2.3 earthquake 30 km northeast of Provo near Wallsburg on December 16;

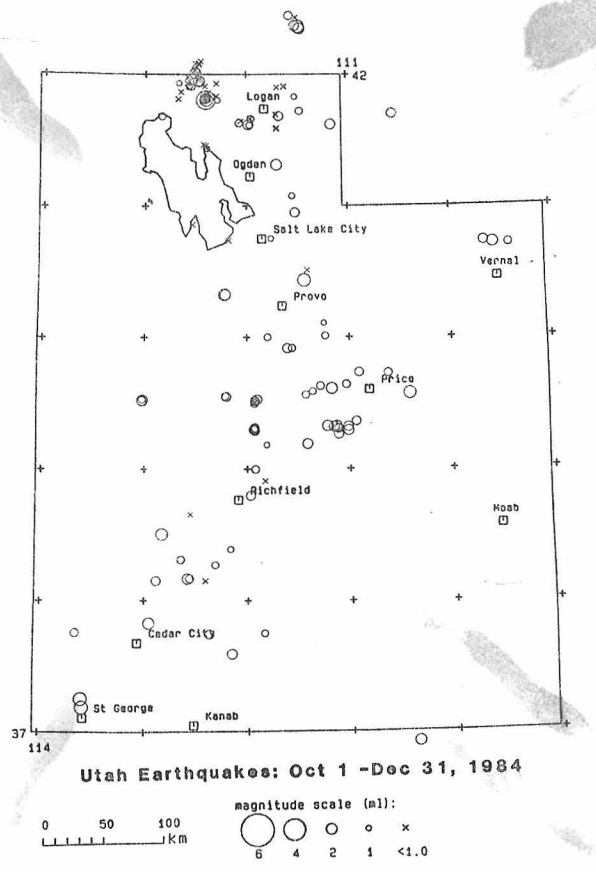
5) clustered small-magnitude earthquake activity in the vicinity of active underground coal mining west and southwest of Price in central Utah;

6) tightly clustered earthquakes (mag.$<$2.0) in two localities in central Utah--within Juab Valley and the northern Sevier Valley; and

7) scattered small earthquakes (mag.$<$2.1) throughout a broad belt between Cedar City and Richfield in southwest Utah.

(Note: Epicenters for small-magnitude seismic events north of Vernal and 50 km west of Provo are believed to represent local blasts.)

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



Utah Earthquakes: Oct 1 -Dec 31, 1984

CALL FOR PAPERS

REGIONAL EARTHQUAKE HAZARDS ASSESSMENTS WASATCH FRONT, UTAH

U.S. GEOLOGICAL SURVEY PROFESSIONAL PAPER

Participants in the Regional Earthquake Hazards Assessments Program are requested to prepare a manuscript for the professional paper on "Evaluation of Urban and Regional Earthquake Hazards and Risk in Utah" which will be published in the 3rd year of the program (FY 86).

Deadline for transmittal of the manuscript is OCTOBER 11, 1985. The manuscript may represent a synthesis of several research studies or present the findings of a topical study. The manuscripts must receive peer review according to standard USGS procedures. The format for the manuscript may be obtained by contacting Walter Hays or Paula Gori at (703) 860-6471 or (FTS) 928-6471 or writing to them at U.S. Geological Survey, 905 National Center, Reston, Virginia 22092.

EARTHQUAKE HAZARDS REDUCTION PROGRAM SOLICITATION

The U.S. Geological Survey has begun the process of soliciting detailed formal proposals for research projects relevant to three major program elements:

1) Current Tectonic and Earthquake Potential
2) Earthquake Prediction
3) Regional Earthquake Hazards Assessments

Under Regional Earthquake Hazards Assessment Research (Element III), proposals were solicited to meet the following objectives in the Wasatch Front and other regions of the U.S.:

1. Mapping and synthesis of geologic hazards and establishment of information systems.

2. Loss estimation modeling, including the development and application of techniques for estimating earthquake losses.

3. Implementation, including the development and application of techniques that will foster utilization of basic data, synthesis reports, and research results.

All proposals for Fiscal Year 1986 had to be received by the U.S.G.S, Branch of Procurements and Contracts by 5pm local time on March 4, 1985.

CHANGES IN THE USGS EXTERNAL RESEARCH PROGRAM

From John R. Filson, Chief, Office of Earthquakes, Volcanoes, and Engineering (USGS):

We have created the position of Deputy for External Research with primary responsibility of administration of the USGS grants and contracts under the Earthquake Hazards Reduction Program. Dr. Elaine R. Padovani has agreed to accept this position as of November 5, 1984.

Dr. Padovani, her staff, and Duleep Pandite, Chief of the Procurement Section servicing this program will be located at the USGS National Center in Reston, Virginia. All external programs and contractual activities related to Fiscal Year 1986 and beyond will be administered from Reston. Program activities related to Fiscal Year 1985 and previous fiscal years will continue to be administered from Menlo Park for the remainder of Fiscal Year 1985. Dr. Padovani's address and telephone number are, respectively:

U.S. Geological Survey
905 National Center
Reston, Virginia 22092

and

703-860-6471

FEMA's National Emergency Training Center now houses the Emergency Management Information Center (EMIC) established to keep records of specific disasters and make them available to emergency officials. EMIC has a growing collection of printed and non-print materials on natural and technological disasters - materials that will be compiled into case studies for each particular event. The 31 case studies currently being assembled include such disasters as the September, 1978 plane crash in San Diego; the hazardous materials spill in Livingston, Louisiana in 1982; the Three Mile Island nuclear plant incident of March, 1979; and the MGM Grand fire in Las Vegas.

In addition to journal articles, reports, analyses, video tapes, and slide/tape presentations, each EMIC case study also has guidelines for further study and an evaluation questionnaire. EMIC studies will be loaned for two weeks to state level fire and emergency management professionals. Requests from any other individual or governmental entity will be referred back to the appropriate state. To order a case study, contribute materials on significant disasters, or obtain more information, contact Patricia Kuhns, EMIC Librarian, Learning Resource Center, NETC, 16825 South Seton Avenue, Emmitsburg, MD 21727, (800) 638-1821, ex. 6032.

The Society for Risk Analysis, a non-profit, professional organization, was formed in 1980 to promote knowledge and understanding of risk analysis techniques and their applications. To those ends, the Society is engaged in disseminating risk analysis information and concepts, facilitating communication among those involved with risk analysis, and contributing to the advancement of the state-of-the-art in risk analysis.

Members of the Society come from government, academia, and industry, and represent a great variety of disciplines; health sciences, social sciences, physical sciences, engineering, decision analysis, and public and business administration. Interdisciplinary and international exchange among all these groups are promoted in the Society's meetings and publications. Most important among these vehicles are the annual meeting, held this October in Knoxville, Tennessee, and the quarterly journal, RISK ANALYSIS, published by Plenum Press. Membership dues of $30.00 per year include a subscription to RISK ANALYSIS. For more information, contact the Society for Risk Analysis, 1340 Old Chain Bridge Road, Suite 300, McLean, Virginia 22101.

FROM USGS

The U.S. Geological Survey is currently conducting two data acquisition programs that could aid hazard researchers, mitigation planners, and others involved in natural hazards. Products from both programs are now available from the Survey's EROS Data Center.

The National High-Altitude Photography Program (NHAP) is compiling both black-and-white and color-infrared photography of the conterminous United States. These NHAP photographs provide a new and very useful tool for researchers and offer the added benefit of being inexpensive and readily available. They are high-resolution, quad-centered images, obtained under optimal conditions for mapping, that can provide a uniform base for the compilation of geological, biological, cultural or other data. Used in conjunction with satellite imagery or by themselves, NHAP photographs, with their stereo coverage, are an exceptional medium for data compilation.

Side-Looking Airborne Radar (SLAR) data are also now available for limited areas of Alaska and the conterminous United States, with even more coverage planned in the next few years. Available as strip images or mosaics, SLAR data are useful for geological analysis in disciplines such as petroleum exploration, mineral detection, and ground-water analysis.

For further information about NHAP and SLAR products, contact User Services, U.S. Geological Survey, EROS Data Center, Sioux Falls, South Dakota 57198, (605) 594-6151.

MEETINGS

UTAH GEOLOGICAL ASSOCIATION 1985 FIELD CONFERENCE AND SYMPOSIUM

Doug Sprinkel, President of the Utah Geological Association for 1985 has announced the 1985 UGA Field Conference and Symposium.....OROGENIC PATTERNS AND STRATIGRAPHY OF NORTH-CENTRAL UTAH AND SOUTHEASTERN IDAHO..... For additional information regarding the Conference and the Guidebook, contact Doug Sprinkel, c/o UGA, Box 11334, Salt Lake City, Utah 84147, 801-532-5005.

4/30-5/2 — FLOOD HAZARD MANAGEMENT IN GOVERNMENT AND THE PRIVATE SECTOR -- Where Are We? Ninth Annual Conference of the Association of State Floodplain Managers, New Orleans Contact Robert Cox, General Chair, ASFPM Conference, DUCA, P.O. Box 44455, Baton Rouge, LA 70804, (504) 925-3690

5/21-24 — EMERGENCY '85 EXPOSITION AND CONFERENCE Research Alternatives Inc. conference organizers, Washington D.C. Contact James Morentz or Roy Popkin, Co-chairmen of the conference, EMERGENCY 85, Suite 31, 966 Hungerford Drive, Rockville, MD 20850 (301) 424-2803

1/24-26 1986 — COMPUTER SIMULATION IN EMERGENCY PLANNING The Society for Computer Simulation, San Diego. Contact Society, P.O. Box 2228, La Jolla, California 92038. (619) 459-3888

The Golden Gate Chapter of the American Red Cross has developed a slide presentation for business and other interested groups. "Employee Earthquake Preparedness for the Workplace and Home" is a 20-minute program with 139 slides, a synchronized cassette tape, script, and workbook that emphasizes planning as the key to earthquake safety and survival. The workbook has a checklist for workplace preparedness, a family disaster plan, and a personal survival guide. The slide show which was produced by Pacific Gas and Electric, demonstrates common hazards that can be prevented or controlled when disaster strikes.

"Employee Earthquake Preparedness for the Workplace and Home" can be obtained from the Golden Gate Chapter, American Red Cross, 1550 Sutter Street, San Francisco, California 94109, (415) 776-1500, x 211. The slide carousel, tape and workbook cost $250.00; the workbooks are $1.00 each.

FROM THE NATURAL HAZARDS INFORMATION CENTER

New publications:

WHEN THE GROUND FAILS: PLANNING AND ENGINEERING RESPONSE TO DEBRIS FLOWS, Martha Blair et al. Monograph # 40 in the Environment and Behavior Series is 110 pages long and costs $8.00

"....concludes with findings and recommendations that will be of interest to any professional or public official that has worked with the problems of debris flows, or has even the slightest chance of dealing with ground failure at some time in the future."

ADDRESS, TOPICS OF INTEREST, AND GEOGRAPHIC DISTRIBUTION OF PROFESSORS WORKING ON LANDSLIDES IN THE UNITED STATES. Earle E. Brabb, USGS and Ann FitzSimmons of Information Center. 37 pages long and costs $3.50.

"....directory was prepared to get some understanding of the extent of landslide research in all disciplines."

Both publications are available from the Publications Clerk, Natural Hazards Observer, Natural Hazards Research and Applications Information Center, Campus Box 482, University of Colorado, Boulder, Colorado 80309.

PREPARING A DETAILED LANDSLIDE-INVENTORY MAP FOR HAZARD EVALUATION AND REDUCTION...Gerald F. Wieczorek, in Bulletin of the Association of Engineering Geologists XXI (1984), #3:337-342. For reprints, contact the Editorial and Publications Office, AEG, Box 506, Short Hills, New Jersey 07078. "....presents engineering geologists and land use planning specialists with basic information needed to evaluate landslide hazards or risk on a regional or community level."

DISASTER MANAGEMENT: Warning Response and Community Relocation. R.W. Perry and A.H. Mushkatel, 1984. 280 pages, $35.00. Greenwood Press, 85 Post Road West. P.O. Box 5007, Westport, CT 06881

JOINT SEMINAR ON RESEARCH FOR MULTIPLE HAZARDS MITIGATION. Proceedings of a seminar held at the National Cheng-Kung University, Tainan, Taiwan, January 16-19, 1980. 800 pages, $25.00. Order from Leon R.L. Wang, Chairman, Department of Civil Engineering, Old Dominion University, Norfolk, VA 23508-8546

THE UTAH MUDSLIDES, DEBRIS FLOWS, AND FLOODS OF MAY AND JUNE 1983. Loren A. Anderson et al, National Academy of Sciences, National Research Council, 1984. 96 pages. NTIS, 5285 Port Royal Road, Springfield, VA 22161 as report CETS-CND-025. Paper copy is $13.00, microfiche is $4.50

PLANNING INFORMATION FOR EARTHQUAKE HAZARD RESPONSE AND REDUCTION. Christopher Arnold and Richard K. Eisner, 1984. 79 pages, $8.50 from Building Systems Development Inc. 3130 LaSelva, Suite 308, San Mateo, California 94403

NATIONAL EARTHQUAKE HAZARDS REDUCTION PROGRAM (NEHRP) recommended Provisions for the Development of Seismic Regulations for New Buildings. 1984, $27.75 per set. Order from the Building Seismic Safety Council, 1015 15th Street NW, Suite 700, Washington D.C. 20005/

" In a multi-phased program, the Building Seismic Safety Council (BSSC) is developing an authoritative, technically sound resource document for use by voluntary standards and model code organizations, the building community, the research community, and the public as a foundation for improved seismic safety design. Volume I overviews Phases I & II of the project, phases which evaluated two sets of structural designs - one using local seismic codes and the other using a set of provisions developed by the Applied Technology Council (ATC) in 1978. These phases evaluated 46 buildings, located in nine U.S. cities representing different levels of seismic risk. Volume 2 is divided into three parts. The first presents provisions submitted for review, comments, or concurrence by BSSC member organizations. The second provides commentary supplementing the 1984 provisions, as prepared for BSSC ballot.

GRANTS

EARTHQUAKE FORECASTING..."Probabilistic Approach to Earthquake Forecasting", U.S. Geological Survey, $65,661, 12 months, Principal Investigator: Mansour Niazi, Tera Advanced Services Corporation, 2150 Shattuck Avenue, Berkeley, California 94704 (415) 845-5200.

Crone, A.J. and Machette, M.N., 1984, Surface Faulting accompanying the Borah Peak earthquake, central Idaho, GEOLOGY, v. 12, p 664-667

ABSTRACT

The M_S 7.3 Borah Peak earthquake that struck central Idaho on October 28, 1983 was one of the strongest historic earthquakes in the Intermountain Seismic Belt. Much of the 34-km-long, northwest-trending zone of fault scarps and surface ruptures that formed during the earthquake follows Holocene and upper Pleistocene scarps of the Lost River fault. Throw along the new fault scarps averages 0.8 m, exceeds 1.0 m along 43% of their length, and attains a maximum of 2.7 m along the broad and complex zone of deformation in the southern section. The net slip was normal sinistral, averaging 17 cm lateral slip for 100 cm of dip slip. The preferred nodal plane from the focal mechanism strikes N 22° W, dips 59°SW, and suggests a much larger component of strike slip than do the geologic data.

U.S.G.S. PUBLICATIONS

(prices listed for the following Open-File reports are for paper copy; micro-fiche is also available. Reports can be ordered through USGS,Public Inquiries Office, 8105 Federal Building,SLC,Utah 84138-1177, 801-524-5652, FTS 588-5652)

HYPOELLIPSE/VAX: a computer program for determining local earthquake hypocentral parameters, magnitude, and first motion patterns. John C. Lahr , 63 pages, OF 84-519 $8.25

LITHOTECTONIC TERRANE MAPS OF THE NORTH AMERICA CORDILLERA, N.J. Silberling and D.L. Jones, editors, 106 pages, 4 plates. OF84-523

WATER-RESOURCE STUDIES IN UTAH, by the U.S.G.S., July 1, 1983 to June 30, 1984. L.S. Hamblin, 50 pages. OF84-585 $7.00

DEBRIS-FLOW DYNAMICS, J.E. Costa and G.P. Williams. (This is a videotape, contact the PIO for information on availability)

STRONG-MOTION DATA RECORDED NEAR COALINGA, CA. (May 2,1983) and processed data from 5/2 and 5/9, 1983 (U.S. National Strong Motion Network)R.Maley and others, 265 pages. OF 84-626 $34.25

GEOLOGIC MAP OF THE LYNNDYL 30' x 60' QUADRANGLE, Tooele, Juab, Utah, and Millard counties,UT Earl H. Pampeyan, 22 pages, 1 plate. OF 84-660 $6.75

LIQUEFACTION DURING THE 1981 AND PREVIOUS EARTHQUAKES NEAR WESTMORELAND, CALIFORNIA, T.L. Youd and G.F. Wieczorek, 38 pages. OF 84-680 $5.00

DESCRIPTION OF THE WEIGHTED REGRESSION AND QUALITY ESTIMATION used in the earthquake location program HYPOELLIPSE. J. Lahr, 38 pages OF84-766 $5.00

REGIONAL STRUCTURAL SETTING OF YUCCA MOUNTAIN, southwestern Nevada, and Late Cenozoic rates of tectonic activity in part of the southwestern Great Basin, NEVADA and CALIFORNIA, W.J. Carr, 114 pages OF84-854 $15.00

JOURNAL ARTICLES

Morphologic dating of fluvial terrace scarps and fault scarps near West Yellowstone, Montana.
David B. Nash, Geological Society of America, Bulletin 12, Vol. 95, December 1984, 1202-1207

Seismic stratigraphy and bedrock forms in peri-alpine lakes,
Peter Finckh and others, Geological Society of America, Vol. 95, No. 9, September 1984 1118-1128.

Mesozoic structure of the Newfoundland Mtns, Utah: Horizontal shortening and subsequent extension in the hinterland of the Sevier Belt.
R.W. Allmendinger and T.E. Jordan, Geological Society of America, Vol. 95 , No. 11, November 1984, 1280-1292.

UTAH DEPARTMENT OF NATURAL RESOURCES
Utah Geological and Mineral Survey
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