SUMMARY
Utah Quaternary Fault Parameters Working Group Meeting
Tuesday, February 15, 2011
Utah Department of Natural Resources Building, Room 2000
1594 West North Temple, Salt Lake City

WELCOME AND INTRODUCTION

Bill Lund (Utah Geological Survey [UGS]) called the 2011 Utah Quaternary Fault Parameters Working Group (UQFPWG) meeting to order at 8:00 a.m. After welcoming Working Group members and guests (attachment 1), Bill summarized the UQFPWG's past activities and outlined the Working Group's purpose and goals for the future.

UQFPWG Purpose and Goals

- Helps set and coordinate the earthquake-hazard research agenda for the State of Utah.
- Reviews ongoing paleoseismic research in Utah, and updates the Utah consensus slip-rate and recurrence-interval database as necessary.
- Provides advice/insight regarding technical issues related to fault behavior in Utah and the Basin and Range Province.
- Identifies and prioritizes future Utah Quaternary fault paleoseismic studies.

TECHNICAL PRESENTATIONS

The following presentations were made on current paleoseismic research and related activities in Utah:

- Preliminary results from the Penrose Drive trench on the Salt Lake City segment; Chris DuRoss, UGS
- Update on fault trenching at the Baileys Lake site, West Valley fault zone; Mike Hylland, UGS
- A brief summary of recent work on the northern Nephi segment of the Wasatch fault, Utah; Daniel Horns, Utah Valley University (UVU)
- Joes Valley fault zone; Lucy Piety, U.S. Bureau of Reclamation (USBR)
- Main Canyon and East Canyon faults; Lucy Piety, USBR

- Interactive Utah Quaternary fault map demonstration; Corey Unger and Mike Hylland, UGS

- HAZDOCS document archive presentation and progress report on UGS publishing USBR seismotectonic reports in the *Paleoseismology of Utah* series; Steve Bowman, UGS

- Utah Lake faults study – Preliminary progress report as of 2/15/2011; David Dinter, University of Utah Department of Geology and Geophysics (UUGG)

- Update on the Working Group on Utah Earthquake Probabilities; Ivan Wong, URS Corp.

- Integration of paleoseismic data from multiple sites to develop an objective earthquake chronology – Application to the Weber segment of the Wasatch fault zone, Utah; Chris DuRoss, UGS

- Implementation: The third dimension of seismic hazard mitigation; Ron Harris, Brigham Young University (BYU)

A scheduled presentation by Jim Evans, Utah State University, on the East Cache fault zone trenching study was cancelled because Jim failed to attend the meeting.

TECHNICAL DISCUSSION ITEM

- Recommendations to the U.S. Geological Survey (USGS) for the Quaternary Fault and Fold Database of the United States regarding the Joes Valley fault zone and the East Canyon and Main Canyon (East of East Canyon) faults; discussion moderator Bill Lund, UGS

Recent USBR investigations of the Joes Valley fault zone and the East Canyon and Main Canyon (East of East Canyon) faults (see http://geology.utah.gov/ghp/workgroups/uqfpwg.htm) completed as part of seismic hazard evaluations for the Joes Valley and East Canyon dams demonstrate that (a) the Joes Valley fault zone likely consists of shallow structures (a few to five kilometers deep) that may not be seismogenic, (b) clear evidence of Quaternary surface faulting is lacking on the East Canyon fault, and (c) the Main Canyon fault has had two surface-faulting earthquakes during the past 30,000 to 38,000 years, with the most recent earthquake likely occurring shortly before 5000 to 6000 years ago (Piety and others, 2010). The Joes Valley fault zone and East Canyon faults are currently classified as Class A faults in the Quaternary Fault and Fold Database of the United States. The Main Canyon (East of East Canyon) fault is classified as a Class B fault in the database. The definitions of Class A and B faults are as follows:

Class A	Geologic evidence demonstrates the existence of a Quaternary fault of tectonic origin, whether the fault is exposed by mapping or inferred from liquefaction or other deformational features.

Class B — Geologic evidence demonstrates the existence of Quaternary deformation, but either (1) the fault might not extend deeply enough to be a potential source of significant earthquakes, or (2) the currently available geologic evidence is too strong to confidently assign the feature to Class C, but not strong enough to assign it to Class A.

A Class C fault is defined as:

Class C — Geologic evidence is insufficient to demonstrate (1) the existence of tectonic faulting, or (2) Quaternary slip or deformation associated with the feature.

The UQFPWG discussed the results of the USBR paleoseismic and geologic investigations for the Joes Valley fault zone and East Canyon and Main Canyon faults, and whether or not the working group should make a recommendation to the USGS to reclassify the Joes Valley fault zone and East Canyon fault as Class B faults and the Main Canyon fault as a Class A fault. Lucy Piety indicated that the USBR plans to continue studying the Joes Valley fault zone as funds and time permit (neither being presently available), because the USBR is not yet fully convinced that the fault zone is not seismogenic. Based on the USBR's continued interest in the Joes Valley fault zone, the UQFPWG decided to withhold making a recommendation regarding fault reclassification pending the results of future USBR investigations. However, it should be noted that in 2004, the UQFPWG recommended to the USGS that they (1) combine all of the various groupings of the Joes Valley fault system into a single fault group, and (2) reclassify the fault to the "S" ("suspected") category (attachment 2), which corresponds to the current Class B faults of the Quaternary Fault and Fold Database of the United States.

The UQFPWG concurred that the East Canyon and Main Canyon faults should be reclassified, and referred the new USBR information on those faults to Mike Hylland, UGS, for inclusion in the next UGS update of Utah Quaternary faults submitted to the USGS for revision of the Quaternary Fault and Fold Database of the United States.

UQFPWG 2012 FAULT STUDY PRIORITIES

In 2005, the UQFPWG recommended that 20 Quaternary faults/fault segments in Utah be investigated to "adequately characterize Utah's earthquake hazard to a minimally acceptable level" (Lund, 2005). Since then, the Working Group has added an additional 10 faults/fault segments to the list: five in 2007, one in 2009, one in 2010, and three in 2011 (see table 1).

The UQFPWG reviews the progress made toward investigating the priority faults/fault segments annually, and based on that review, establishes a short list of highest priority faults for future study. Following the 2011 review, the Working Group designated the following six faults/fault segments as the highest priority Utah faults for paleoseismic study in 2012: Brigham City segment WFZ rupture extent (north and south ends); long-term earthquake record Nephi segment WFZ; long-term earthquake record northern Provo segment WFZ; long-term earthquake

record southern Weber segment WFZ; penultimate event Provo segment WFZ; and West Valley fault zone – Taylorsville fault. Additionally, the working group added the Hansel Valley fault to the list of "Other" priority faults. Table 2 shows the 2012 highest priority faults, and the current investigation status for all faults/fault segments identified by the UQFPWG as requiring additional study.

REFERENCES

Black, B.D., Giraud, R.E., and Mayes, B.H., 2000, Paleoseismic investigation of the Clarkston, Junction Hills, and Wellsville faults, West Cache fault zone, Cache County, Utah – Paleoseismology of Utah, Volume 9: Utah Geological Survey Special Study 98, 23 p., 1 plate. [http://ugspub.nr.utah.gov/publications/special_studies/SS-98.pdf]

Lund, W.R., 2005, Consensus preferred recurrence-interval and vertical slip-rate estimates – Review of Utah paleoseismic-trenching data by the Utah Quaternary Fault Parameters Working Group: Utah Geological Survey Bulletin 134, 109 p., CD. [http://ugspub.nr.utah.gov/publications/bulletins/B-134.pdf]

McCalpin, J.P., 1985, Quaternary fault history and earthquake potential of the Hansel Valley area, north-central Utah: Final Technical Report to the U.S. Geological Survey, Contract No. 14-08-001-21899, 37 p.

McCalpin, J.P., Robison, R.M., and Garr, J.D., 1992, Neotectonics of the Hansel Valley-Pocatello Valley corridor, northern Utah and southern Idaho, *in* Gori, P.L., and Hays, W. W., editor, Assessment of regional earthquake hazards and risk along the Wasatch Front, Utah: U.S. Geological Survey Professional Paper 1500-G, 18 p.

Piety, L.A., Anderson, L.A., and Ostenaa, D.A., 2010, Late Quaternary faulting in East Canyon Valley, northern Utah - Paleoseismology of Utah, Volume 19: Utah Geological Survey Miscellaneous Publication 10-5, 45 p., CD. [http://geology.utah.gov/online/mp/mp10-05/mp10-05.pdf]

Robison, R.M., 1986, The surficial geology and neotectonics of Hansel Valley, Box Elder County, Utah: Logan, Utah State University, M.S. thesis, 120 p., scale 1:24,000.

Table 1. List of Quaternary faults/fault segments identified by the UQFPWG as requiring additional study to adequately characterize Utah's earthquake hazard to a minimally acceptable level.

Fault/Fault Segment	Original UQFPWG Priority (2005)
Nephi segment WFZ	1
West Valley fault zone	2
Weber segment WFZ – most recent event	3
Weber segment WFZ – multiple events	4
Utah Lake faults and folds	5
Great Salt Lake fault zone	6
Collinston & Clarkston Mountain segments WFZ	7
Sevier/Toroweap fault	8
Washington fault	9
Cedar City-Parowan monocline/ Paragonah fault	10
Enoch graben	11
East Cache fault zone	12
Clarkston fault	13
Wasatch Range back-valley faults	14
Hurricane fault	15
Levan segment WFZ	16
Gunnison fault	17
Scipio Valley faults	18
Faults beneath Bear Lake	19
Eastern Bear Lake fault	20
Bear River fault zone	2007
Brigham City segment WFZ – most recent event	2007
Carrington fault (Great Salt Lake)	2007
Provo segment WFZ – penultimate event	2007
Rozelle section – East Great Salt Lake fault	2007
Salt Lake City segment WFZ – northern part	2009
Warm Springs fault/East Bench fault subsurface geometry and connection	2010
Brigham City segment WFZ rupture extent (north and south ends)	2011
Long-term earthquake record northern Provo segment WFZ	2011
West Valley fault zone – Taylorsville fault	2011

Table 2. UQFPWG 2012 list of highest priority Quaternary faults/fault segments requiring additional study to adequately characterize Utah's earthquake hazard to a minimally acceptable level, and status of current paleoseismic investigations on all currently identified Utah priority faults/fault segments.

2012 Highest Priority Faults/Fault Sections For Study			
Fault/Fault Section[1]	**Investigation Status**		**Investigating Institution[2]**
Brigham City segment WFZ rupture extent (north and south ends)	No activity		
Long-term earthquake record Nephi segment WFZ	No activity		
Long-term earthquake record northern Provo segment WFZ	No activity		
Long-term earthquake record southern Weber segment WFZ	No activity		
Penultimate event Provo segment WFZ	Trench site reconnaissance		UGS
West Valley fault zone – Taylorsville fault	No activity		
Other Priority Faults/Fault Sections Requiring Further Study			
Fault/Fault Section	**Original UQFPWG Priority**	**Investigation Status**	**Investigating Institution[2]**
Cedar City-Parowan monocline/Paragonah fault[3]	10	No activity	
Enoch graben	11	No activity	
Clarkston fault[3]	13	Black and others (2000)	
Gunnison fault	17	No activity	
Scipio Valley faults	18	No activity	
Faults beneath Bear Lake	19	No activity	
Eastern Bear Lake fault	20	No activity	
Carrington fault (Great Salt Lake)	2007	No activity	
Rozelle section, Great Salt Lake fault[4]	2007	No activity	
Warm Springs fault/East Bench fault subsurface geometry and connection[4]	2010	No activity	
Hansel Valley fault[3]	2011	McCalpin, (1985), McCalpin and others (1992), Robinson (1986)	
Faults/Fault Sections Studies Complete or Ongoing			
Fault/Fault Section	**Original UQFPWG Priority**	**Investigation Status**	**Investigating Institution[2]**
Nephi segment WFZ	1	UGS Special Study 124 USGS Map 2966 UVU study ongoing	UGS/USGS/UVU
West Valley fault zone	2	Study funded for 2010	UGS/USGS
Weber segment WFZ – most recent event	3	UGS Special Study 130	UGS/USGS
Weber segment WFZ – multiple events	4	UGS Special Study 130	UGS/USGS
Utah Lake faults and folds	5	Study funded 2009	UUGG
Great Salt Lake fault zone	6	Ongoing	UUGG
Collinston & Clarkston Mountain segments WFZ	7	UGS Special Study 121	UGS
Sevier/Toroweap fault	8	UGS Special Study 122	UGS
East Cache fault zone	12	Ongoing	USU
Wasatch Range back-valley faults	14	Ongoing	USBR
Hurricane fault	15	UGS Special Study 119	UGS
Levan segment WFZ	16	UGS Map 229	UGS
Brigham City segment WFZ – most recent event	2007	Ongoing	UGS/USGS
Bear River fault zone	2007	Ongoing	USGS
Salt Lake City segment WFZ – north end	2009	Study funded for 2010	UGS/USGS

[1]Listed in alphabetical, not priority order
[2]UGS (Utah Geological Survey), USU (Utah State University), USGS (U.S. Geological Survey), UVU (Utah Valley University), UUGG (University of Utah Department of Geology & Geophysics), USBR (U.S. Bureau of Reclamation)
[3]Earthquake source on the USGS National Seismic Hazard Maps
[4]Previously a highest priority fault/fault segment

ATTACHMENT 1
Meeting Attendees

Quaternary Fault Parameters Working Group

Tony Crone, USGS
Dave Dinter, UUGG
Chris DuRoss, UGS
Kathy Haller, USGS
Ron Harris, BYU
Daniel Horns, UVU
Michael Hylland, UGS
William Lund, UGS
Susan Olig, URS Corp.
James Pechmann, University of Utah Seismograph Stations
Steve Personius, USGS
Mark Petersen, USGS
Lucy Piety, USBR
Ivan Wong, URS Corp.

Guests

Dan Aubrey, Utah Division of Water Resources
Steve Bartlett, University of Utah Department of Civil Engineering
Doug Bausch, Federal Emergency Management Agency
Steve Bowman, UGS
Sarah Derouin, USBR
Rich Giraud, UGS
Greg McDonald, UGS
David Simon, Simon-Bymaster, Inc.
Anna Vargo, Natural Resources Conservation Service
Grant Willis, UGS

ATTACHMENT 2
Suggested UQFPWG revisions to the Joes Valley fault zone entry in the Quaternary Fault and Fold Database of the United States forwarded to the USGS in 2005.
Yellow highlights suggested text changes.

2453S, JOES VALLEY FAULT ZONE

Structure number: 2453S.
Comments: Previously treated as four separate fault zones: Hecker's (1993) fault numbers 13-5, 13-6, 13-7, and 13-8 (2454, 2453, 2455, and 2456, respectively, in Black and others [2003]).
Structure name: Joes Valley fault zone.
Comments: Includes the northern Joes Valley fault zone, consisting of the west, east, and intragraben faults, and the southern Joes Valley fault zone, consisting of the Muddy, Paradise, and intragraben faults.
Synopsis: Normal-fault-bounded graben, consisting of parallel, en echelon, and locally overlapping, north- to northeast-trending faults, which extend along the east side of the Wasatch Plateau (Foley and others, 1986). The northern Joes Valley fault zone is characterized by linear graben-bounding bedrock escarpments and fault scarps on Quaternary deposits. The southern Joes Valley fault zone has less stratigraphic throw and generally no scarps on Quaternary deposits. There is no net slip across the entire Joes Valley fault zone, and the seismogenic potential of the individual faults is poorly understood. The recurrence-interval estimates for the Joes Valley fault zone reflect the consensus values of the Utah Quaternary Fault Parameters Working Group (Lund, 2004). The preferred value of Lund (2004) approximates the "mean" based on available paleoseismic-trenching data, and the minimum and maximum values approximate two-sigma (5^{th} and 95^{th} percentile) confidence limits. The confidence limits incorporate both epistemic (e.g., data limitation) and aleatory (e.g., process variability) uncertainty (Lund, 2004).
Date of Compilation: 6/04.
Compiler and affiliation: Bill D. Black, Christopher B. DuRoss, and Greg N. McDonald (Utah Geological Survey), and Suzanne Hecker (U.S. Geological Survey).
State: Utah
County: Sanpete, Emery, and Sevier.
1° x 2° sheet: Price.
Province: Colorado Plateaus.
Reliability of location: Good.
Comments: Mapping from Foley and others (1986).
Geologic setting: Joes Valley is a long, straight, north-trending graben that splits the Wasatch Plateau, which is capped mainly by Tertiary Flagstaff Limestone. Faults forming the graben are subdivided into the northern and southern Joes Valley fault zones, based on the relative timing of fault movement. The northern Joes Valley graben is bounded by the east and west Joes Valley fault zones, which have the greatest amount of bedrock displacement near the center of the graben, with slip decreasing toward the north and south. Several intragraben faults on unconsolidated Quaternary alluvium exist, including the Middle Mountain fault and the Bald Mountain fault (Foley and others, 1986). The southern Joes Valley graben is bounded by the

Muddy and Paradise faults, and several intragraben faults, which have very limited evidence for Quaternary movement.

Sense of movement: N.

Comments:

Dip: No data.

Comments:

Dip direction: E and W.

Geomorphic expression: Within the northern Joes Valley graben, the west fault is divided into the Huntington, Seely, and Dugway Hollow sections (from north to south, 4, 42, and 7.5 km long) based on relative age and displacement (Foley and others, 1986). Fault throw varies from less than 500 m across an eroded bedrock escarpment, partially buried by Pinedale (~11-14 ka) terminal moraines on the Huntington section, to ~150 m across the Dugway Hollow fault section, marked by a deeply incised scarp on colluvial veneer and bedrock. The Seely section has an undetermined amount of throw across two en echelon faults in Quaternary deposits. Scarps along the longer (en echelon) fault are 8-12 m high on latest Pleistocene (<30 ka) deposits, and 12-14 m high on latest Pinedale (11-14 ka) deposits along the shorter (en echelon) fault.

Foley and others (1986) divide the east fault (based on relative age and displacement) into the Miller Flat, Straight Canyon, and Ferron sections (from north to south, 8, 42,and 5 km long). Both the Miller Flat and Ferron sections have evidence for up to 100 m of total stratigraphic throw in bedrock. The Ferron section is expressed as a deeply incised scarp on colluvial veneer and bedrock, whereas a steep linear escarpment with up to 900 m of throw across bedrock and unconsolidated deposits marks the Straight Canyon section. Only the Straight Canyon section has significant inferred late Quaternary (<150 ka) displacement. The youngest measured displacement (2.5 m) is apparently due to monoclinal folding and may be the result of several small events.

Intragraben faults within the northern Joes Valley graben include the Bald Mountain faults, consisting of two horst-bounding scarps on upper Pleistocene deposits, and unfaulted Late Pleistocene moraines to the north and south. The Middle Mountain fault consists of several en-echelon, down-to-the-west scarps; the faults may be antithetic to the west Joes Valley fault based on similarities in movement histories. Trenches across the Middle Mountain fault expose two surface-faulting events separated by a soil inferred to be 14-30 ka in age; the events show measured displacements of <1 m for the most recent event and about 3 m for the earlier event.

The southern Joes Valley graben is bounded by the Muddy fault on the west and the Paradise fault on the east, with numerous smaller intragraben faults in between. Faults in the southern Joes Valley fault zone have less total stratigraphic throw, less topographic definition, and lower Quaternary activity rates than faults bounding the northern Joes Valley graben. Late Quaternary displacement on the faults is restricted to two short grabens. Gravels inferred to be more than 150 ka in age are displaced about 30 m in the grabens, but show no net tectonic displacement.

The estimated maximum credible earthquake for individual ruptures of faults within the Joes Valley fault zone (e.g., the west Joes Valley fault in the northern Joes Valley fault zone) is 7.5 (M_s). However the seismogenic nature of the faults is questionable, due to a lack of net slip across the entire graben and presently unidentified rupture pathways to the base of the seismogenic crust.

Age of faulted deposits: Holocene to Middle Pleistocene.

Paleoseismology studies: Fault trench studies are limited to the northern Joes Valley fault zone. Along the east Joes Valley fault a trench was excavated on the southeast side of Scad Valley, at the north end of the Straight Canyon section (site 2453S-1).
Stratigraphic and structural relations indicate at least four surface-faulting events since 150-300 ka, which is the interpreted age (based on amino acid racemization of snail shells) of the oldest unit exposed in the trench. The four events appear to have involved both brittle rupture and monoclinal folding. Two bulk-soil samples and one charcoal sample from the modern (unfaulted) soil profile yielded radiocarbon age estimates that place a minimum limiting age on the most recent event.

Several trenches excavated across the Middle Mountain fault (site 2453S-2), within the intragraben fault zone, exposed stratigraphic evidence for at least two surface-faulting events (Foley and others, 1986). The trenches were located east of the mouth of Reeder Canyon where two parallel en echelon scarps cross the three oldest of four upper Pleistocene alluvial fans (site 2453S-2). Radiocarbon age estimates from three bulk-soil samples of an unfaulted, organic-rich paleosol A horizon provide a minimum limiting age for the most recent event.

Foley and others (1986) excavated a trench on the Seely section of the west Joes Valley fault, about 270 m north of Littles Creek near the north end of a 450-m-long scarp crossing the highest of three alluvial terraces (site 2453S-3). Stratigraphic relations indicate a minimum of two surface-faulting events. Radiocarbon age estimates from a bulk-soil sample and charcoal derived from unfaulted colluvium provide a minimum age of the most recent event. Geomorphic relations and soils data provide additional broad constraints on earthquake timing.

An additional trench (site 2453S-4) across the inferred southern extension of the Middle Mountain fault (west-facing scarps on the west side of Joes Valley Reservoir) indicated multiple small (< 1 m) displacements (Foley and others, 1986).

Timing of most recent paleoevent: (2) Latest Quaternary (<15 ka).
Comments: Based on fault trench investigations and both radiocarbon dating and the relative ages of displaced deposits in the northern Joes Valley fault zone (Foley and others, 1986). The east Joes Valley fault experienced a minimum of four earthquakes in 250 ky, whereas the west Joes Valley and intragraben faults have each experienced a minimum of two earthquakes in the past ~30 ky. Individual earthquake timing is poorly constrained. Within the southern Joes Valley fault zone, the timing of the most recent paleoevent is estimated to be between the middle and late Quaternary (<750 ka).

Recurrence interval: 10 ky (preferred); minimum 5, maximum 50 ky (<30-300 ka)

Comments: Consensus recurrence-interval range reported in Lund (2004), based on a review of available fault-trench data for the northern Joes Valley fault zone by Foley and others (1986). The intentionally broad range reflects high uncertainty in the timing of events (Lund, 2004). Includes broadly constrained recurrence interval estimates for the Middle Mountain fault (10-15 ky) and west Joes Valley fault (10-20 ky) over a ~30 ky period of fault record, and the east Joes Valley fault (<60 ky) estimated over a ~250 ky period of record (Foley and others, 1986).

Slip rate: Unknown, probably <0.2 mm/yr.

Comments: Foley and others (1986) report no net slip across the Joes Valley graben, and question the seismogenic capability of the fault zone. Consequently, Lund (2004) did not estimate a slip rate range for the Joes Valley fault zone. Existing slip-rate estimates are limited to individual faults in the northern Joes Valley fault zone. Fault scarps at five localities along the Seely section of the west Joes Valley fault indicate about 12 m of displacement in deposits

ranging in age from 11-30 ka, suggesting a long-term geologic slip rate of 0.4-1.1 mm/yr. The northern part of the section appears to have the largest Holocene displacement, where 12-14-m-high scarps are in Pinedale (11-14 ka) moraines. Geologic slip-rate estimates for the Middle Mountain fault (since ~30 ka) and east Joes Valley fault (since 150-300 ka) range from 0.1 to 0.3 mm/yr.

Length: End to end (km): 83
Cumulative trace (km): 350

Average strike (azimuth): N6°E

REFERENCES

Foley, L.L., Martin, R.A., Jr., and Sullivan, J.T., 1986, Seismotectonic study for Joes Valley, Scofield and Huntington North Dams, Emery County and Scofield Projects, Utah: Denver, U.S. Bureau of Reclamation Seismotectonic Report No. 86-7, 132 p., scale 1:60,000 and 1:155,000.

Hecker, Suzanne, 1993, Quaternary tectonics of Utah with emphasis on earthquake-hazard characterization: Utah Geological Survey Bulletin 127, 2 plates, scale 1:500,000, 257 p.

Lund, W.R., 2004, Utah Quaternary Fault Parameters Working Group review of Utah paleoseismic-trenching data and determination of consensus recurrence-interval and vertical slip-rate estimates: Salt Lake City, Utah Geological Survey, unpublished Final Technical Report for the U.S. Geological Survey, National Earthquake Hazards Reduction Program, Contract No. 03HQGR0033, variously paginated.