

SUMMARY
Utah Quaternary Fault Parameters Working Group Meeting
Tuesday, February 9, 2010
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 2010 Utah Quaternary Fault Parameters Working Group (UQFPWG) meeting to order at 7:30 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 studies.

TECHNICAL PRESENTATIONS

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

- Brigham City segment, trenching update; Tony Crone/Steve Personius, USGS
- Washington fault northern segment, trenching update; Bill Lund/Tyler Knudsen, UGS
- Washington fault Southern Beltway trenching investigation; Dave Simon, Simon - Bymaster, Inc.
- U.S. Bureau of Reclamation Utah fault studies update; Larry Anderson, USBR
- Bear River fault zone, trenching update; Suzanne Hecker, USGS

- Salt Lake City segment/West Valley fault zone investigation, progress report: Mike Hylland, UGS
- Working Group on Utah Earthquake Probabilities; Ivan Wong, URS Corp.

A scheduled presentation by Jim Evans, USU, on the East Cache fault zone trenching study was cancelled because Jim did not attend the meeting.

TECHNICAL DISCUSSION ITEMS

An Updated Chronology of Surface-Faulting Earthquakes on the Weber Segment, Wasatch Fault Zone; Chris DuRoss, UGS/Steve Personius, USGS

Recently updated and new paleoseismic data (UGS Miscellaneous Publication 05-8 [Nelson and others, 2006]; UGS Special Study 130 [DuRoss and others, 2009]) are now available for the Weber segment of the Wasatch fault zone (WFZ). Based on these newly available data and information from previously published paleoseismic studies on the segment, Chris DuRoss (UGS) and Steve Personius (USGS) prepared an updated chronology of surface-faulting earthquakes for the Weber segment. Their scope of work included: (1) carefully evaluating the paleoseismic data from the Kaysville (Swan and others, 1980; McCalpin and others, 1994), East Ogden (Nelson and others, 2006), Garner Canyon (Nelson and others, 2006), and Rice Creek (DuRoss and others, 2009) paleoseismic trench sites, (2) creating OxCal models for each site using stratigraphic information and reviewed ¹⁴C and luminescence ages, (3) correlating the resulting individual earthquake-timing probability density functions (PDFs) from OxCal across the segment, (4) comparing and combining the site PDFs into a Weber segment chronology, and (5) estimating average recurrence intervals and slip rates based on the revised chronology.

Review of data for the Kaysville site revealed the possibility of a fourth earthquake between the two most recent earthquakes identified by McCalpin and others (1994). This earthquake would correlate with the second event identified at Rice Creek, Garner Canyon, and East Ogden. Evidence for the additional event includes soil unit S3 of McCalpin and others (1994) (similar to unit S2 of Swan and others, 1980) that predates the most recent earthquake, but apparently postdates faults and fissures formed in colluvium from the second earthquake (unit 4 of McCalpin and others, 1994). Unit S3 has a wedge shape, tapering from about 2 m thick near the fault scarp to about 0.5 m thick in a graben west of the scarp and appears to bury preexisting topography. Swan and others (1980) also show complex deformation below their soil unit S2 (S3) but few faults extending through it. However, it is possible that these faults and fissures extended up through the soil (unit S3) in the most recent event, but could not be accurately mapped. Chris and Steve plan to discuss this possible reinterpretation with the original study authors and restore the Swan and others (1980) trench map to look for additional evidence for the event.

A preliminary conclusion of the correlation analysis is that four earthquakes ruptured all paleoseismic sites on the Weber segment in the last about 4 ka (including the additional

Kaysville event). The most recent earthquake, W1, occurred at 0.5 ± 0.15 ka (2 sigma), and older events (W2 to W4) occurred at 1.1 ± 0.7 ka, 3.1 ± 0.75 ka, and 4.1 ± 0.9 ka. A fifth earthquake, identified only at Rice Creek, occurred at 6.3 ± 1.2 ka. These earthquake times and uncertainties are similar to the UQFPWG consensus values (Lund, 2005), but have broader uncertainties:

| <u>UQFPWG (Lund, 2005)</u> | <u>New Chronology</u> |
|--|----------------------------------|
| • W1: 0.5 ± 0.3 ka ($\sim 2 \sigma$) | 0.5 ± 0.15 ka (2σ) |
| • W2: 0.95 ± 0.45 ka | 1.1 ± 0.7 ka |
| • W3: 3.0 ± 0.7 ka | 3.1 ± 0.75 ka |
| • W4: 4.5 ± 0.7 ka | 4.1 ± 0.9 ka |
| • W5: 6.1 ± 0.7 ka | 6.3 ± 1.2 ka |

Using the revised Weber segment earthquake chronology, the average recurrence interval (based on the four intervals between W5 and W1) is 1.5 ± 0.9 ky (0–3.2 ky at 2 sigma). The large uncertainty reflects short (~ 0.5 –1-ky) intervals between W2–W1 and W4–W3 and longer (~ 2 ky) intervals between W3–W2 and W5–W4, and is similar to estimates of Nelson and others (2006) and DuRoss and others, (2009). The preferred UQFPWG recurrence interval for the Weber segment is 1.4 ky (0.5–2.4 estimated two-sigma range).

The average interval slip rate is 2.0 mm/yr (0–4.6 mm/yr at 2 sigma), based on per-event displacement and revised individual-earthquake recurrence estimates. The large rate stems from moderate to large displacements and short recurrence times, but is similar to average post-mid-Holocene slip rate estimates of about 1 to 3 mm/yr reported in McCalpin and others (1994), Nelson and others (2006), and DuRoss and others, (2009). The preferred UQFPWG slip rate of the Weber segment is 1.2 mm/yr (0.6–4.3 estimated two-sigma range).

The UQFPWG members noted the general similarity between the UQFPWG consensus values and the new earthquake chronology and recurrence-interval estimates; however, the new mean slip-rate estimate is significantly higher than the UQFPWG consensus value. The UQFPWG decided to delay modifying their Weber segment consensus values until Chris and Steve speak with the authors of the original Kaysville studies (Swan and others, 1980; McCalpin and others, 1994) to resolve the question of three versus four surface faulting earthquakes at that site (south Weber segment) and adjust their earthquake chronology accordingly. The Working Group members also suggested that some reasonable minimum values of recurrence and slip rate be selected for the new recurrence-interval and slip-rate estimates to avoid reporting minimum recurrence-interval and slip-rate end values of zero (see above).

UQFPWG 2011 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). In 2007, the Working Group added five additional faults/fault segments to the priority list, and in 2009 they added a sixth fault segment (see table below). The UQFPWG reviews the progress made toward investigating the priority faults/fault sections annually (see above), and following that review identifies a list of highest priority faults/fault segments for

additional study. The Working Group ranked the following five faults/fault segments as having the highest priority for study in 2011: (1) subsurface geometry of and connection between the East Bench and Warm Springs strands of the Salt Lake City segment WFZ, (2) penultimate event Provo segment WFZ, (3) long-term earthquake record on the Nephi segment WFZ, (4) Washington fault, and (5) chronology of mid- to late-Holocene surface-faulting earthquakes on the southern half of Weber segment WFZ. The following table shows the 2011 highest priority fault list and the current status for all priority faults/fault segments identified by the UQFPWG as requiring additional study.

UQFPWG 2011 highest priority list of 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 Utah priority faults/fault segments.

| 2011 Highest Priority Faults/Fault Sections For Study | | | |
|---|---------------------------------|---|--|
| Fault/Fault Section | Priority | Investigation Status | Investigating Institution¹ |
| Warm Springs fault/East Bench fault subsurface geometry and connection | 1 | No activity | |
| Penultimate event Provo segment WFZ | 2 | Trench site reconnaissance | UGS |
| Long-term earthquake record Nephi segment WFZ | 3 | No activity | |
| Washington fault | 4 | Two trenching investigations | UGS/Simon-Bymaster |
| Mid- to late-Holocene earthquake chronology southern part Weber segment WFZ | 5 | No activity | |
| Other Priority Faults/Fault Sections Requiring Further Study | | | |
| Fault/Fault Section | Original UQFPWG Priority | Investigation Status | Investigating Institution¹ |
| Cedar City-Parowan monocline/Paragonah fault ² | 10 | No activity | |
| Enoch graben | 11 | No activity | |
| Clarkston fault ² | 13 | No activity | |
| 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 | 2007 | No activity | |
| Faults/Fault Sections Studies Complete or Ongoing | | | |
| Fault/Fault Section | Original UQFPWG Priority | Investigation Status | Investigating Institution¹ |
| 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 |

¹UGS (Utah Geological Survey), USGS (U.S. Geological Survey), UVU (Utah Valley University), UUGG (University of Utah Department of Geology & Geophysics), USU (Utah State University), USBR (U.S. Bureau of Reclamation).

²Used as an earthquake source on the USGS National Seismic Hazard Maps

ATTACHMENT 1
Meeting Attendees

Quaternary Fault Parameters Working Group

Tony Crone, USGS
Chris DuRoss, UGS
Kathy Haller, USGS
Ron Harris, BYU
Suzanne Hecker, USGS
Daniel Horns, UVU
Michael Hylland, UGS
William Lund, UGS
Susan Olig, URS Corp.
James Pechmann, UUSS
Steve Personius, USGS
Mark Petersen, USGS
Larry Anderson, USBR
Ivan Wong, URS Corp.

Guests

Steve Bartlett, UUCE
Steve Bowman, UGS
Jessica Castleton, UGS
Ashley Elliot, UGS
Tyler Knudsen, UGS
Greg McDonald, UGS
David Simon, Simon-Bymaster, Inc.

ATTACHMENT 2

References Cited

- 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>]
- DuRoss, C.B., Personius, S.F., Crone, A.J., McDonald, G.N., and Lidke, D.J., 2009, Paleoseismology of Utah Volume 18—Paleoseismic investigation of the northern Weber segment of the Wasatch fault zone at the Rice Creek trench site, North Ogden, Utah: Utah Geological Survey Special Study 130, 38 p., CD.
[<http://geology.utah.gov/online/ss/ss-130.pdf>]
- McCalpin, J.P., Forman, S.L., and Lowe, M., 1994, Reevaluation of Holocene faulting at the Kaysville site, Weber segment of the Wasatch fault zone, Utah: *Tectonics*, v. 13, no. 1, p. 1-16.
- Nelson, A.R., Lowe, M., Personius, S., Bradley, L-A, Forman, S.L., Klauk, R., and Garr, J., 2006, Paleoseismology of Utah Volume 13—Holocene earthquake history of the northern Weber segment of the Wasatch fault zone, Utah: Utah Geological Survey Miscellaneous Publication 05-8, 39 p., CD. [http://ugspub.nr.utah.gov/publications/misc_pubs/MP-05-8.pdf]
- Swan, F.H. III, Schwartz, D.P., and Cluff, L.S., 1980, Recurrence of moderate to large magnitude earthquakes produced by surface faulting on the Wasatch fault zone, Utah: *Bulletin of the Seismological Society of America*, v. 70, no. 5, p. 1431-1462.