**SUMMARY**
**SEVENTH MEETING**
**WORKING GROUP ON UTAH EARTHQUAKE PROBABILITIES**
**Thursday & Friday, February 16 & 17, 2012**
**Utah Department of Natural Resources Building, Room 1040-1050**
**1594 West North Temple, Salt Lake City**

## WELCOME AND INTRODUCTION

Working Group on Utah Earthquake Probabilities (WGUEP) Coordinator Bill Lund called the seventh WGUEP meeting to order at 8:30 a.m. After welcoming the Working Group members and UGS staff (attachment 1), Bill turned the meeting over to Ivan Wong (WGUEP Chair) who reviewed the meeting agenda (attachment 2), recapped WGUEP progress to date, and reviewed the current WGUEP task list, which included the following:

1. Complete revision of the historical earthquake catalog (Walter/Jim).
2. Decluster historical earthquake catalog and calculate recurrence for background seismicity correcting for magnitude bias (Mark/Walter/Ivan).
3. Finalize selection of recurrence models and weights (Ivan).
4. Finalize coefficient of variation (COV) and uncertainties for the Wasatch fault zone (WFZ) – asymmetric or symmetric (Chris).
5. Finalize recurrence intervals (RIs) for single and multi-segment ruptures on central WFZ (Chris/Nico).
6. Finalize slip rates for end segments of the WFZ (Mike/Chris).
7. Finalize rupture model, RIs, slip rates, and COV for Oquirrh-Great Salt Lake fault zone (O-GSLFZ) (Susan/Jim).
8. Finalize $M_{max}$ procedures (Susan).
9. Finalize seismogenic crustal thicknesses for west and east of the WFZ (Jim/Ivan).
10. Finalize parameters for “Other Faults” (Bill).
11. Finalize parameters for antithetic rupture of Hansel Valley fault (Mike/Bill).
12. Finalize weights of time-dependent versus time-independent models for WFZ and O-GSLFZ (Chris/Susan/Jim).
13. Finalize average displacements for calculating magnitudes (**M**) for central WFZ (Chris/Susan).
14. Compare geologic horizontal slip rates with geodetic rates across Wasatch Front (David/Jim/Mark).
15. Finalize approach for background seismicity (Ivan/Mark).

## TECHNICAL PRESENTATIONS

The meeting then moved to a series of technical presentations and issue updates. Available PowerPoint presentations from the meeting are at http://geology.utah.gov/ghp/workgroups/pdf/wguep/WGUEP-2012A_Presentations.pdf. Note that not all presentations included a PowerPoint.

### Thursday, February 16

- Update on Consensus Wasatch Front Catalog – Walter Arabasz and Jim Pechmann
- Multi-Segment Ruptures on Normal Faults – Dave Schwartz
- Working Group on Utah Earthquake Probabilities Paleoseismology Subgroup Update – Chris DuRoss
- The Wasatch Fault Zone End Segments (Malad City, Clarkston Mountain, Collinston, Levan, and Fayette), Slip Rate and Length, Model Distributions and Weights – Mike Hylland
- Oquirrh-Great Salt Lake Fault Zone Revisited – Susan Olig and Jim Pechmann
- Other Fault Parameters – Bill Lund
- Final Recurrence Models and Weights – Ivan Wong

### Friday, February 17

- Antithetic Fault Parameters – Mike Hylland
- Maximum Earthquake Focal Depths in the WGUEP Wasatch Front Region – Jim Pechmann
- Smoothing of Background Seismicity – Ivan Wong
- Evaluation of Geodetic Models in Northern California – Mark Petersen
- UCERF3 Evaluation of Geodetic Models in California – Ivan Wong
- Probability Calculations and Input Sensitivities – Patricia Thomas

## ISSUE DISCUSSIONS

Technical presentations and the ensuing discussions they generated are summarized below.

**Update on Consensus Wasatch Front Earthquake Catalog**

Walter Arabasz presented an update on the effort to compile a consensus Wasatch Front Region (WFR) earthquake catalog. The principal points of the presentation included:

- Information items
    - Efforts similar to the WGUEP are underway to rigorously derive earthquake rate information from the University of Utah's earthquake catalog as part of the Blue Castle project for a proposed nuclear power plant near Green River, Utah.
    - Final report for the Central and Eastern United States Seismic Source Characterization for Nuclear Facilities is now available at http://www.ceus-ssc.com/project_report.html. (The report contains abundant details on the state of practice for using earthquake catalogs and paleoseismological data in seismic source characterizations.)

- The data set of reliable moment magnitudes for the Utah region totals more than 100 earthquakes. These measurements are useful not only for the events themselves, but are also critical for assessing the relation between $M_L$ and $M_C$ in the University of Utah Seismograph Stations' (UUSS) catalog with $M_W$.
    - pre-1962: N=2 (Hansel Valley main shock and after shock)
    - 1962-1980: N=7 (Pechmann, unpublished compilation; ~same sources as Pancha and others [2006], Doser and Smith [1982] values excluded)
    - 1981-2003: N=52 (Pechmann and others, 2007, 2010), nine overlap with Whidden and Pankow (2012)
    - 1997-2011: N=48 (Whidden and Pankow, 2012), 25 overlap with Herrmann and others (2011)

      N=29 (Herrmann and others, 2011)

- Work on magnitude conversions and corresponding uncertainties (historical: $M_L$ ($I_o$); instrumental: $M_L$, $M_C$, and $M_W$) – Walter reviewed (1) why these uncertainties are important, notably because they bias earthquake-rate estimates, and (2) approaches to account for the magnitude-conversion uncertainties in earthquake-rate calculations.

- Update on unifying UUSS and National Seismic Hazard Maps (NSHM) catalogs (and magnitudes, see table 1, below)
    - Historic catalog (1850 -1962)
    - Instrumental catalog (1962 -2010)

- Target for passing catalog to URS Corporation/U.S. Geological Survey "analysts"
    - Attempting to complete before mid-March – likely to take at least a month longer

- o Decision on declustering method to be made by analysts

Mark Petersen asked whether or not we should try smoothing to **M** 3 events? Walter's opinion was that we should because of the sparse amount of available data; Mark and Ivan agreed.

***Table 1.*** *Unifying UUSS and NSHM Catalogs.*

| Time Period | UUSS | NSHM | Pancha and others (2006) |
|---|---|---|---|
| *1850 - JUN 1962*<br>**No. of Events** | 462<br>307 ($M_{int}$)<br>140 (no mag) | 143 | 68<br>**Reconciling Magnitudes** |
| *JUL 1962 - SEP 1974* | 866<br>$M_C$, $M_L$<br>(347 ≥ M2.5) | 226<br>mbneic, $M_L$<br>**Variance weighting?** | 22 |
| *OCT 1974 - DEC 1980* | 5,256<br>$M_C$, $M_L$<br>(452 ≥ M2.5) | 47<br>Mostly $M_L$<br>(reliant on UUSS) | 5 |
| *JAN 1981 - DEC 2010* | 49,737<br>$M_C$, $M_L$, $M_W$<br>(3,337 ≥ M2.5) | 371 | 19 |

## Multi-Segment Ruptures on Normal Faults

David Schwartz made a presentation on three very large normal-fault earthquakes (Sanriku **M** 8.6, Kuril **M** 8.1, and Tohoku (normal) **M** 7.7; A, B, and C respectively on figure 1) associated with the Japan trench subduction zone. All three earthquakes are well located and occurred where outer-rise/outer-slope gravity anomalies are positive and large in the subducting Pacific plate (figure 1). David stated that the Tohoku (megathrust) earthquake has caused some in the seismic-hazard community at large to ask questions such as:

- How do we know that we have seen the largest possible earthquake?
- Is fault segmentation dead?
- Is the characteristic earthquake model dead?

David recognizes that these normal fault earthquakes occurred within a tectonic setting very different from the one that is operative in the WGUEP study area, but felt that it was important to discuss these events to demonstrate that we are thinking about the issue of capturing the largest possible event in our earthquake model.

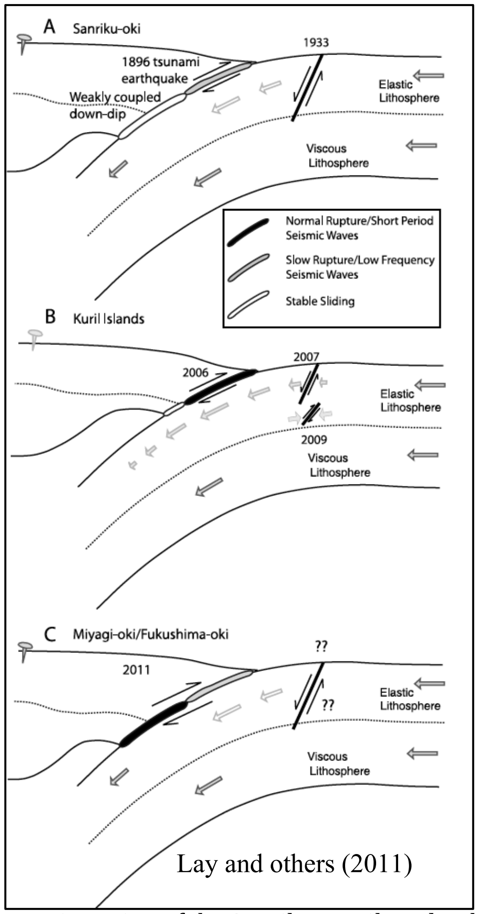


***Figure 1.*** *Tectonic setting of the Sanriku, Kuril, and Tohoku (Fukushima) normal fault interpolate earthquakes in the flexing Pacific plate as it subducts at the Japan trench.*

Tony and Ivan felt that whatever earthquake we select as the model for a possible "Black Swan" earthquake (extremely rare, almost impossible event with a very low probability) for the WGUEP study area, it should be based on an earthquake that occurred within the continental crust (e.g., the 1887, estimated **M** 7.4 Sonoran [Pitaycachi] earthquake), and not one at a convergent plate margin. Ivan recommended limiting our largest rupture to a two segment rupture on the Wasatch fault, and to be prepared to defend that decision as a realistic maximum. Dave stated that there is a movement to do away with segmented earthquake models, to which Ivan replied that our earthquake source model will include a floating M 6.5-7.5 earthquake along the Wasatch fault probably weighted at 10 percent. Walter stated that it is important in our final report to remind our readers about the difference between multisegment ruptures on strike-slip and normal faults. Dave volunteered to write up this section of the final technical report.

Following up on David's discussion regarding identifying the largest possible earthquakes in our source model, Mark revisited the question of maximum magnitude for a background earthquake in the WGUEP study area. The previously agreed upon maximum was **M** 6.75 $\pm$ 0.25; however, Mark questioned whether all **M** 6.75 earthquakes in the WGUEP study area have produced ground rupture. If not, which is Mark's opinion, then an unknown number of large earthquakes are not represented in the geologic record in the study area. After discussion, it was determined as an experiment to increase the maximum magnitude of the background earthquake to **M** 7, and to calculate the recurrence for both fault and background events to see if the increased magnitude creates an earthquake bulge for the study area.

## Paleoseismology Subgroup Update

Chris DuRoss presented a Paleoseismology Subgroup update on model parameters for the central WFZ. Chris discussed (1) final RIs per segment, (2) a composite RI for the central WFZ, (3) time-dependent and time-independent weights for the central WFZ segments, (4) revised displacement per rupture (and source) calculation methods and values, (5) vertical slip rate estimates per segment, and a strawman model for which slip rate values to include, and (6) a final strawman model for which magnitude regressions to include (with weights).

The Paleoseismology Subgroup had previously assigned strawman weights for the time-dependent (0.8) and time-independent (0.2) branches of the logic tree, which the working group revised to 0.7-time dependent, 0.3-time independent (table 2). The consensus of the group was that a time dependent model likely is more appropriate for the WFZ and there is sufficient paleoseismic data to model the central WFZ in a time-dependent manner. In contrast, weight given to the time-independent branch considers the short (~0.5 kyr) and long (~2 kyr) recurrence times between events (per segment), which indicate that earthquakes are not perfectly periodic (as also shown by a COV on recurrence of about 0.5). However, most agreed that although a Poisson (time-independent) process cannot be ruled out considering the earthquake timing data, a process of stress renewal, where the time to the next earthquake is linked to the time since the last, is likely more appropriate for the WFZ.

***Table 2.*** *Currently proposed time-independent and time-dependent behavior weights and weights for recurrence interval models for the five central segments of the Wasatch fault zone.*

| | Recurrence intervals | Weight |
|---|---|---|
| • Time independent (0.3) | | |
| | o Composite N-in-T | 0.5 |
| | o Segment-specific N-in-T | 0.5 |
| • Time dependent (0.7) | | |
| | o Brigham City segment (BCS) | |
| | ▪ Closed mean | 0.33 |
| | ▪ Composite closed mean | 0.33 |
| | ▪ N-in-T | 0.34 |
| | o Weber, Salt Lake City, and Provo segments | |
| | ▪ Closed mean (per segment) | 0.5 |
| | ▪ Composite closed mean | 0.5 |
| | o Nephi segment (NS) | |
| | ▪ Composite closed mean | 0.5 |
| | ▪ Closed mean | 0.25 |
| | ▪ N-in-T | 0.25 |

Open mean RIs for the segments are based on an N-in-T calculation (number of events N occurring in time window T). These values range from about 1.1 kyr to 1.5 kyr depending upon the segment considered. The shorter mean RI reflects the short (late Holocene to present) time window (and possibility of clustered events) on the Nephi segment. In contrast, the Brigham City segment has the longest mean recurrence because of the long elapsed time since the segment's most recent earthquake, which is included in the N-in-T calculation. Chris presented and discussed weights for the open mean recurrence estimates, which will be used in the time-independent branch.

Closed mean (inter-event) RIs for the central WFZ segments range from about 0.9 kyr to 1.3 kyr depending on the segment considered. The closed mean values per segment, plus a composite mean recurrence for the central WFZ will be used in time-dependent earthquake probabilities for the five central WFZ segments. The Brigham City and Nephi segments will also include open mean recurrence, based on an N-in-T calculation per segment. The working group discussed weights for the closed mean recurrence estimates, which will be used in the time-dependent branch.

Chris presented revised displacement per event estimates, which reflect a more reproducible calculation method. The average vertical displacement is based on a least-squares best-fit half ellipse that is fit to the trench site displacement observations. The best-fit ellipse is that which minimizes the error (sum of squared deviations from the field observations) from a range of ellipses with varying shapes and heights. The best-fit ellipse method reasonably approximates average displacements as measured in historical normal-faulting earthquakes.

Vertical slip rate estimates for the central WFZ include (1) closed slip rates based on the total (or average) displacement to occur in a specific inter-event time window (or average closed recurrence interval), (2) open slip rates, which include the open intervals from the oldest event to its maximum-limiting age constraint and from the youngest event to the present, and (3) long-term slip rates, generally based on displaced Lake Bonneville sediments and shorelines. The working group discussed the pros and cons for each of these measurement types (and values for each segment), as well as composite slip rates for the central WFZ to be consistent with the recurrence intervals used. The subgroup presented a revised strawman model for slip rates:

- Brigham City and Nephi segments — Weight
    - Composite closed (paleoseismic) slip rate — 0.3
    - Mean (~composite) long-term slip rate — 0.3
    - Closed (paleoseismic) slip rate per segment — 0.2
    - Open paleoseismic slip rate (per segment) — 0.2

- Weber, Salt Lake City, and Provo segments — Weight
    - Composite closed (paleoseismic) slip rate — 0.35
    - Closed (paleoseismic) slip rate per segment — 0.35
    - Mean (~composite) long-term slip rate — 0.3

The working group also discussed characteristic magnitude ($\mathbf{M}_{char}$) estimates for the central WFZ (category A) and other faults (category B/C). The consensus was to use the final strawman developed by Paleoseismology Subgroup:

- Category A faults (2+ paleoseismic sites) — Weight
  - Hanks and Kanamori (1979) – $M_o$ — 0.3
  - Stirling and others (2002) – SRL (censored instrumental) — 0.3
  - Wells and Coppersmith (1994) – SRL (all fault types) — 0.2
  - Wells and Coppersmith (1994) – A (all fault types) — 0.2

- Category B/C faults (all others) — Weight
  - Stirling and others (2002) – SRL (censored instrumental) — 0.4
  - Wells and Coppersmith (1994) – SRL (all fault types) — 0.2
  - Wells and Coppersmith (1994) – A (all fault types) — 0.2
  - Anderson and others (1996) – slip rate and SRL — 0.2

  ($M_0$ – seismic moment, SRL – surface rupture length, A – area)

However, for the central WFZ, the working group also discussed possible modeling issues related to using the Wells and Coppersmith (1994) regressions (for SRL and A), which predict less moment release per earthquake than the Hanks and Kanamori (1979) and Stirling and others (2002) regressions. Depending on the modeling results, additional discussion of the M regressions used or the weights assigned may be necessary.

**The Wasatch Fault Zone End Segments**
**Slip Rate and Length — Model Distributions and Weights**

Mike Hylland reviewed the available paleoseismic data (table 3) for the WFZ end segments (north = Malad City, Clarkston Mountain, Collinston; south = Levan, Fayette). He then summarized the strawman source parameters for the five segments (table 4). The principal change in this iteration of the strawman parameters from previous versions, was the inclusion of length and slip-rate (SR) distributions for the segments that reflect $5^{th}$, $50^{th}$, and $95^{th}$ percentiles.

Discussion accompanying Mike's presentation included the decision to treat the WFZ end segments as 50% unsegmented and 50% segmented. For the unsegmented model on the three northern segments, it is proposed to float a 60 km-long boxcar with a minimum magnitude of 6.75 $\pm$ 0.25, a maximum magnitude commensurate with a 60 km surface rupture length, and a magnitude distribution slope of b = 0.8. The unsegmented model for the two southern end segments will utilize a 46 km-long boxcar again with a minimum magnitude of 6.75 $\pm$ 0.25, a maximum magnitude commensurate with a 46 km surface rupture length, and a magnitude distribution slope of b = 0.8.

***Table 3.*** *Summary of earthquake parameters for the Wasatch fault zone end segments.*

| ***Segment*** | ***MRE Timing*** | ***Displacement/ Surface Offset (m)*** | ***Time Interval (kyr)*** | ***Estimated SR (mm/yr)*** | ***Recommended SR (mm/yr)*** | ***RI (kyr)*** |
|---|---|---|---|---|---|---|
| Malad City | Late Pleistocene | ≤1.5 (est.) | >18 | <0.08 | 0.01–0.1 | NA |
| Clarkston Mountain | Late Pleistocene | 2 | >18 | <0.1 | 0.01–0.1 | NA |
| Collinston | Late Pleistocene | ≤2 (est.)<br><12 | >18<br>300 | <0.1<br><0.04 | 0.01–0.1 | NA |
| Levan | ≤1000 cal yr B.P.<br>1000–1500 cal yr B.P. | 1.8<br>1.8–3.0<br><br><br>4.8 | >4.8–9.8<br>>1.3–3.3<br><br><br>100–250 | <0.2–0.4<br><0.5–2.3<br><0.3±0.1*<br>0.1–0.6**<br>0.02–0.05 | 0.1–0.6 | >3 & <12** |
| Fayette | Early(?) Holocene (SW strand)<br>Latest Pleistocene (SE strand) | 0.8–1.6<br>0.5–1.3<br>3 | <11.5<br><18<br>100–250 | >0.07–0.1<br>>0.03–0.07<br>0.01–0.03 | 0.01–0.1 | NA |

**Hylland and Machette (2008)*
*** Utah Quaternary Fault Parameters Working Group (UQFPWG; Lund, 2005).*

***Table 4.*** *Wasatch fault zone end segments strawman model parameters.*

| Segment | Length (km) | Length Uncertainty (km) | Length Range (km) | Length Distribution (5th, 50th, 95th) (0.2–0.6–0.2) | Slip Rate Consensus Range (mm/yr) | Slip Rate Distribution (5th, 50th, 95th) (0.2–0.6–0.2) |
|---|---|---|---|---|---|---|
| Malad City | 40 | +/-6 | 34 – 46 | 34 – 40 – 46 | 0.01 – 0.1 | 0.01 – 0.05 – 0.1 |
| Clarkston Mountain | 19 | +/-6 | 13 – 25 | 13 – 19 – 25 | 0.01 – 0.1 | 0.01 – 0.05 – 0.1 |
| Collinston | 30 | +/-6 | 24 – 36 | 24 – 30 – 36 | 0.01 – 0.1 | 0.01 – 0.05 – 0.1 |
| Levan | 32 | +/-6 | 26 – 38 | – | 0.1 – 0.6 | 0.1 – 0.3 – 0.6 |
| Levan (mapped Holocene rupture) | 25 | +/-6 | 19 – 31 | – | – | – |
| Levan (incl. faults in L-F step-over) | 37 | +/-6 | 31 – 43 | – | – | – |
| Levan – ***Length range to consider*** | – | – | 19 – 43 | 19 – 31 – 43 | – | – |
| Fayette | 22 | +/-6 | 16[1] – 28 | 17.5 – 22 – 28 | 0.01 – 0.1 | 0.01 – 0.05 – 0.1 |
| Levan + Fayette (multi-segment rupture)[2] | 46[3] | +/-6 | 40 – 52 | 40 – 46 – 52 | – | – |

[1] *Use default minimum length to generate M 6.5 earthquake (17.5 km).*
[2] *WGUEP recommends giving 0.5 weight to this model.*
[3] *End-to-end combined length; avoids double-counting length of overlap that would occur from simply summing individual segment lengths.*

## Oquirrh-Great Salt Lake Fault Zone Revisited

Susan Olig reviewed the current segmentation model for the Oquirrh-Great Salt Lake fault zone (O-GSLFZ) (figure 2) and the timing information available for the most recent surface-faulting earthquake on each of the proposed O-GSLFZ segments (table 5).

**O-GSLFZ SEGMENTS**

Rozelle (RZ) – 25 km
Promontory (PY) – 25 km
Fremont Is. (FI) – 25 km
Antelope Is. (AI) – 35 km
No. Oquirrh (NO) – 30 km
So. Oquirrh (SO) – 31 km
Topliff Hills (TH) – 26 km
East Tintic (ET) – 35 km

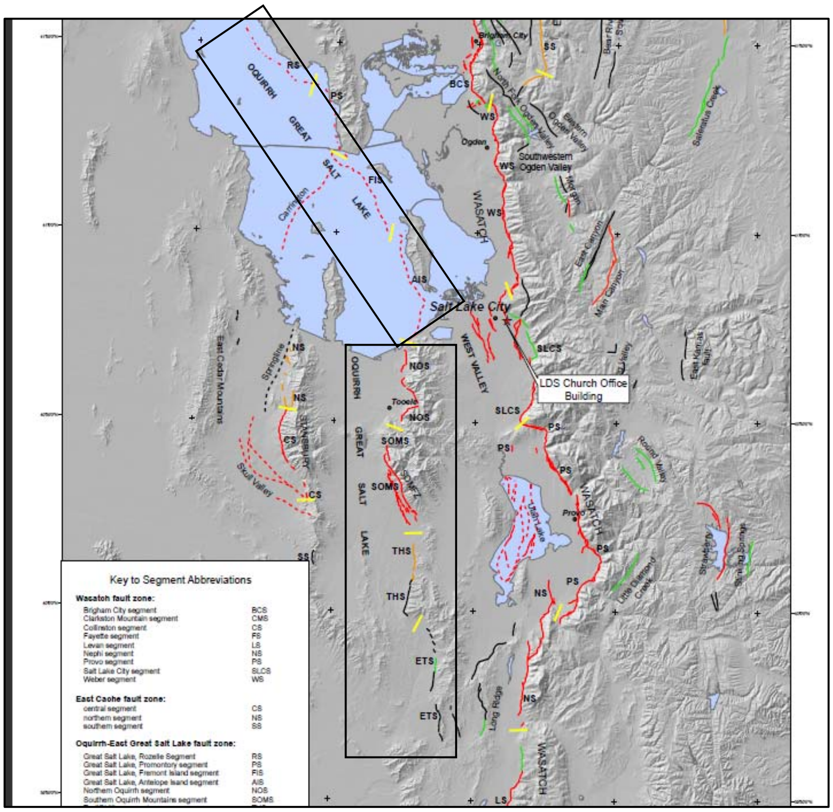


***Figure 2.*** *Boxes enclose the segments of the Oquirrh-Great Salt Lake fault zone.*

***Table 5.*** *Ages of youngest surface-faulting along segments of the Oquirrh-Great Salt Lake fault zone.*

| | Fault Segment | Youngest Event | Penultimate Event | Older Events?[3] |
|---|---|---|---|---|
| *Great Salt Lake fault*[2] | Rozelle (RZ) | Holocene? | ?[3] | ?[3] |
| | Promontory (PY) | Holocene? | ?[3] | ?[3] |
| | Fremont Island (FI) | 3,150 (+240, -210) | 6,410 (+210, -210) | < 11,430 (+610, -450) |
| | Antelope Island (AI) | 590 (+200, -240) | 6,170 (+240, -230) | 9,900 (+250, -300) |
| | Northern Oquirrh (NO)[4] | 6330 ( 4960 to 7650) | 20,300 - 26,400 | > > 33,000 |
| | Southern Oquirrh (SO)[5] | 1,300 to **4,830**[6] | 20 to 50 ka[6] | shortly after 42 ± 8; shortly after 75 ± 10 ka; ca. 92 ± 14 ka[6] |
| | Topliff Hills (TH) | > 15,000[7] or < 15,000[8] | ?[3] | ?[3] |
| | East Tintic (ET) | > > 15,000 (middle to late Pleistocene)[9] | ?[3] | ?[3] |

*Note: Footnotes for table 5 not provided in Susan's PowerPoint presentation.*

Susan then presented revised strawman rupture models for the O-GSLFZ (table 6) and supporting evidence for her segmentation model.

***Table 6.*** *Proposed rupture models and weights for the Oquirrh-Great Salt Lake fault zone.*

| Rupture Scenarios[1,2] | | Old Strawman 2 Weights (Meeting #6) | New Strawman 3 Proposed Weights |
|---|---|---|---|
| **1** | RZ, PY, *FI, AI*, NO+SO, TH, ET | 0.25 | 0.15 |
| **2** | RZ, PY, *FI, AI*, NO, SO, TH, ET | 0.4 | 0.5 (or 0.45?) |
| **3** | RZ, PY, FI+AI, NO, SO, TH, ET | 0.1 | 0.1 |
| **4** | RZ, PY, *FI, AI,* NO, SO+TH, ET | 0.1 | 0.1 |
| **5** | Unsegmented (floating) | 0.15 | 0.15 (or 0.2?) |

[1] *Rupture scenario abbreviations defined in table 5.*
[2] *Red italics indicates time-dependent model considered.*

Supporting data for each of the proposed segmentation models is as follows:

1. RZ, PY, FI, AI, NO+SO, TH, ET
   - Ages of penultimate event (PE) and antepenultimate event (APE) overlap for NO and SO (but uncertainties are large).
   - Displacements per event are very large for both NO (2.2-2.7 m) and SO (1.3-2.2 m) given their individual lengths of only 21 and 24 km, respectively.
   - Late Quaternary displacement profiles (from scarp profile data) do not taper but stay large near the NO-SO segment boundary.
   - NO and SO have similar late Quaternary slip rates of 0.1-0.2 mm/yr.

2. RZ, PY, FI, AI, NO, SO, TH, ET
   - Gaps and step-overs of late Quaternary scarps and ranges.
   - Age of most recent earthquakes (MREs) different (for those that are reasonably constrained).
   - Basin geometry (except SO & TH and FI & AI).

3. RZ, PY, FI+AI, NO, SO, TH, ET
   - Age of PEs of FI and AI overlap.

- Similar slip rates for FI and AI.
- Traces overlap and geometrical step-over is small.
- Large displacements per event for AI for length of 32 km.

4. RZ, PY, FI, AI, NO, SO+TH, ET
   - Basin geometry (continuous and deepest at SO-TH boundary).
   - Large displacements per event for SO.
   - Permissible that ages of events overlap (data poor on TH).

5. Unsegmented
   - Large uncertainties (particularly for RZ, PY, TH, ET).
   - Accounts for scenarios with weight < 0.1.

6. Why AI+NO weight is considered < 0.1.
   - Large difference between the rates of activity on the AI and NO (rates on AI are 2 to 4 times higher than NO).
   - The major right-step and change in strike between AI and NO fault traces.
   - Basin and range geometry.
   - Large uncertainty in age of MRE on NO (6330 yr, 4960 yr to 7650 yr) argues against the significance of the overlap between this age and that of the PE on AI (6170 yr, + 240, - 230); (sum of the 2-sigma uncertainty limits is (7650 yr - 4960 yr) + (240 yr + 230 yr ) = 3160 years, which is 75% (56% to 113%) of the estimated average single-segment recurrence interval for the southern Great Salt Lake fault zone of 4200 yr +/- 1400 years).

Considerable discussion ensued within the working group regarding both the rupture models and the weights assigned to them. In the end, although some would have liked to see a rupture scenario that included an AI+NO multisegment rupture, Susan's rupture model was adopted by the working group. However, based on the discussion, the rupture model weights were adjusted as shown in table 7.

Susan then presented weighted recurrence intervals for the Great Salt Lake fault zone segments and weighted vertical slip rates for the segments of the Oquirrh fault zone, a recommendation for COV, parameters for the unsegmented model, and strawman weights for the time-dependent analysis of the fault.

Rates

- Use UQFPWG (Lund, 2005) recurrence intervals for GSLFZ:
  1,800 yrs (0.2)
  4,200 yrs (0.6)
  6,600 yrs (0.2)
- Use UQFPWG (Lund, 2005) (vertical) slip rates for NO and SO:

0.05 mm/yr (0.3)
0.15 mm/yr (0.4)
0.3 mm/yr (0.3)

- Use lower rates for TH and ET (based on scarp-profile data):
  0.05 mm/yr (0.3)
  0.1 mm/yr (0.4)
  0.2 mm/yr (0.3)

Other parameters

- COV: Use WFZ COVs.
- Unsegmented model: approach generally consistent with WFZ – float **M** 6.75 to $M_{char}$ (using average segment length times 3) ruptures; b = 0.8.
- Strawman weight on time-dependent: 50/50.

***Table 7.*** *Final rupture models and weights for the Oquirrh-Great Salt Lake fault zone.*

| **Rupture Scenarios[1,2]** | | **New Strawman 4 Weights** |
|---|---|---|
| **1** | RZ, PY, *FI, AI,* NO+SO, TH, ET | 0.15 |
| **2** | RZ, PY, *FI, AI,* NO, SO, TH, ET | 0.4 |
| **3** | RZ, PY, FI+AI, NO, SO, TH, ET | 0.15 |
| **4** | RZ, PY, *FI, AI,* NO, SO+TH, ET | 0.1 |
| **5** | Unsegmented (floating)<br>(3 times average segment length) | 0.2 |

[1] *Rupture scenario abbreviations defined in table 5.*
[2] *Red italics indicates time-dependent model considered.*

## Other Fault Parameters

Bill Lund reviewed the current status of the Wasatch Front Region (WFR) "Other Fault" database. Revisions since WGUEP Meeting #6 include:

- Revised dip angles for the Hansel Valley (35-50-90 deg) and Joes Valley (50-75-85 deg) faults based on Mike Hylland's review of antithetic fault pairs in the WFR.
- A rupture length for the Joes Valley fault of 37 km, which reflects the evidence for the surface rupture length of latest Quaternary (< 15 kyr) movement on the fault.

- A revised rupture depth for the Joes Valley fault of 3 km, based on seismic-line evidence which shows that the fault does not displace the top of the Navajo Sandstone (at least within the resolution of the seismic profiles).
- A revised Probability of Activity for the Joes Valley fault of 0.5, based on the shallow rupture depth.
- A revised slip-rate distribution and weights for the Western Bear Lake fault of 0.1 (0.2), 0.5 (0.6), 0.8 (0.2).
- Removal of the Great Salt Lake, Oquirrh, and East Canyon faults from the "Other Fault" database.

**Final Recurrence Models and Weights**

Ivan presented the final recurrence models for faults in the WGUEP study area as follows:

- Wasatch and Oquirrh-Great Salt Lake Fault Zones
  0.9 Maximum Magnitude ($M_{min}$ 6.75)
  0.1 Truncated Exponential ($M_{min}$ 6.75)
- Other Faults
  0.8 Maximum Magnitude ($M_{min}$ 6.75)
  0.2 Truncated Exponential ($M_{min}$ 6.75)
- Background Seismicity (also includes earthquakes that may be on faults)
  1.0 Truncated Exponential (**M** 5.0 to $M_{max}$ 7.0)
- For faults that have $M_{max} < 6.75$, only the Maximum Magnitude model will be used.

**Antithetic Fault Parameters**

Mike Hylland addressed the question of how antithetic fault pairs should be modeled, since depending on fault dip and distance between faults, one fault of an antithetic pair will likely truncate the other within seismogenic depths. The principal question for modeling is how to determine which fault is the master fault and which is the subsidiary (truncated) fault.

The Basin and Range Province Earthquake Working Group II (BRPEWGII) (Lund, 2012) addressed the antithetic fault pair question as it relates to the National Seismic Hazard Maps, and made the following recommendations to the U.S. Geological Survey National Seismic Hazard Mapping Program.

- Explore using metrics (such as length, topographic relief, overlap) to guide selection of master and subsidiary faults.

- Evaluate dataset for overlapping relations (comparative indicator of controlling structure) to select master fault based on length (proxy for fault maturity).
- Evaluate using aspect ratio (length/width) for individual fault pairs
- Where data allow, structural throw should be used rather than topographic relief (proxy for long-term slip rate).
- Evaluate using length times throw as a parameter for selecting master fault.

- Subsurface data (e.g., seismic reflection) should be used to guide master fault selection, where available.
- Where available data do not give a clear indication of master versus subsidiary faults, model both alternatives using a logic tree approach.

Mike evaluated fault metrics for six antithetic fault pairs in the WGUEP study area, including length, percent overlap, minimum and average topographic relief, and length times relief. Results of the evaluation allowed Mike to identify three master faults based on fault metrics. Two other master faults could only be identified using available subsurface data, and one fault pair required using a logic tree approach. Results of the evaluation are summarized in table 8.

***Table 8.*** *Master/subsidiary fault classification for antithetic fault pairs in the WGUEP study area.*

| Fault | Length | Overlap | Relief | Length X Relief | Classification |
|---|---|---|---|---|---|
| West Valley fault zone | S | S | S | S | **S** |
| Salt Lake City segment | M | M | M | M | **M** |
| Utah Lake faults | S | S | S | S | **S** |
| Provo segment | M | M | M | M | **M** |
| Hansel Valley–Hansel Mtns (east side) faults | [M] | [M] | M | M | **M** (0.25) |
| North Promontory fault | [S] | [S] | S | S | **M**[1] (0.75) |
| West Cache fault | S | S | S | S | **S** |
| East Cache fault (incl. James Peak fault) | M | M | M | M | **M** |
| Western Bear Lake fault | S | [S] | M | M | **S** |
| Eastern Bear Lake fault | M | [M] | S | S | **M**[2] |
| Joes Valley faults (west side) | — | — | M | M | **S** |
| Joes Valley faults (east side) | — | — | S | S | **M**[3] |

*M, master fault; S, subsidiary fault.*
*Brackets indicate <10% difference in parameter values.*
*[1] Likelihood for master fault based on regional pattern of half-graben structure.*
*[2] Master fault based on interpreted seismic reflection data (Evans, 1991).*
*[3] Master fault based on interpreted seismic reflection data (Anderson, 2008); neither fault penetrates deeper than about 3.4 km.*

Based on his evaluation, Mike assigned preliminary 5$^{th}$ and 95$^{th}$ percentile dip distributions with weights for each fault pair, and assigned preliminary weights for coseismic versus independent behavior for the faults (table 9).

***Table 9.*** *Strawman parameters for antithetic fault pairs in the WGUEP study region.*

| Fault | Classification[1] | Dip[2] (degrees) (5th, 50th, 95th) (0.3–0.4–0.3) | Independent vs. Coseismic (vs. non-seismogenic)[3] |
|---|---|---|---|
| West Valley fault zone | S | 35–50–65 | 0.55, 0.45 |
| Salt Lake City segment | M | 35–50–65 | 0.55, 0.45 |
| Utah Lake faults | S | 35–50–65 | 0.4, 0.3 (0.3)[4] |
| Provo segment | M | 35–50–65 | 0.55, 0.45 |
| Hansel Valley + Hansel Mtns (east side) faults | M (0.25) | 35–50–90[5] | 0.55, 0.45 |
| North Promontory fault | M (0.75) | 35–50–65 | 0.55, 0.45 |
| West Cache fault | S | 35–50–65 | 0.7, 0.3[6] |
| East Cache fault + James Peak fault | M | 35–50–65 | 0.8, 0.2[6] |
| Western Bear Lake fault | S | 35–50–65 | 0.55, 0.45 |
| Eastern Bear Lake fault | M | 35–50–65 | 0.55, 0.45 |
| Joes Valley faults (west side) | S | 55–70–85[7] | 0.3, 0.4 (0.3)[8] |
| Joes Valley faults (east side) | M | 55–70–85[7] | 0.4, 0.3 (0.3)[8] |

[1] *M, master fault; S, subsidiary fault (truncated at depth by master fault) with weights as appropriate.*
[2] *Default WGUEP dip distribution (50° ± 15°) except where noted.*
[3] *Preliminary WGUEP recommended range except where noted.*
[4] *Potential non-seismogenic character of the fault weighted 0.3 after S. Olig (p[a] = 0.7; written communication).*
[5] *Preliminary WGUEP recommended range.*
[6] *Higher weights for independent behavior relative to other fault pairs based on greater average separation distance between the West and East Cache fault; higher weight for East Cache fault being independent relative to West Cache fault based on higher likelihood of East Cache fault being the master fault.*
[7] *Range based on interpreted seismic reflection data (Anderson, 2008).*
[8] *Potential non-seismogenic character of the faults weighted 0.3 after S. Olig (p[a] = 0.7; written communication); higher weight for east side fault being independent relative to west side fault based on higher likelihood of east side fault being the master fault.*

In the discussion following Mike's presentation, Walter noted that in our region, master faults are always on the east side (west dipping) of Basin and Range valleys. For that reason, he favors the North Promontory fault as the master fault in the North Promontory/Hansel Valley fault pair. Jim Pechmann pointed out that the focal mechanism for the 1934 Hansel Valley earthquake was strike slip, and may not represent a characteristic earthquake on the Hansel Valley fault – the northern part of which showed no surface rupture in the 1934 event. Discussion then turned to weighting of independent versus coseismic behavior of the faults. The following values seemed to gain general approval from the working group.

| | |
|---|---|
| West Valley fault Zone | 50/50 |
| Utah Lake faults | 50/50 |
| Hansel Valley fault | 60/40 |
| West Cache fault zone | Independent (100) |
| East Cache fault zone | Independent (100) |
| West Bear Lake fault | 50/50 |

Discussion continued regarding the Joes Valley fault zone. The working group agreed that because of the very small separation distance between the graben-bounding faults (~2-3 km), the Joes Valley fault zone should be treated as a single system rather than individual faults. Discussion then turned to the seismogenic nature of the fault zone and, given the apparent shallow rupture depth (~3 km), whether the faults are seismogenic at all. Available U.S. Bureau of Reclamation seismic-reflection lines show that the Joes Valley faults become listric and sole into the Carmel Formation, which contains gypsum/anhydrite and likely forms a regional detachment surface. The seismic lines do not show the faults penetrating the upper contact of the underlying Navajo Sandstone, which appears as a very strong reflector on the seismic profiles. Concern was expressed that the resolution of the seismic lines may be insufficient to resolve displacements of only a few tens of meters, so it cannot be conclusively stated that the faults do not penetrate the Navajo and continue to seismogenic depth. However, if the bedrock units below the Carmel are displaced, the amount of displacement is small and significantly less than the displacements observed within the Joes Valley graben at the surface (~ 300 m). The working group recommended assigning the Joes Valley fault zone a probability of activity of 0.4 (40% seismogenic, 60% non-seismogenic), and including a branch on the earthquake source logic tree for a fault plane that penetrates to full seismogenic depth ($15 \pm 3$ km), but assigning that branch a low weight.

## Maximum Earthquake Focal Depths in the WGUEP Wasatch Front Region

Jim Pechmann reported on his investigation of WGUEP earthquake focal depths and whether the WGUEP seismic source model should incorporate different seismogenic depths for faults in different parts (physiographic provinces) of the WGUEP study region. Jim limited his investigation to earthquakes that met both of the following criteria:

- Epicentral distance to the nearest station less than or equal to the focal depth or 5 km, whichever was larger.
- Standard vertical hypocentral error of 2 km or less, as calculated by the location program.

Jim identified 2523 earthquakes in the WGUEP study area that met the two quality criteria. The events are poorly distributed across the study area, with the majority in a comparatively narrow, north-south-trending band along either side of the WFZ. There were few good quality events in the western (Basin and Range) portion of the study area. Jim's analysis showed that the focal depths systematically increased east of about $111^{o}$ 50' west longitude (table 10). Jim noted that $111^{o}$ 50' west longitude is about the location of the WFZ in the WGUEP study area.

| | West of $-111^{o}$ 50' | East of $-111^{o}$ 50' | Entire Region |
|---|---|---|---|
| Number of events | 1505 | 1018 | 2523 |
| $90^{th}$ percentile depth | 11.1 km | 16.2 km | 14.1 km |
| $95^{th}$ percentile depth | 12.4 km | 18.0 km | 16.0 km |

***Table 10.*** *Focal depth percentiles for the WGUEP study region.*

Jim went on to note and Walter concurred that although there is a systematic 5 to 6 km increase in the depth of earthquake hypocenters east of the WFZ, for the largest historic earthquakes in the Intermountain West, the hypocentral depths have consistently been about 15 km (figure 3), and those are the data we should use for this study.

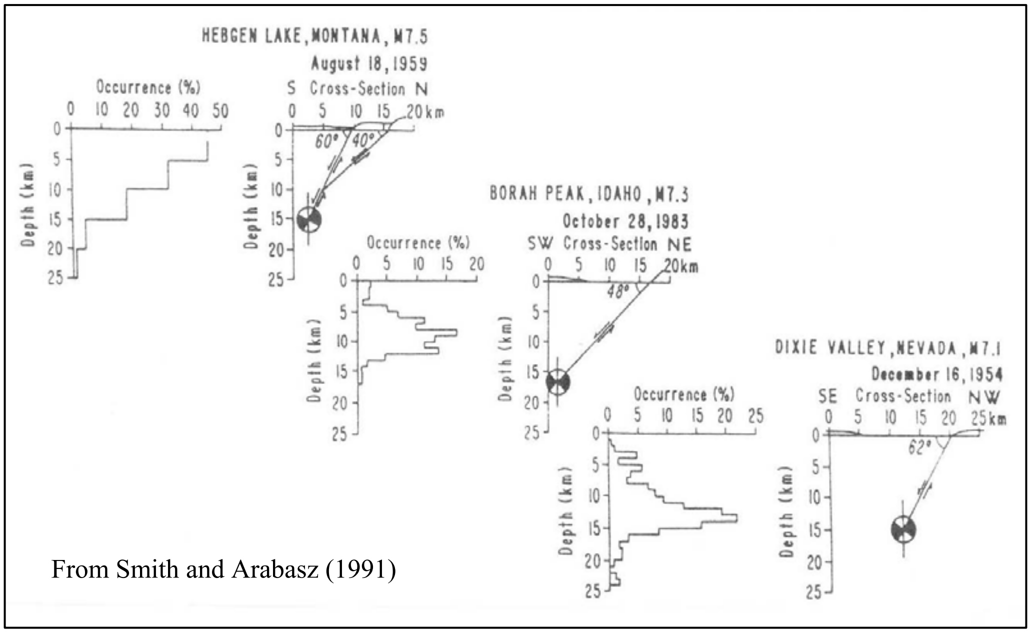


***Figure 3.*** *Hypocentral depths of large Intermountain West normal fault earthquakes.*

Based on Jim's analysis, the working group determined to adjust the seismogenic depth for the WGUEP earthquake model from 15 $\pm$ 2 km to 15 $\pm$ 3 km, and to apply different weights east and west of the WFZ as follows:

East of the WFZ: 12 (0.1), 15 (0.7), 18 (0.2)
West of the WFZ: 12 (0.2), 15 (0.7), 18 (0.1)

## Smoothing of Background Seismicity

Following the discussion on spatial smoothing at WGUEP Meeting #6, Ivan stated that he would discuss that issue and also the appropriate smoothing kernel to use with Bob Youngs (AMEC Geomatrix Consultants, Inc.). Ivan reported at this meeting that the WGUEP would use some form of Gaussian smoothing, starting with a 10 km kernel (50 km is too coarse for a regional study), and would go to adaptive smoothing as necessary. Mark Petersen states that the USGS was looking into adaptive smoothing as was done for the Central and Eastern United States Seismic Source Characterization for Nuclear Facilities project. Ivan and Mark agreed that the USGS would take responsibility for handling the background earthquake forecast.

## Evaluation of Geodetic Models in Northern California

Mark Petersen showed a series of five slides. The first two compared California geologic slip-rate data for various faults with four geodetic slip models (Zeng, G1, NeoKinema, and bounded). There was reasonable correlation between the geologic slip data and the bounded geodetic model. The other models systematically under predicted the geologic slip for the San Andreas from the central California creeping section to the San Bernardino Mountain segment.

Mark next showed a figure depicting the largest Quaternary faults in the Wasatch Front region. Six boxes, each representing one of the six Holocene-active segments of the WFZ, extending 50 km east and 100 km west of the WFZ were plotted on the figure. Each box was assigned an average geodetic slip rate that corresponded to the total GPS vector differences east and west of the WFZ projected to a 50 degree fault plane. With the exception of the Weber segment, the slip rates become progressively larger from north to south, with values for the Nephi and Levan segments a factor of two or greater than those for the other four segments. Mark's fourth slide showed GPS velocity profiles for each of the 150-km-wide segment boxes, and the average GPS velocities east and west of the WFZ for each segment. Velocities west of the WFZ were all larger (in some cases by more than a factor of 2) than velocities east of the WFZ. The fifth slide showed three east-west GPS velocity profiles that correspond to (1) the entire north-south length of the six central WFZ segments, (2) the Brigham City, Weber, and Salt Lake City segments, and (3) the Provo, Nephi, and Levan segments. The profiles again showed that geodetic extension is systematically higher west of the WFZ than to the east, in all cases by greater than a factor of two.

## Uniform California Earthquake Rupture Forecast, Version 3
## Evaluation of Geodetic Models in California

Ivan and Dave recently attended the 2012 Northern California Earthquake Hazards Workshop. Kaj Johnson, University of Michigan, made a presentation on the Uniform California Earthquake Rupture Forecast, version 3 (UCERF3) geodetic model. The UCERF3 model is based on a single block model by Dawson and Weldon that was not reviewed. Ivan's observations/notes on the workshop were as follows:

- Systematic misfits: geodetic rates were too high along northern San Andreas and too low along southern San Andreas. Match was good along central San Andreas (San Francisco Bay area).
- High bias to predicted geodetic slip rates for faults with low geologic slip rates – Tim Dawson
- Expect bias to be opposite – Ray Weldon
- Possible explanations
    - Geologic rates overestimated?
    - Deformation models inadequate?
    - Missing postseismic deformation?
    - Temporal variation in velocity field?
    - Experiencing some time-dependent mantle flow?
    - Internal block deformation?
- Reduce block size to improve match?
- Effect of locking depth is small.

- How to evaluate block model assumption?
- None of the models fit the data – Kaj Johnson
- Pushing rigid block models too far? – Paul Segall
- Choice of block geometry subjective – Wayne Thatcher
- Don't rely on a single model – Kaj Johnson
- Careful model validations are needed – Kaj Johnson

It is Ivan and Dave's impression from the workshop that the California geodetic model is not ready to be applied to individual faults, and since the geodetic model for the Wasatch Front Region is similarly limited, they see no reason to attempt to apply the Wasatch Front data to individual faults in the WGUEP study area. Dave stated that at best, the Wasatch Front geodetic data should be used as a regional constraint on slip.

## Probability Calculations and Input Sensitivities

Patricia Thomas reported on her preliminary probability calculations and input sensitivities for the five central segments of the WFZ (Brigham City, Weber, Salt Lake City, Provo, and Nephi). Because the results are preliminary and subject to change, neither the probabilities nor the input values used to calculate them are reported here. Patricia's presentation addressed the following four elements for the WFZ central segments:

- $M_{char}$ distributions
- Moment balanced RIs
- Poisson probabilities
- Brownian Passage Time (BPT) probabilities

### $M_{char}$ Distributions

Patricia presented Weighted Mean $M_{char}$, 5th Percentile $M_{char}$, and 95th Percentile $M_{char}$ magnitudes for a single segment model of the five central WFZ segments. Four $M_{char}$ relations (SRL, A, SRL-c, and $M_o$) were used to calculate the mean values; inputs for the relations (length, dip, seismogenic thickness, and average displacement) were as specified by the Paleoseismology Subgroup (see previous WGUEP meeting summaries at http://geology.utah.gov/ghp/workgroups/wguep.htm). Patricia showed plots of the weighted mean $M_{char}$ distribution and of the contribution each of the four $M_{char}$ relations made to the weighted mean $M_{char}$ for each of the five central WFZ segments.

### Moment Balanced RIs

Patricia reviewed the WGUEP recurrence models (Truncated Exponential and Maximum Magnitude) and the two rupture source rates (A-priori [data driven] and moment balanced [calculated from modeled slip rates]) used with the models to determine RIs. Using the Brigham City segment as an example, Patricia showed a graph of moment balanced rates versus A-priori rates, and follow up graphs showing the range of moment balanced RIs calculated for the segment using each of the four $M_{char}$ relations. Depending on the relation used the range in RIs varied by more than a factor of three. Patricia then presented a table of moment balanced Weighted Mean RIs, 5th Percentile RIs, and 95th Percentile RIs for a WFZ single segment model for the five central WFZ segments. The values were generally lower than A-priori RIs determined from paleoseismic trenching investigations on those segments. Two follow up tables demonstrated the sensitivity of the moment-balanced RIs to $M_{char}$ and slip-rate relations. Graphs of the results showed that RIs calculated using the $M_{char}$ relations for SRL and A were consistently lower than A-priori rates. Conversely, graphs showing RIs calculated using the $M_0$ and SRL-c $M_{char}$ relations compared well with A-priori rates, raising the question—*Should we continue to use the SRL and A $M_{char}$ relations in the WGUEP forecast model if they consistently underestimate both $M_{max}$ and RI?* A final table compared weighted mean slip rates determined from A-priori rupture rates with weighted mean slip rates determined from moment-balanced rupture rates for the five central WFZ segments. The values compared well for the Brigham City and Weber segments, but varied by as much as 0.4 for the other three segments.

**Probability Calculations**

Patricia reviewed the probability inputs for the WFZ model:

- 10% Poisson (rupture rates, $M_{char}$ distribution)
- 90% Time Dependent (rupture rates, $M_{char}$ distribution, MRE, COV)
  - Rupture rates: moment-balanced versus A-Priori
    (A-priori: weighting for Closed Mean, N Event in T Time; Composite Mean RIs based on segment and Poisson / Time Dependent)
  - COVs: 0.3 (0.2), 0.5 (0.6), 0.7 (0.2)

Patricia then presented a table showing the probability of an M > 6.7 earthquake in 50 years for a Wasatch fault single segment model using A-priori rates (1/RIs). The table included both Poisson and BPT (COVs of 0.3, 0.5, and 0.7) probabilities for each of the five central WFZ segments and for the five segments combined. The table was followed by a series of Tornado plots showing the sensitivity of the Poisson probabilities for each of the five WFZ segments to the model input parameters. Patricia summarized the sensitivity of Poisson probabilities using A-priori rates as follows:

- Poisson probabilities = f (Rupture rates, $P[\mathbf{M} > \mathbf{M}_T]$).
- $M_{char}$ relation has greatest impact on $P(\mathbf{M} > \mathbf{M}_T)$.
- Rupture length, dip, seismogenic thickness and average displacement have lesser impact on $P(\mathbf{M} > \mathbf{M}_T)$.
- Distribution of A-priori rupture rates has smaller impact on Poisson probabilities than $M_{char}$ relations.

Patricia then presented a table showing the probability of an M > 6.7 earthquake in 50 years for a Wasatch single segment model using moment-balanced rates. The table included both Poisson and BPT (COVs of 0.3, 0.5, and 0.7) probabilities for each of the five central WFZ segments and for the five segments combined. The table was followed by a series of Tornado plots showing the sensitivity of the Poisson probabilities using moment-balanced rates for each of the five WFZ segments to the model input parameters. Patricia summarized the sensitivity of Poisson probabilities using moment-balanced rates as follows:

- Poisson probabilities = f (Rupture rates, $P[\mathbf{M} > \mathbf{M}_T]$).
- Rupture rates balance long-term segment moment rate with mean moment of $M_{char}$.
- Slip rate, length, dip, and seismogenic thickness impact long-term segment moment rate.
- $M_{char}$ relation impacts both rupture rate and $P(\mathbf{M} > \mathbf{M}_T)$.
    - Increased $M_{char}$ increases $P(\mathbf{M} > \mathbf{M}_T)$, but reduces rupture rate.
- Rupture length, dip, seismogenic thickness and average displacement have lesser impact on $P(\mathbf{M} > \mathbf{M}_T)$.

Finally, Patricia presented a WFZ single segment model for the probability of a M > 6.7 earthquake in 50 years based on 80% time dependent and 20% Poisson models for both A-priori and moment-balanced rates. Her first table showed the combined A-priori and moment-balanced probabilities for each of the five central WFZ segments and the five segments as a whole, the second table showed the contribution to the combined probabilities from the Poisson and time dependent models for each segment and the segments as a whole.

Patricia finished her presentation by summarizing the remaining inputs required to complete the WGUEP earthquake forecast:

- Multisegment rupture rates
- WFZ unsegmented model slip rates
- Background seismicity
- O-GSLFZ input parameters
- Antithetic fault inputs
- Weighting on moment balanced versus A-priori rates
- Weighting on time-dependent and Poisson

## REFERENCES

Presenters did not provide complete citations for the references given in their presentations and reported in these minutes.

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., available at http://ugspub.nr.utah.gov/publications/bulletins/B-134.pdf.

Lund, W.R., editor, 2012, Basin and Range Province Earthquake Working Group II - Recommendations to the U.S. Geological Survey National Seismic Hazard Mapping Program for the 2014 update of the National Seismic Hazard Maps: Utah Geological Survey Open-File Report 591, 17 p, available at http://geology.utah.gov/online/ofr/ofr-591.pdf.

## NEXT MEETING

The next WGUEP meeting is scheduled for August 8-9, 2012, at the Utah Department of Natural Resources Building (1594 West North Temple, Salt Lake City, Utah).

## ATTACHMENT 1

**Attendance**
**Working Group on Utah Earthquake Probabilities**
**Meeting #7**

Walter Arabasz, UUSS
Tony Crone, USGS
Chris DuRoss, UGS
Mike Hylland, UGS
Nico Luco, USGS
Bill Lund, UGS, Coordinator
Susan Olig, URS Corporation
James Pechmann, UUSS
Steve Personius, USGS
Mark Petersen, USGS
Dave Schwartz, USGS
Bob Smith, UUGG
Patricia Thomas, URS Corporation
Ivan Wong, URS Corporation, Chair

Others presenting or assisting the Working Group
Steve Bowman, UGS Liaison to WGUEP

# ATTACHMENT 2
# AGENDA
# WORKING GROUP ON UTAH EARTHQUAKE PROBABILITIES
# MEETING #7
## Thursday/Friday, 16 & 17 February 2012
## Utah Department of Natural Resources Building, Room 1040-1050 (1st floor)
## 1594 West North Temple, Salt Lake City

**Thursday, 16 February**

| | | |
|---|---|---|
| 8:00 – 8:30 | Continental Breakfast | |
| 8:30 – 8:45 | Overview of Agenda and Review of Last Meeting's To Do List | Ivan |
| 8:45 – 9:30 | Update on Consensus Wasatch Front Earthquake Catalog | Walter/Jim |
| 9:30 – 10:00 | Multi-Segment Ruptures on Normal Faults | David |
| 10:00 – 10:15 | Break | |
| 10:15 – 11:15 | Wasatch Central Segment Final RIs, Time-Dependent/Time Independent Weights, $M_{max}$ | Chris/Nico |
| 11:15 – 11:45 | Wasatch End Segments Final Slip Rates and $M_{max}$ | Mike/Chris |
| 11:45 – 12:30 | Lunch | |
| 12:30 – 1:30 | O-GSL Parameters | Susan/Jim |
| 1:30 – 2:15 | Other Faults Final Parameters | Bill/Susan |
| 2:15 – 2:45 | Final Recurrence Models and Weights | Ivan |
| 2:45 – 3:15 | Final Seismogenic Thicknesses | Jim |
| 3:15 – 3:30 | Break | |
| 3:30 – 4:15 | Update on Geodetic Analysis | Jim/Mark/ David |
| 4:15 – 5:00 | Evaluation of Geodetic Models in Northern California | Ivan |

**Friday, 17 February**

| | | |
|---|---|---|
| 8:00 – 8:30 | Continental Breakfast | |
| 8:30 – 9:15 | Background Seismicity Parameters | Mark/Ivan |
| 9:15 – 10:00 | Antithetic Fault Parameters | Mike |
| 10:00 – 10:15 | Break | |
| 10:15 – 12:00 | Preliminary Forecast | Patricia |
| 12:00 – 1:00 | Lunch | |
| 1:00 – 2:00 | Path Forward | All |
| 2:00 | Adjourn | |

WGUEP Members

Ivan Wong, URS (Chair)
Bill Lund, UGS (Coordinator)
Walter Arabasz, UUSS
Jim Pechmann, UUSS
Tony Crone, USGS
Mark Petersen, USGS
Steve Personius, USGS
David Schwartz, USGS
Nico Luco, USGS
Bob Smith, UUGG
Chris DuRoss, UGS
Mike Hylland, UGS
Susan Olig, URS
Patricia Thomas, URS

Other Participants

Steve Bowman, UGS