

**SUMMARY
EIGHTH MEETING
WORKING GROUP ON UTAH EARTHQUAKE PROBABILITIES
Wednesday & Thursday, August 8 & 9, 2012
Utah Department of Natural Resources Building
1594 West North Temple, Salt Lake City, Utah**

WELCOME AND INTRODUCTION

Working Group on Utah Earthquake Probabilities (WGUEP) Chair Ivan Wong called Meeting Eight of the WGUEP to order at 10:30 a.m. After welcoming the Working Group members and UGS staff (attachment 1), Ivan reviewed the meeting agenda (attachment 2), recapped WGUEP progress to date, and reviewed the current WGUEP task list. Ivan stated that the principal goals of this meeting were to (1) decide on the final central Wasatch fault zone (WFZ) paleoseismic parameters, (2) decide on the appropriate paleoearthquake magnitude regressions and their respective weights for calculating M_{\max} for WGUEP category A, B, and C faults, (3) review the WFZ and Great Salt Lake-Oquirrh fault zone (GSL-OFZ) logic trees, and (4) review preliminary results of the WGUEP earthquake probability calculations.

TECHNICAL PRESENTATIONS

The meeting then moved to a series of technical presentations and issue updates. Available PowerPoint presentations for the technical presentations are at http://geology.utah.gov/ghp/workgroups/pdf/wguep/WGUEP-2012B_Presentations.pdf. Note that not all technical presentation PowerPoints are included, the WGUEP considers the final central WFZ paleoseismic parameters, details of the WFZ and GSL-OFZ logic tree, and the results of the earthquake probability calculations proprietary to this process and are not part of public records under the Utah Government Records Access and Management Act until released in the final WGUEP report. Additionally, some technical presentations did not include a PowerPoint presentation.

Wednesday, August 8

- Final Data for Central WFZ – Chris DuRoss
- Poisson & BPT Parameter Estimates – Nico Luco
- Geodetic Modeling – Mark Petersen and Jim Pechmann (no PowerPoint)
- Update on Consensus Wasatch Front Earthquake Catalog – Walter Arabasz and Jim Pechmann
- Logic Trees for Wasatch and Great Salt Lake-Oquirrh Fault Zones – Patricia Thomas

Thursday, August 9

- Preliminary Results (Earthquake Probability Calculations) – Patricia Thomas

ISSUE DISCUSSIONS

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

Final Data for Central Wasatch Fault Zone

Chris DuRoss presented a Paleoseismology Subgroup update on the final paleoseismic data for the central segments of the WFZ. These data are not presented here because the WGUEP considers them proprietary to this process until released in the final WGUEP report. In the final report, details of the paleoseismic parameters will be presented in 11 appendices:

- Appendix A - Central WFZ OxCal summary
- Appendix B2 - OxCal output data
- Appendix C - Earthquake timing – central WFZ rupture models
- Appendix D - Single segment earthquake recurrence
- Appendix E1 - Displacement per site
- Appendix E2 - Displacement per rupture
- Appendix E3 - Displacement per source
- Appendix E4 - Displacement per source summary
- Appendix E5 - Displacement along strike
- Appendix F1 - Slip rates for central WFZ
- Appendix F2 - Summary of slip rates and weighted mean rate

Chris noted that since the WGUEP meeting in February 2012, (http://geology.utah.gov/ghp/workgroups/pdf/wguep/WGUEP-2012A_Summary.pdf and http://geology.utah.gov/ghp/workgroups/pdf/wguep/WGUEP-2012A_Presentations.pdf) only minor changes have been made by the Paleoseismology Subgroup to the consensus WFZ paleoseismic parameters. The changes were chiefly to minimum and mean displacement values for the Provo segment. A draft of the fault parameters report is complete and has been distributed within the WGUEP for review. In his PowerPoint, Chris showed tables and figures from the draft report that summarize: (1) earthquake timing for the central WFZ, (2) correlation of surface-faulting earthquakes for the Salt Lake City segment, (3) mean recurrence intervals for the central WFZ, (4) displacement per source on the central WFZ, (5) vertical slip rates for the central WFZ, (6) possible multisegment ruptures for the central WFZ, and (6) rupture models and weights for the central WFZ.

Poisson and Brownian Passage Time Parameter Estimates

Nico Luco discussed the Poisson “rate” parameter λ (lambda), and the Brownian Passage Time (BPT) “repeat time” parameter μ (mu). For each parameter, he discussed the approach used for determining those parameters in the Central and Eastern United States Seismic Source Characterization report (<http://www.ceus-ssc.com/PDF/012712EPRI1021097.zip>), provided examples using WFZ data, and summarized his WFZ results. Those data are summarized in Nico’s PowerPoint presentation at http://geology.utah.gov/ghp/workgroups/pdf/wguep/WGUEP-2012B_Presentations.pdf.

Nico noted that λ is an uncertainty function into which he will eventually also incorporate uncertainty in T (time), but that for the WFZ, the uncertainty due to T is swamped by the uncertainty introduced by the small earthquake dataset (x events in y years). Nico noted that with fewer events, the earthquake distribution gets wider (less specific). As an example, he presented a multisegment example with return period ends of 23,733 and 1198 years. Mark Petersen asked if these kinds of numbers are reasonable, since we are essentially talking about an event that we aren’t sure has happened even once in 6000 years.

A discussion ensued regarding the weighting assigned to the various rupture scenarios for the WFZ—is 0.5 for single segment ruptures too low? Mark indicated that he thought 0.5 is too high for the single segment rupture model. However, it was the general consensus of the working group that the most probable rupture scenario for the WFZ is one consisting of all single segment ruptures and that a weight of 0.5 is about right or even a low value.

With regard to the BPT model, μ = arrival times and α = aperiodicity, which are used to inform a time dependent likelihood function. The current WFZ logic tree only incorporates time dependence for the single segment rupture scenario model. Ivan recommended incorporating time dependence for segments with only single segment ruptures in the rupture scenario models that include some multisegment ruptures (i.e., a mix of time dependent single segment ruptures and time independent multisegment ruptures). In this approach, the current minimum rupture scenario model would be entirely time independent because in that model all of the central WFZ segments are involved in at least one multisegment rupture.

Ivan recommended a weighting for the single segment rupture scenario model of 0.7 for time dependent and 0.3 for time independent. Mark asked how we would moment balance such a model—stating that the process would likely be complicated and time consuming. The path forward for performing such a task is also unclear.

Geodetic Modeling

Jim Pechmann noted that he had agreed to apply Kostrov’s equation to compare moment rate from the WGUEP probability model to the geodetic moment rate. Mark was to provide geodetic strain rates and Patricia was to provide moment rates from the probability model. Jim stated that he had only recently received this information and has not had time to make the necessary calculations for his comparison. Mark stated that he is computing maximum shear and dilatation rates. So far, the geodetic rate without a background factor is about two times greater than the fault rate, which is about what was seen in earlier studies. A question was raised about

what to do with the shear moment? Are there strike-slip faults in the WGUEP study area to which the shear can be assigned? Bob Smith stated that the shear likely comes from the big bend on the southern WFZ.

Jim stated that it is his intention to make his comparison and to discuss the results/difference between geodetic and geologic slip in the final WGUEP report. At present, it appears that the difference amounts to roughly one M 5.8 earthquake per year.

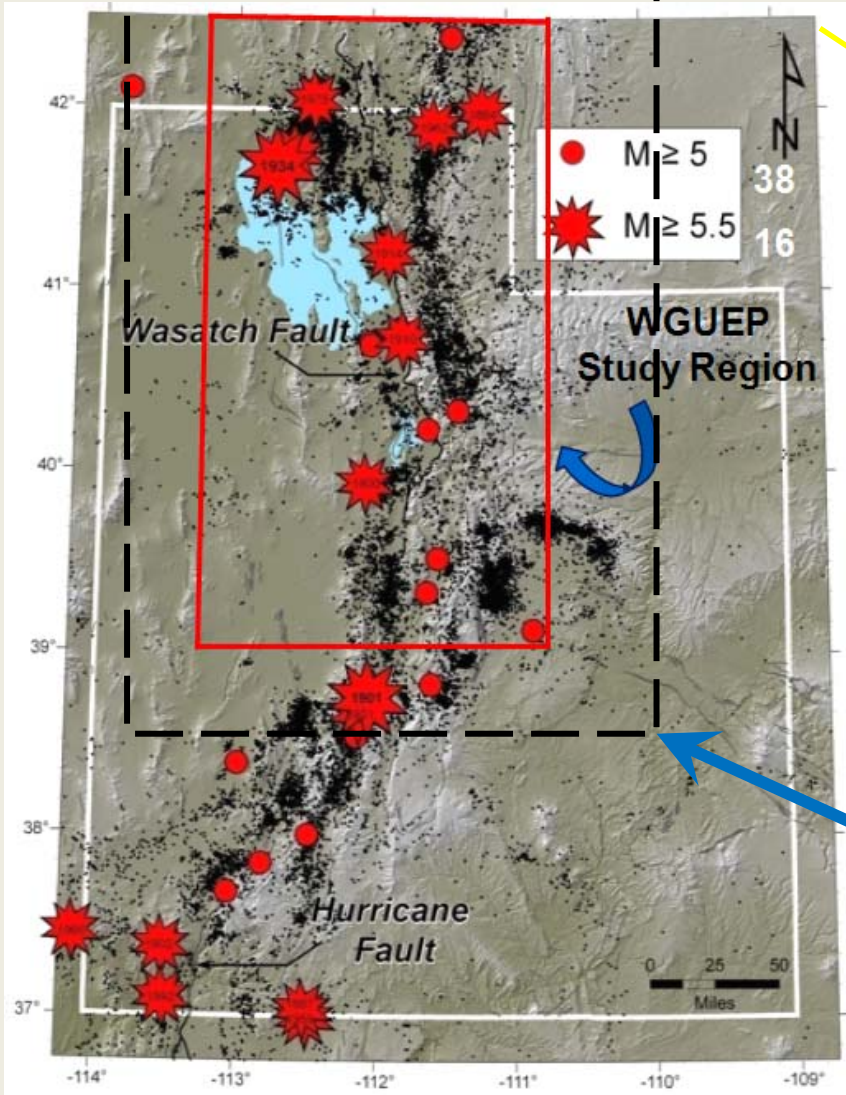
Update on Consensus Wasatch Front Earthquake Catalog

Walter Arabasz summarized the tasks required to create a consensus Wasatch Front earthquake catalog, with the ultimate goal of unifying the University of Utah Seismograph Stations (UUSS) catalog with the U.S. Geological Survey (USGS) National Seismic Hazard Maps catalog for the entire Utah region.

Summary of Tasks

- Compile and evaluate available info on earthquake size in the WGUEP/Utah region, both for pre-instrumental and instrumental data.
- Assess magnitude uncertainties and rounding errors.
- Derive relationships between M_w and other size measures, carefully using orthogonal regression, when appropriate, to avoid propagation of systematic errors into frequency-magnitude relations.
- Calculate uniform magnitudes and tabulate uncertainties needed for rate corrections.
- Compile catalog for the WGUEP study region (and surrounding buffer region for declustering), including merging of UUSS and key USGS catalogs.
- Remove duplicates and non-tectonic events.
- Substitute hypocenters from special studies.
- Assess catalog completeness.
- Pass catalog to URS and USGS analysts for declustering and processing.

See Walter's PowerPoint presentation at http://geology.utah.gov/ghp/workgroups/pdf/wguep/WGUEP-2012B_Presentations.pdf for details pertaining to each task and current project status. The figure below shows the region of interest for which the catalog is being compiled.



Area for which a WGUEP consensus earthquake catalog is being generated.

“Utah Region”

**Desired goal:
Unify UUSS and
NSHM catalogs
for the entire
Utah region**

**Immediate goal:
WGUEP + 0.5°
buffer zone for
declustering**

Walter's conclusions regarding the consensus catalog to date include:

- Complexity of project far greater than bargained for
- Methodology well in hand
- Important part of the end game is a unified UUSS/NSHM catalog for the Utah region
- Working on expedited processing for WGUEP purposes

Logic Trees for Wasatch and Great Salt Lake-Oquirrh Fault Zones

Patricia Thomas gave a PowerPoint presentation showing the current status of the logic trees for the WFZ and GSL-OFZ. These data are proprietary to the WGUEP process, and therefore the PowerPoint is not available on the UGS website. The Working Group reviewed the details of the logic trees, paying particular attention to the weights assigned to the various logic tree branches. Many of these values remain under active discussion, as do other logic tree details (e.g., the appropriate M_{char} relations to use for calculating M_{max} for category A, B, and C faults), and may change in the future.

Preliminary Results Earthquake Probability Calculations

Patricia gave a PowerPoint presentation showing the preliminary results of the WGUEP earthquake probability calculations to date. These data are proprietary to the WGUEP process, and therefore the PowerPoint is not available on the UGS website. Topics covered in Patricia's presentation included:

- Wasatch Fault Zone Central Segments
 - M_{char} Distributions (including multisegment ruptures)
 - Rupture Rates: Recurrence Intervals (RI) vs. Slip Rates
 - Segment Moment Rates
 - Poisson Probabilities
 - BPT Probabilities
- Wasatch Fault Zone End Segments
- Wasatch Fault Zone Unsegmented
- Great Salt Lake Fault-Oquirrh Fault Zone
- Other Faults
- Remaining Inputs
 - Final RI distributions for all rupture sources and models
 - Multisegment rupture rates based on segment slip rates (moment balanced rates)

- Weighting on slip rate versus recurrence interval-based rates for all five segmented models of central Wasatch fault zone
- Background seismicity
- Antithetic fault inputs
- Latitude and longitude of fault endpoints and segment boundaries

Discussion ensued regarding the correct b value to use for faults in the Wasatch Front Region—currently using $b = 0$, but not sure if that is an appropriate value. It was also suggested that the name of the “truncated exponential model” be changed to something less confusing; however, a satisfactory replacement name was not agreed upon.

Mark Petersen called the WGUEP’s attention to a recent report on magnitude scaling relations prepared by GNS Science for the Faulted Earth and Regionalisation Global Component of the Global Earthquake Model (Stirling and Goded, 2012). The report evaluated 72 magnitude-area and magnitude-length scaling relations, and recommended which of the 72 (18 total) are suitable for application to the Global Earthquake Model. The Stirling and others (2002) relation was one of the scaling relations evaluated, and the report states that “The authors [of the relation] did not intend this regression to be used in seismic hazard studies, so it should only be used if a large number of regressions are required for a logic tree framework.” This information resulted in considerable discussion within the WGUEP, because the Stirling and others (2002) relation is one of the magnitude scaling relations being considered by the WGUEP for calculating M_{\max} within the Wasatch Front Region. Jim Pechmann indicated that he was not happy with the Stirling and others (2002) relation because it censors low displacement earthquakes and focuses only on larger displacement events. The Paleoseismology Subgroup was tasked to follow up on this issue.

David Schwartz commented that the numbers used for the Bear River fault zone in the probability calculations are incorrect. He does not know what the correct numbers should be, but based on recent investigations by the USGS on the fault, he feels that the numbers will eventually have to be revised. Likewise, Susan Olig stated that the recurrence intervals used in the probability calculations for the GSL-OFZ are too short and violate the paleoseismic data for that fault.

Major issues that surfaced after review of the preliminary probability calculations include:

- Magnitude scaling relations need further evaluation.
- Does the current WGUEP model include enough time dependence? Ivan proposed revising the model to include 0.8 time dependence and 0.2 time independence.
- Approach to computing rates for multisegment ruptures needs further clarification, specifically the weighting of rates based on grouped ruptures and individual rupture rates, the grouping scheme, and the incorporation of judgment to limit the statistical uncertainty. Use group and individual rates and maybe coefficient of variation?

- Should the rupture scenario weights be revised? A possible, new weighting scheme was proposed as follows:
 - Segmented = 0.7
 - Multisegment A = 0.05, B = 0.05, C = 0.075, Min = 0.025 (0.2 total)
 - Unsegmented = 0.1

MEETING ADJOURNED

WGUEP Meeting Eight was adjourned at 12:00 p.m. A date for Meeting Nine will be established once the results of the URS/UGS National Earthquake Hazard Reduction Program proposal requesting an additional year of funding for the WGUEP process become known – likely in October.

REFERENCES

- Stirling, M., Rhoades, D., and Berryman, K., 2002, Comparison of earthquake scaling relations derived from data of the instrumental and preinstrumental era: Bulletin of the Seismological Society of America, v. 92, no. 2, p. 812-830.
- Stirling, M.W., and Goded, T., 2012, Magnitude and scaling relationships—Report produced for the GEM faulted earth and regionalisation global components: GNS Science, Miscellaneous Series 42, ver. 2, 35 p.

ATTACHMENT 1

Attendance Working Group on Utah Earthquake Probabilities Meeting #8

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 #8
Wednesday/Thursday, 8 & 9 August 2012
Utah Department of Natural Resources Building
1594 West North Temple, Salt Lake City**

Wednesday, 8 August (Room 1040-1050)

10:30 – 10:45	Overview of Agenda and Review of Last Meeting's To Do List	Ivan
10:45 – 11:30	Final Paleoseismic Parameters for the Central WFZ	Chris
11:30 – 12:15	Poisson and BPT Parameter Estimates for the WFZ	Nico
12:15 – 1:00	Lunch	
1:00 – 1:30	Geodetic Modeling	Jim and Mark
1:30 – 2:00	Update on Consensus Wasatch Front Earthquake Catalog	Walter
2:00 – 3:00	Review Wasatch Fault Logic Tree	Patricia
3:00 – 3:15	Break	
3:15 – 5:00	Review Wasatch Fault Logic Tree	Patricia

Thursday, 8 August (Room 2000)

8:00 – 8:30	Continental Breakfast	
8:30 – 10:00	Preliminary Earthquake Probability Results	Patricia
10:00 – 10:15	Break	
10:15 – 12:00	Preliminary Earthquake Probability Results (continued)	Patricia
12:00	Adjourn	

WGUEP Members

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

Other Participants

Steve Bowman, UGS