Working Group on Utah Earthquake Probabilities
Preliminary Fault Characterization Parameters for Faults Common to the Working Group Study Area and the U.S. National Seismic Hazard Maps

Data Provided to the U.S. Geological Survey for Use in the 2014 Update of the National Seismic Hazard Maps in Utah

Compiled by William R. Lund
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March 28, 2013

Dr. Mark Petersen
U.S. Geological Survey
P.O. Box 25046, MS 966
Denver, CO 80225-0046

RE: Working Group on Utah Earthquake Probabilities preliminary fault parameters.

Dear Mark:

The accompanying table presents the Working Group on Utah Earthquake Probabilities (WGUEP) fault parameters for faults in the WGUEP study area that are also seismic sources in the U.S. Geological Survey's (USGS) National Seismic Hazard Maps (NSHMs). These data are provided for your information as the USGS prepares the next update of the NSHMs in Utah. However, note that these data are preliminary, are part of a project still in progress, largely have not received peer review outside of the WGUEP, and are subject to possible future revision by the WGUEP. The slip-rate and recurrence-interval data for the five central segments of the Wasatch fault zone are the product of a detailed re-examination of all paleoseismic trench data available for those segments by the WGUEP's Paleoseismology Subgroup. The data for the remaining faults in the table have been taken from existing literature and industry data, and have been carefully reviewed by the WGUEP.

The WGUEP anticipates that it will have a draft Final Technical Report ready later this summer. The report will be submitted for review to various entities at that time and review comments incorporated as appropriate. Publication of the Final Technical Report is scheduled for late 2013, at which time full documentation for all fault parameters in the attached table will be publically available. The WGUEP has conducted nine working meetings to date. Summaries of those meetings are available at http://geology.utah.gov/ghp/workgroups/wguep.htm.

Sincerely,

William Lund, Senior Scientist
WGUEP Coordinator

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Table of Working Group on Utah Earthquake Probabilities (WGUEP) parameters for faults in the WGUEP Wasatch Front study area that are also seismic sources on the U.S. Geological Survey National Seismic Hazard Maps. Note that these data are preliminary, are part of a project in progress, largely have not received peer review outside of the WGUEP, and are subject to possible future revision.

Fault Name	Rupture Model[1]	Segment Model	Length[2] (km)	Probability of Activity[3]	Dip[4] (degrees)	Seismogenic Depth[5] (km)	Vertical Slip Rate (mm/yr)	Recurrence Interval[6] (yr or kyr)
Bear River fault zone	Independent	Unsegmented	35	1.0	50±15	15±3	—	2250±1260[7] Elapsed time since MRE 2370 yr
East Cache fault zone	Independent (0.2)	Unsegmented	86[8]	1.0	50±15	15±3	0.04 (0.2) 0.2 (0.6) 0.4 (0.2)	—
	Segmented (0.8)	Northern	41				0.04 (0.3) 0.1 (0.4) 0.2 (0.3)	—
		Central	17				**0.8** 0.04 (0.2) 0.2 (0.6) 0.4 (0.2)	**0.2** 4000 (0.3)[9] 10,000 (0.4) 15,000 (0.3)
		Southern	31				**0.8** 0.01 (0.3) 0.03 (0.4) 0.07 (0.3)	**0.2** 10,000 (0.3)[9] 50,000 (0.4) 100,000 (0.3)
Eastern Bear Lake fault	Independent (0.3)	Unsegmented	73[8]	1.0	50±15	15±3	0.2 (0.2) 0.6 (0.6) 1.6 (0.2)	—
	Segmented (0.7)	Northern	19				0.1 (0.2) 0.3 (0.6) 0.8 (0.2)	—
		Central	24				0.2 (0.2) 0.6 (0.6) 1.6 (0.2)	—
		Southern	35				**0.8** 0.2 (0.2) 0.6 (0.6) 1.6 (0.2)	**0.2** 3000 (0.2)[9] 8000 (0.6) 15,000 (0.2)

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Oquirrh – Great Salt Lake fault zone	Independent (0.2)	Floating entire fault	87	1.0	50±15	15±3	0.05 (0.3) 0.2 (0.4) 0.4 (0.3)	—
		Floating Great Salt Lake fault zone only	87				0.25 (0.3)[10] 0.4 (0.4) 1.2 (0.3)	—
	Segmented (0.8)	Rozelle	27				—	1800 (0.2) 4200 (0.6) 6600 (0.2)
		Promontory	22				—	1800 (0.2) 4200 (0.6) 6600 (0.2)
		Fremont Island	26				—	1800 (0.2) 4200 (0.6) 6600 (0.2)
		Antelope Island	34				—	1800 (0.2) 4200 (0.6) 6600 (0.2)
		North Oquirrh	30				0.05 (0.3) 0.2 (0.4) 0.4 (0.3)	—
		South Oquirrh	31				0.05 (0.3) 0.2 (0.4) 0.4 (0.3)	—
		Topliff Hills	23				0.05 (0.3) 0.2 (0.4) 0.4 (0.3)	—
		East Tintic	40				0.05 (0.3) 0.1 (0.4) 0.2 (0.3)	—
Hansel Valley fault	Independent (0.6)[11] Coseismic (0.4)	Unsegmented	30	1.0	50±15	Truncated antithetic fault[12]	0.06 (0.2) 0.1 (0.6) 0.2 (0.2)	—
Joes Valley fault zone	Shallow penetration (0.6) Deep penetration (0.4)[13]	Unsegmented	37	Shallow (0.4) Deep (1.0)	70±15[14]	Shallow (4) Deep (15±3)	—	5000 (0.2)[9] 10,000 (0.6) 50,000 (0.2)

Morgan fault	Independent	Unsegmented	17	1.0	50±15	15±3	**0.8** 0.01(0.3) 0.02 (0.4) 0.04 (0.3)	**0.2** 25,000 (0.5)[9] 100,000 (0.5)
North Promontory fault	Independent	Unsegmented	26	1.0	50±15	15±3	0.1 (0.3) 0.2 (0.4) 0.5 (0.3)	—
Rock Creek fault	Independent	Unsegmented	41	1.0	50±15	15±3	**0.8** 0.2 (0.1) 0.6 (0.6) 1.0 (0.3)	**0.2** 600 (0.1) 4000 (0.6) 10,000 (0.3)
Stansbury fault	Independent (0.3)	Unsegmented	70[8]	1.0	50±15	15±3	0.07 (0.2) 0.4 (0.6) 1.0 (0.2)	—
	Segmented (0.7)	Northern	24				0.07 (0.2) 0.4 (0.6) 1.0 (0.2)	—
		Central	29				0.07 (0.2) 0.4 (0.6) 1.0 (0.2)	—
		Northern	17				0.07 (0.2) 0.4 (0.6) 1.0 (0.2)	—
Strawberry fault	Independent	Unsegmented	32	1.0	50±15	15±3	**0.5** 0.03 (0.2) 0.1 (0.6) 0.3 (0.2)	**0.5** 5000 (0.2)[9] 15,000 (0.6) 25,000 (0.2)
Utah Lake faults	Independent (0.5) Coseismic (0.5)	Unsegmented	31	1.0	50±15	Truncated antithetic fault	0.1 (0.2) 0.4 (0.6) 0.6 (0.2)	—

Wasatch fault zone	Independent (0.1)	Floating earthquake up to M 7.6	127	1.0	50±15	15±3	0.01 (0.2) 0.05 (0.6) 0.10 (0.2)	—
							0.73 (0.2) 1.43 (0.6) 2.22 (0.2)	—
	Segmented (0.9)	Brigham City	36				1.6 (1.0–2.4)[15]	1100±200[16]
		Weber	56				1.9 (1.1–2.9)	1300±100
		Salt Lake City	40				1.3 (1.0–1.8)	1300±100
		Provo	59				2.0 (1.2–3.0)	1300±200
		Nephi	43				1.7 (1.1–3.2)	900±200
		Levan[17]	32				0.1 (0.2) 0.3 (0.6) 0.6 (0.2)	>3000 & <12,000[9]
West Cache fault zone	Independent (0.3)	Unsegmented	59[8]	1.0	50±15	15±3	0.1 (0.2) 0.4 (0.6) 0.7 (0.2)	—
	Segmented (0.70)	Clarkston	21				0.1 (0.2) 0.4 (0.6) 0.7 (0.2)	—
		Junction Hills	24				0.05 (0.2) 0.1(0.6) 0.2 (0.2)	—
		Wellsville	20				0.05(0.2) 0.1 (0.6) 0.2 (0.2)	—
West Valley fault zone	Independent (0.25) Coseismic (0.75)	Unsegmented	16	1.0	50±15	Truncated antithetic fault	0.1 (0.2) 0.4 (0.6) 0.6 (0.2)	—

[1]Rupture models include independent (unsegmented), segmented, coseismic (antithetic fault pairs), and deep or shallow penetrating for the Joes Valley fault zone.
[2]Measured straight line end-to-end.
[3]Probability of activity is the likelihood that the fault is a seismogenic source capable of generating earthquakes within the modern stress field.
[4]Range of crustal fault dips recommended by the Basin and Range Province Earthquake Working Group II (Lund, 2012) to the USGS for the next update of the National Seismic Hazard Maps and adopted by the WGUEP for most normal faults in their Wasatch Front study area; dips are weighted 35 (0.3), 50 (0.4), 65 (0.3).
[5]Range of seismogenic depths (15±3 km) adopted by the WGUEP for most normal faults in the WGUEP study; weighted 12 km (0.2), 15 km (0.7), 18 km (0.1) west of the Wasatch fault zone (WFZ) and 12 km (0.1), 15 km (0.7), 18 km (0.2) east of the WFZ.
[6]Where available, the WGUEP uses recurrence intervals to model fault recurrence, particularly for time-dependent earthquake forecasts on the Brigham City, Weber, Salt Lake City, Provo, and Nephi segments of the WFZ, and the Fremont Island and Antelope Island segments of the Oquirrh-Great Salt Lake fault zone.
[7]West (1994) identified two earthquakes on the Bear River fault zone at 4620±690 and 2370±1050 cal yr. BP with a single closed-seismic-cycle recurrence interval of 2250±1260 yr (rounded to nearest decade). West (1994) calendar calibrated the earthquake ages, but did not correct for the mean residence time of the carbon in the bulk soil samples from which the ages were obtained; therefore, he feels the ages may be too old by several hundred years.

[8]Unsegmented rupture lengths for all segmented faults are for the entire fault and are measured straight line end to end, consistent with the empirical regressions the WGUEP is using to estimate M_{CHAR}. Discrepancies between unsegmented fault length and the sum of individual segment lengths is chiefly due to overlapping segment boundaries and/or gaps or stepovers between segments.
[9]Recurrence intervals from the Utah Quaternary Fault Parameters Working Group (Lund, 2005).
[10]This rate has been adjusted for the rate of the floating earthquake over the entire fault.
[11]Part of an antithetic fault pair, weights provided for independent and coseismic rupture with the paired master fault.
[12]Fault truncated by the master fault in an antithetic fault pair; depth of truncation depends upon the separation distance between the two faults at the ground surface and projecting both faults to depth with a dip of 50±15 degrees.
[13]Available geologic and seismic data are inconclusive regarding whether the Joes Valley fault zone penetrates to seismogenic depth (15±3 km; deep) or become listric and sole into a shallow detachment fault at a depth of about 4 km (shallow).
[14]Based on surface expression (narrow "keystone" graben with minimal displacement across it) and seismic evidence, the WGUEP assigned a steeper dip (70±15 degrees) to the Joes Valley fault zone than the dip adopted for most other normal faults in the WGUEP study area.
[15]Closed mean slip rates for the Brigham City, Weber, Salt Lake City, Provo, and Nephi segments are based on the mean of two calculation methods: (1) mean displacement divided by mean recurrence, and (2) total displacement (excluding that from the earliest earthquake) divided by the total elapsed time between the earliest and most-recent earthquakes. Ranges represent the minimum and maximum possible slip rates using these methods, ranges in displacement per segment, and two-sigma recurrence intervals. Note that the WGUEP uses recurrence interval, not slip rate to make earthquake forecasts on these segments.
[16]Closed mean recurrence (elapsed time between the oldest and youngest events divided by the number of closed intervals) reported for the Brigham City, Weber, Salt Lake City, Provo, and Nephi segments; two-sigma uncertainties are based on the timing distributions of the oldest and youngest earthquakes sampled in a Monte Carlo model (see DuRoss and others [2011] for discussion) and do not include sample-size uncertainties. Mean recurrence for the Weber and Brigham City segments are discussed in DuRoss and others (2011) and Personius and others (2012), respectively. Recurrence values for the Salt Lake City, Provo, and Nephi segments are preliminary.
[17]Note that the WGUEP is modeling all 10 segments of the WFZ for its earthquake forecast.

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