



## **2017 UTAH EARTHQUAKE WORKING GROUP MEETINGS UTAH QUATERNARY FAULT PARAMETERS WORKING GROUP SUMMARY**

**Wednesday, February 8, 2017**

**Utah Department of Natural Resources Building, Auditorium (1<sup>st</sup> Floor)  
1594 West North Temple, Salt Lake City, Utah**

---

### **WELCOME AND INTRODUCTION**

Steve Bowman (Utah Geological Survey [UGS]) called the 2017 Utah Quaternary Fault Parameters Working Group (UQFPWG) meeting to order at 8:15 a.m. After welcoming Working Group members and guests, Steve summarized the UQFPWG's past activities and outlined the Working Group's purpose and goals for the future.

#### **UQFPWG Purpose and Goals**

- One of three standing committees created to help set and coordinate Utah's earthquake-hazard research agenda.
- Reviews ongoing paleoseismic research in Utah, and updates the Utah consensus slip-rate and recurrence-interval database as necessary.
- Provides advice/insight regarding technical issues related to fault behavior in Utah and the Basin and Range Province.
- Identifies and prioritizes future Utah Quaternary fault paleoseismic investigations.

#### **U.S. Geological Survey Update**

Ryan Gold, Intermountain West Coordinator for the U.S. Geological Survey (USGS), Earthquake Hazards Program, gave a summary and status of the External Research Support function, and information on the upcoming 2017 funding announcement for proposals.

### **TECHNICAL PRESENTATIONS**

The following presentations were made on current paleoseismic research and related activities in Utah, most presentations are available at <http://geology.utah.gov/hazards/earthquakes-faults/utah-earthquake-working-groups/quaternary-fault-parameters/>.

- Results from the Airport East Trench Site, Taylorsville Fault, West Valley Fault: Adam I. Hiscock, Utah Geological Survey, Geologic Hazards Program
- Paleoseismic Insight into the Normal Fault Segmentation of the Wasatch Fault: Chris DuRoss, U.S. Geological Survey, Earthquake Hazards Program
- Seismic Imaging of the Wasatch Fault Beneath Salt Lake City—Results and New Field Campaign Plans: Lee Liberty, Boise State University, Department of Geosciences

- Preliminary Results from the Traverse Ridge Paleoseismic Site: Nathan Toke, Utah Valley University, Department of Earth Science
- Characterization of Segmentation and Long-Term Slip Rates of the Wasatch Fault Zone, Utah: Julia Howe, University of Utah, Department of Geology & Geophysics
- Constraints on the Timing, Surface Displacement, and Lateral Extent of the Oquirrh Fault's Most Recent Surface-Rupturing Event from High Resolution Topography: Mike Bunds, Utah Valley University, Department of Earth Science
- Investigating the Spatial Extent of a Barely Prehistoric Earthquake on the Bear River Normal Fault, Wyoming and Utah (Poster): Susanne Hecker, U.S. Geological Survey, Earthquake Hazards Program
- Updating Quaternary Fault Parameters for the Reno and Las Vegas Areas, Nevada: Rich D. Koehler, Nevada Bureau of Mines and Geology
- Comparison of Geodetic and Geological/Seismological Moment Rates for the Wasatch Front Region, Utah: James C. Pechmann, University of Utah Seismograph Stations
- Using Consultant Surface Fault Rupture Investigations to Supplement Geologic Mapping in Salt Lake Valley: Adam McKean, Utah Geological Survey, Geologic Hazards Program
- The Impact on Seismic Hazard from Modeling the Time-Dependent Behavior of the Wasatch Fault: Ivan Wong, Lettis Consultants International, Inc.
- Update of Ongoing Studies to Evaluate the Seismic Potential of the Joes Valley Fault Zone, East-Central Utah: Lucy Piety; U.S. Bureau of Reclamation; Seismology, Geomorphology, and Geophysics Group
- Utah Geological Survey Earthquake Hazards Projects for the Upcoming Year: Adam I. Hiscock, Utah Geological Survey, Geologic Hazards Program
- Quaternary Fault and Fold Database Update: Emily Kleber, Utah Geological Survey, Geologic Hazards Program
- New Utah Earthquakes (1850 to 2016) and Quaternary Fault Map: Steve Bowman, Utah Geological Survey, Geologic Hazards Program
- FORGE Experimental Geothermal Site: Emily Kleber, Utah Geological Survey, Geologic Hazards Program

## **TECHNICAL DISCUSSION ITEMS**

Bill Lund led a discussion about updating the UQFPWG consensus Quaternary fault parameters by adopting the parameters from the Working Group on Utah Earthquake Probabilities (WGUEP) final report (2016) and from Lund (2014). The UQFPWG consensus parameters were last published by Lund (2005). It was agreed by the UQFPWG members to adopt the WGUEP (2016) and Lund (2014) parameters with review by Bill Lund and Adam Hiscock.

## UQFPWG 2018 FAULT INVESTIGATION 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” (table 1; Lund, 2005). Since then, the Working Group has added an additional 12 faults/fault segments to the list: five in 2007; one in 2009; one in 2010; four in 2011; three general recommendations regarding the five central segments of the Wasatch fault zone, fault zone mapping, and acquisition of high resolution imagery in 2012, 2014, 2015, respectively; one in 2016, plus the relationship of salt tectonics to eight faults or fault zones; and slightly modified the existing list of highest priorities in 2017. Utah’s mapped Quaternary faults are shown on figure 1.

Table 2 lists faults and fault segments in the USGS National Seismic Hazard Maps or the UGS Hazus Utah fault database (figure 2; Lund, 2014) not listed in table 1 that may warrant additional investigation. Figure 1 shows the faults and fault segments listed in tables 1 and 2. Table 3 lists the current status of paleoseismic investigations for Utah priority faults and fault segments identified by the UQFPWG as priorities for investigation. Note that faults or fault segments listed in table 3 as having received some level of paleoseismic investigation does not imply that all of the paleoseismic data necessary to fully characterize those faults or fault segments has been acquired; further investigation of those structures may be necessary.

The UQFPWG conducts an annual review of progress made toward investigating the faults and fault segments on the priority list. Based on that review, the Working Group establishes a short list of the highest priority faults and fault segments for future investigation. The list of highest priority faults and fault segments is published on the UGS website (<http://geology.utah.gov/hazards/earthquakes-faults/utah-earthquake-working-groups/>), which is then referenced by the USGS Earthquake Hazards Program in their annual External Research Support (National Earthquake Hazards Reduction Program [NEHRP]) request for proposals. As part of Chris DuRoss’s presentation, he proposed specific areas along the Wasatch fault zone where more work is needed; these areas are shown on figure 3.

The Working Group’s highest priority list for 2018 includes (not in priority order):

- Acquire new paleoseismic information to address data gaps for (a) the five central segments of the Wasatch fault zone (including focusing on the youngest earthquakes [3-5 ka]; large, early Holocene–latest Pleistocene scarps; and secondary faulting [West Valley fault zone and Utah Lake faults and folds]), (b) the northern segment of the Oquirrh fault zone, (c) refining the latest Quaternary earthquake chronology for the Topliff Hills fault, and (d) the East and West Cache fault zones. Examples of paleoseismic data to be acquired include surface rupture extent, earthquake timing, displacement, and fault geometry.
- Use recently acquired lidar data to more accurately map the traces of the East and West Bear Lake, East and West Cache, and Hurricane fault zones, and search for and map previously undiscovered mid-valley Quaternary faults.
- Acquire earthquake timing information for the Utah Lake fault zone to investigate the relation of earthquakes on that fault system to large earthquakes on the adjacent Provo segment of the Wasatch fault zone (coseismic or independent rupture, fault pairs?).
- Acquire high-resolution aerial imagery (lidar, Structure from Motion, etc.), map high-risk (chiefly urban) Utah hazardous faults (including the East and West Bear Lake, East and West Cache, Hansel Valley, and Oquirrh fault zones), and identify new paleoseismic trench sites.

- Acquire and analyze information on salt tectonics and its relation to the Main Canyon fault, Sevier detachment/Drum Mountains fault zone, Bear River fault zone, Spanish Valley (Moab area) faults, Joes Valley fault zone, Levan and Fayette segments of the Wasatch fault zone, Scipio Valley faults, and the Gunnison fault.

The Working Group's other priority list for 2018 was not modified.

Table 4 shows the 2018 highest priority fault and fault segment recommendations, table 5 shows the list of other priority faults and fault segment recommendations, and both tables show the current investigation status for all faults and fault segments identified by the UQFPWG as requiring additional investigation. All of the faults/fault sections listed in table 3 remain priorities and should be considered for future investigation if a compelling case can be made for the need to acquire additional paleoseismic data.

## WORKING GROUP PRODUCTS AND RELATED DATA

The final agenda, speaker presentations, and this summary document are available on the UQFPWG web page at <http://geology.utah.gov/hazards/earthquakes-faults/utah-earthquake-working-groups/quaternary-fault-parameters/>. Paleoseismic investigations that developed out of the UQFPWG meetings and published by the UGS are available in the *Paleoseismology of Utah* series at <http://geology.utah.gov/hazards/technical-information/paleoseismology-of-utah-series/>. Most of the USGS NEHRP funded investigations for Utah that were not published by the UGS are compiled in UGS Miscellaneous Publication 13-03 ([http://ugspub.nr.utah.gov/publications/misc\\_pubs/mp-13-3/mp13-03.pdf](http://ugspub.nr.utah.gov/publications/misc_pubs/mp-13-3/mp13-03.pdf)).

### Utah Quaternary Fault and Fold Database

The UGS last updated the *Utah Quaternary Fault and Fold Database* (figure 1) on January 26, 2017, incorporating new data and updates. Users of any Quaternary fault trace and related data acquired from the UGS or the Utah Automated Geographic Reference Center (AGRC) State Geographic Information Database (SGID) in the past are advised to use the updated database available from the AGRC SGID (<http://gis.utah.gov/data/how-to-connect-to-the-sgid-via-sde/>) as the SGID10.GEOSCIENCE.QuaternaryFaults feature class (<https://gis.utah.gov/data/geoscience/quaternary-faults/>). This single, comprehensive feature class will be periodically updated as new/updated data become available (anticipated several times per year) and replaces the six previously available feature classes of variable completeness. A web map application for the database is available at <http://geology.utah.gov/resources/data-databases/qfaults/>.

### Utah Lidar Data

Lidar data collected by the UGS and its partners (figure 4) are in the public domain and available from OpenTopography (<http://opentopography.org/>) and AGRC (<https://gis.utah.gov/data/elevation-terrain-data/>). General information and previous acquisitions are available at <http://geology.utah.gov/resources/data-databases/lidar-elevation-data/>.

Since 2013, over 106 billion points and 99 GB of raster lidar data collected by the UGS and its partners have been downloaded by users from OpenTopography. In terms of point cloud usage, the *2013–2014 State of Utah Acquired Lidar Data—Wasatch Front* and *2011 Utah Geological Survey Lidar* datasets are currently ranked by OpenTopography as number 10 and 18, respectively, out of 227 datasets.

In terms of raster usage, the *2013–2014 State of Utah Acquired Lidar Data—Wasatch Front* dataset is currently ranked by OpenTopography as number 8 out of 114 datasets.

## REFERENCES

- dePolo, C.M., 2008, Quaternary faults in Nevada: Nevada Bureau of Mines and Geology Map 167, scale 1:1,000,000, online, <http://data.nbmgs.unr.edu/public/freedownloads/m/m167.zip>.
- 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., online, <http://ugspub.nr.utah.gov/publications/bulletins/B-134.pdf>.
- Lund, W.R., 2014, Hazus loss estimation software earthquake model revised Utah fault database, updated through 2013: Utah Geological Survey Open-File Report 631, 11 p., online, [http://ugspub.nr.utah.gov/publications/open\\_file\\_reports/ofr-631.pdf](http://ugspub.nr.utah.gov/publications/open_file_reports/ofr-631.pdf).
- U.S. Geological Survey, 2016, Quaternary fault and fold database of the United States: U.S. Geological Survey, online, <http://earthquake.usgs.gov/hazards/qfaults/>, accessed December 2016.
- Utah Geological Survey, 2016, Utah Quaternary fault and fold database: Utah Geological Survey, online, <http://geology.utah.gov/resources/data-databases/qfaults/>.
- Working Group on Utah Earthquake Probabilities, 2016, Earthquake probabilities for the Wasatch Front region in Utah, Idaho, and Wyoming: Utah Geological Survey Miscellaneous Publication 16-3, 164 p., 5 appendices, online, [http://ugspub.nr.utah.gov/publications/misc\\_pubs/mp-16-3/mp-16-3.pdf](http://ugspub.nr.utah.gov/publications/misc_pubs/mp-16-3/mp-16-3.pdf).

**MEETING ATTENDANCE**  
**Working Group Members (\* Speaker)**

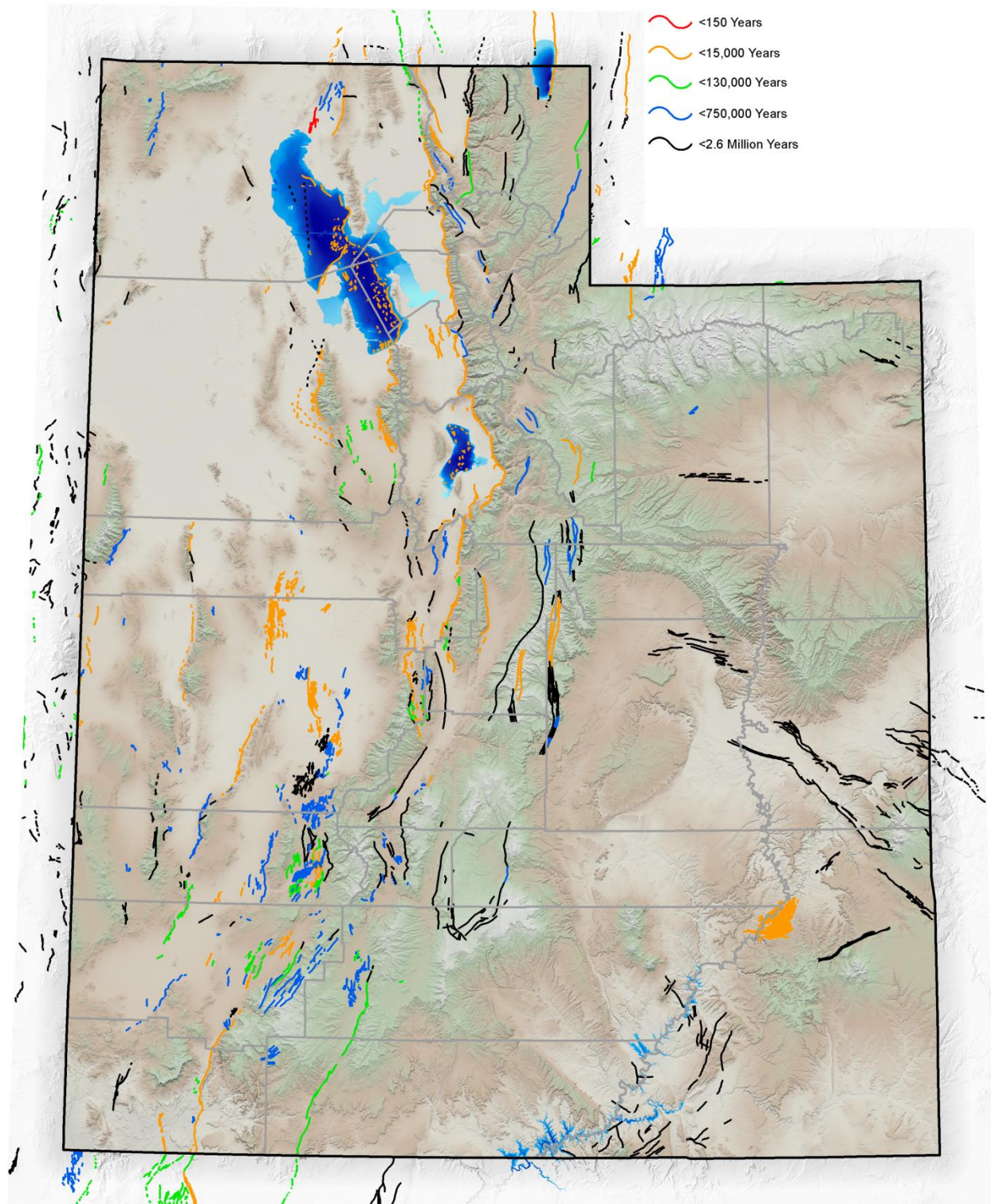
|                 |  |
|-----------------|--|
| Steve Bowman*   | Utah Geological Survey (UQFPWG Chair)                  |
| Michael Bunds*  | Utah Valley University                                 |
| David Dinter    | University of Utah, Department of Geology & Geophysics |
| Chris DuRoss*   | U.S. Geological Survey, Earthquake Hazards Program     |
| Ryan Gold*      | U.S. Geological Survey, Earthquake Hazards Program     |
| Adam Hiscock*   | Utah Geological Survey (UQFPWG UGS Liaison)            |
| Michael Hylland | Utah Geological Survey                                 |
| Susanne Janecke | Utah State University                                  |
| William Lund*   | Utah Geological Survey, Emeritus                       |
| Jim Pechmann*   | University of Utah Seismograph Stations                |
| Lucy Piety*     | U.S. Bureau of Reclamation                             |
| Nathan Toke*    | Utah Valley University                                 |
| Ivan Wong*      | Lettis Consultants International, Inc.                 |

**Guests (\* Speaker)**

|                 |  |
|-----------------|--|
| Zack Anderson   | Utah Geological Survey                                 |
| Gregg Beukelman | Utah Geological Survey                                 |
| Bob Biek        | Utah Geological Survey                                 |
| Bob Carey       | Utah Division of Emergency Management                  |
| Peter Doumit    | Intermountain GeoEnvironmental Services, Inc.          |
| Carl Ege        | Utah Division of Water Resources                       |
| Ben Erickson    | Utah Geological Survey                                 |
| Jim Evans       | Utah State University                                  |
| Richard Giraud  | Utah Geological Survey                                 |
| Michael Hansen  | RB&G Engineering, Inc.                                 |
| Doug Hawkes     | Applied Geotechnical Engineering Consultants, Inc.     |
| Danny Horns     | Utah Valley University                                 |
| Micheal Hozik   | Retired  |
| Julia Howe*     | University of Utah, Department of Geology & Geophysics |
| Corbin Jensen   | Utah Geological Survey                                 |
| Paul Jewell     | University of Utah, Department of Geology & Geophysics |
| Jon King        | Utah Geological Survey                                 |
| Emily Kleber*   | Utah Geological Survey                                 |
| Tyler Knudsen   | Utah Geological Survey                                 |
| Rich Koehler*   | Nevada Bureau of Mines and Geology                     |
| Lee Liberty*    | Boise State University                                 |
| Elliott Lips    | Great Basin Earth Science                              |
| Bill Loughlin   | Loughlin Water Associates                              |
| Rob McDermott   | Unknown  |
| Greg McDonald   | Utah Geological Survey                                 |
| Adam McKean*    | Utah Geological Survey                                 |
| Marc Mukit      | Unknown  |
| Bob Oaks        | Utah State University                                  |
| Kris Pankow     | University of Utah Seismograph Stations                |
| David Simon     | Simon Associates                                       |
| Jason Sorensen  | Unknown  |
| Ana Vargo       | Natural Resources Conservation Service                 |

|                  |                                 |
|------------------|---------------------------------|
| Grant Willis     | Utah Geological Survey          |
| Julie Willis     | Brigham Young University, Idaho |
| Cianna Wysnyteky | Unknown                         |





**Figure 1.** Utah and surrounding area Quaternary faults and folds (for Utah from the [Utah Quaternary Fault and Fold Database](#) [UGS, 2016], for Nevada faults from the [Quaternary Faults in Nevada](#) map database [dePolo, 2008], and faults in Arizona, Colorado, Idaho, and Wyoming are from the [Quaternary Fault and Fold Database of the United States](#) [USGS, 2006]. Additional Quaternary faults may exist that have not been mapped, may not have surface exposures, or were mapped subsequent to the latest database revisions.



**Table 1.** List of Quaternary faults and fault segments identified by the UQFPWG since 2005 as requiring additional investigation to adequately characterize Utah's earthquake hazard to a minimally acceptable level.

| Utah Fault or Fault Segment  | UQFPWG Priorities |               |
|--|-------------------|---------------|
|  | 2005 <sup>1</sup> | Additions     |
| Nephi segment, Wasatch fault zone <sup>2,3</sup>   | 1                 | --            |
| West Valley fault zone <sup>2,3</sup>  | 2                 | --            |
| Weber segment, Wasatch fault zone <sup>2,3</sup> – most recent event   | 3                 | --            |
| Weber segment, Wasatch fault zone <sup>2,3</sup> – multiple events   | 4                 | --            |
| Utah Lake faults and folds <sup>3</sup>  | 5                 | --            |
| Great Salt Lake fault zone <sup>2,3</sup>  | 6                 | --            |
| Collinston and Clarkston Mountain segments, Wasatch fault zone <sup>3</sup>  | 7                 | --            |
| Sevier and Toroweap faults <sup>2,3</sup>  | 8                 | --            |
| Washington fault zone <sup>3</sup> (includes Dutchman Draw fault <sup>2</sup> )  | 9                 | --            |
| Cedar City-Parowan monocline (removed 2016) <sup>3,4</sup> and Paragonah fault <sup>2,3</sup>  | 10                | --            |
| Enoch graben <sup>3</sup>  | 11                | --            |
| East Cache fault zone <sup>2,3</sup>   | 12                | --            |
| Clarkston fault <sup>2,3</sup>   | 13                | --            |
| Wasatch Range back-valley faults (includes Morgan fault <sup>2</sup> and Main Canyon fault <sup>3</sup> )  | 14                | --            |
| Hurricane fault zone <sup>2,3</sup>  | 15                | --            |
| Levan segment, Wasatch fault zone <sup>2,3</sup>   | 16                | --            |
| Gunnison fault <sup>3</sup>  | 17                | --            |
| Scipio Valley faults <sup>3</sup>  | 18                | --            |
| Faults beneath Bear Lake   | 19                | --            |
| Eastern Bear Lake fault zone <sup>2,3</sup>  | 20                | --            |
| Bear River fault zone <sup>2,3</sup>   | --                | 2007          |
| Brigham City segment, Wasatch fault zone <sup>2,3</sup> – most recent event  | --                |               |
| Carrington fault, Great Salt Lake fault zone <sup>3</sup>  | --                |               |
| Provo segment, Wasatch fault zone <sup>2,3</sup> – penultimate event   | --                |               |
| Rozelle section, East Great Salt Lake fault <sup>3</sup>   | --                |               |
| Salt Lake City segment, Wasatch fault zone <sup>2,3</sup> – northern part  | --                | 2009          |
| Warm Springs fault/East Bench fault <sup>2,3</sup> subsurface geometry and connection  | --                | 2010          |
| Brigham City segment, Wasatch fault zone <sup>2,3</sup> rupture extent (north and south ends)  | --                | 2011          |
| Northern Provo segment, Wasatch fault zone <sup>2,3</sup> – long-term earthquake record  | --                |               |
| Taylorville fault, West Valley fault zone <sup>3</sup>   | --                |               |
| Hansel Valley fault <sup>2,3</sup>   | --                | 2012          |
| Acquire new paleoseismic information to address data gaps for the five central segments of the Wasatch fault zone.   | --                |               |
| <i>Focus on the youngest earthquakes (3-5 ka); large, early Holocene–latest Pleistocene scarps; and secondary faulting (West Valley fault zone<sup>1,2,3</sup> and Utah Lake faults and folds<sup>1,3</sup>).</i>  | --                | Modified 2017 |
| Improve the long-term earthquake record for Cache Valley (East <sup>1,2,3</sup> and West Cache <sup>2,3</sup> fault zones).  | --                | 2013          |
| Use recently acquired lidar data to more accurately map the traces of the Wasatch, West Valley, and Hurricane fault zones, and search for and map as appropriate previously undiscovered mid-valley Quaternary faults.   | --                | 2014          |
| <i>East<sup>1,2,3</sup> and West Bear Lake, East and West Cache<sup>1,2,3</sup>, and Hurricane<sup>1,2,3</sup> fault zones</i>   | --                | Modified 2017 |
| Acquire earthquake timing information for the Utah Lake faults <sup>1,3</sup> to investigate the relation of earthquakes to large earthquakes on the adjacent Provo segment of the Wasatch fault zone <sup>3,4</sup> .   | --                | 2015          |
| Acquire new paleoseismic information to address data gaps for the northern Oquirrh fault zone <sup>3</sup> .   | --                |               |
| Acquire high resolution aerial imagery (Lidar, Structure from Motion, etc.) and map high-risk (chiefly urban) Utah hazardous faults. Identify future paleoseismic trench sites.  | --                | Modified 2017 |
| <i>East<sup>1,2,3</sup> and West Bear Lake, East and West Cache<sup>1,2,3</sup>, Oquirrh<sup>2,3</sup>, and Hansel Valley<sup>2,3</sup> fault zones</i>  | --                |               |
| Acquire and analyze information on salt tectonics and its relation to the Main Canyon fault <sup>1,3</sup> , Sevier detachment/Drum Mountains fault zone <sup>3</sup> , Bear River fault zone <sup>2,3</sup> , Spanish Valley (Moab area), Joes Valley fault zone <sup>2,3</sup> , Levan <sup>1</sup> and Fayette segments <sup>2,3</sup> of the Wasatch fault zone, Scipio Valley faults <sup>3</sup> , and the Gunnison fault <sup>1,3</sup> . | --                | 2016          |
| Refine the latest Quaternary earthquake chronology for the Toppliff Hills fault <sup>3</sup> .   | --                |               |

<sup>1</sup> Original priorities from the 2005 UQFPWG meeting.

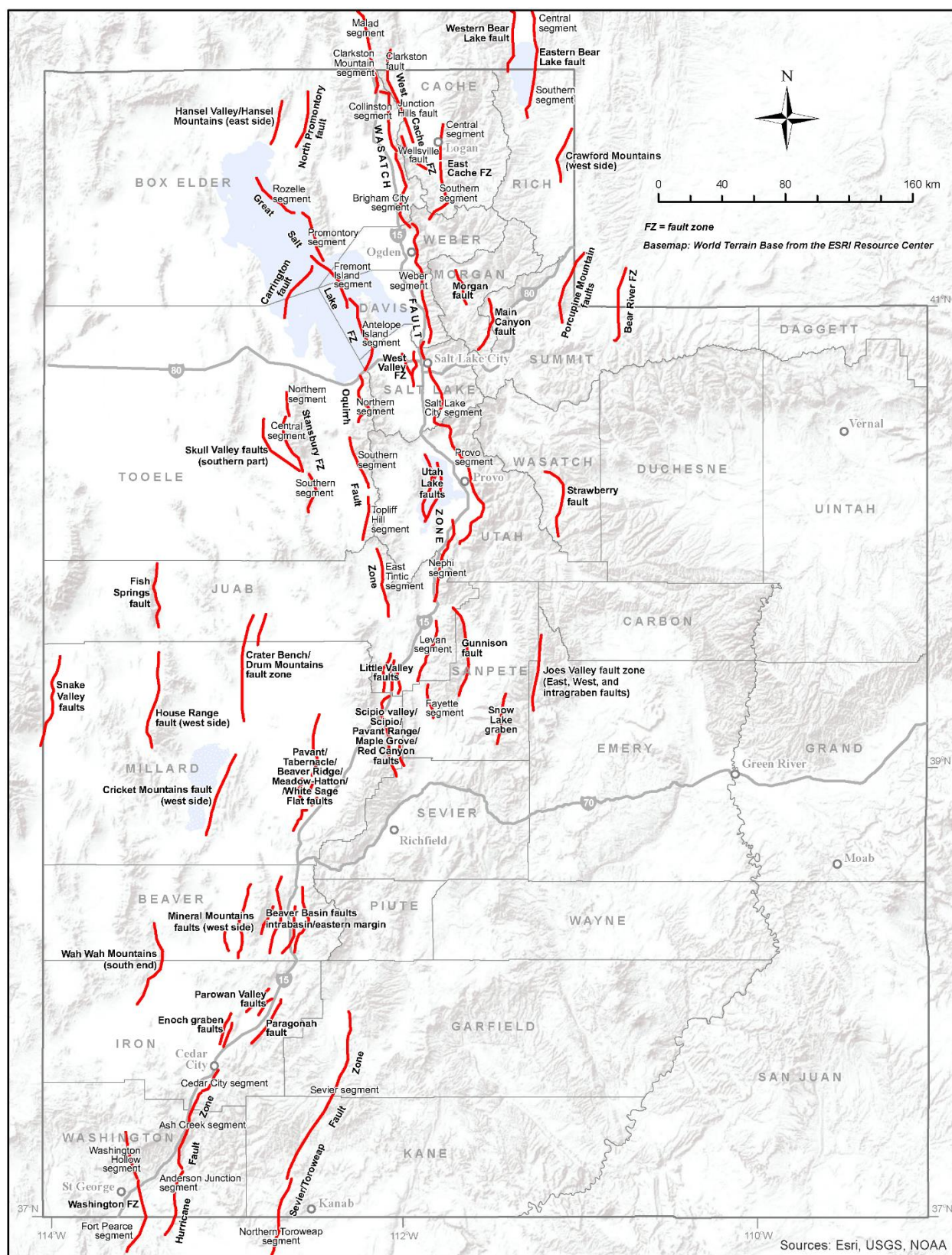
<sup>2</sup> Earthquake source on the USGS National Seismic Hazard Maps.

<sup>3</sup> Earthquake source listed in the UGS Hazus Utah fault database ([UGS Open-File Report 631](#)).

<sup>4</sup> Fault removed from the list at the 2016 UQFPWG meeting, based on new information about the structure.

**Table 2.** Earthquake sources (faults and fault segments) in the USGS National Seismic Hazard Maps (NSHM) or the UGS Hazus Utah fault database ([UGS Open-File Report 631](#)) not listed in table 1 and that may warrant additional investigation.

| Utah Fault or Fault Segment   | Included In |            |
|---|-------------|------------|
|   | NSHM        | Utah Hazus |
| Beaver Basin intrabasin/eastern margin faults                       | --          | Yes        |
| Crater Bench/Drum Mountains fault zone                              | --          | Yes        |
| Crawford Mountains (west side)                                      | --          | Yes        |
| Cricket Mountains fault (west side)                                 | --          | Yes        |
| Fayette segment, Wasatch fault zone                                 | --          | Yes        |
| Fish Springs fault  | --          | Yes        |
| House Range (west side) fault                                       | --          | Yes        |
| Joes Valley fault zone  | Yes         | Yes        |
| Little Valley faults  | --          | Yes        |
| Malad segment, Wasatch fault zone                                   | --          | Yes        |
| Mineral Mountains (west side) faults                                | --          | Yes        |
| North Promontory fault  | Yes         | Yes        |
| Oquirrh fault zone  | --          | Yes        |
| Oquirrh-Southern Oquirrh Mountains fault zone                       | Yes         | Yes        |
| Parowan Valley faults   | --          | Yes        |
| Pavant/Tabernacle/Beaver Ridge/Meadow-Hatton/White Sage Flat faults | --          | Yes        |
| Porcupine Mountain faults   | --          | Yes        |
| Scipio/Pavant Range/Maple Canyon/Red Canyon faults                  | --          | Yes        |
| Skull Valley faults (southern part)                                 | --          | Yes        |
| Snake Valley faults   | --          | Yes        |
| Snow Lake graben  | --          | Yes        |
| Stansbury fault zone  | Yes         | Yes        |
| Strawberry fault  | Yes         | Yes        |
| Wah Wah Mountains (south end)                                       | --          | Yes        |
| West Cache fault, Wellsville section                                | Yes         | Yes        |
| Western Bear Lake fault   | --          | Yes        |



**Table 3.** Current status of paleoseismic investigations for Utah priority faults and fault segments identified by the UQFPWG as requiring additional investigation to adequately characterize Utah's earthquake hazard to a minimally acceptable level. Note that faults or fault segments listed as having received some level of paleoseismic investigation does not imply that all of the paleoseismic data necessary to fully characterize those faults or fault segments has been acquired; further investigation of those structures may be necessary. All of the faults/fault segments listed remain priorities and should be considered for future investigation if a compelling case can be made for the need to acquire additional paleoseismic data.

| Fault or Fault Segment  | UQFPWG Priority <sup>1</sup> | Investigations   |                          |
|---|------------------------------|--|--------------------------|
|   |                              | Status <sup>2,3</sup> (as of 2/2017)   | Institution <sup>4</sup> |
| Nephi segment, Wasatch fault zone <sup>5,6</sup>  | 1                            | UGS Special Study <a href="#">124</a> and <a href="#">151</a><br><a href="#">USGS SI Map 2966</a><br><a href="#">UGS FTR Report</a>              | UGS/USGS                 |
| Granger fault, West Valley fault zone <sup>5,6</sup>  | 2                            | <a href="#">UGS Special Study 149</a>  | UGS/USGS                 |
| Weber segment, Wasatch fault zone <sup>5,6</sup> – most recent event                            | 3                            | <a href="#">UGS Miscellaneous Publication 05-8</a><br><a href="#">UGS Special Study 130</a>  | UGS/USGS                 |
| Weber segment, Wasatch fault zone <sup>5,6</sup> – multiple events                              | 4                            | <a href="#">UGS Miscellaneous Publication 05-8</a><br><a href="#">UGS Special Study 130</a>  | UGS/USGS                 |
| Utah Lake faults and folds <sup>6</sup>   | 5                            | <a href="#">UUGG FTR Report</a>  | UUGG/<br>BYU             |
| Great Salt Lake fault zone <sup>5,6</sup>   | 6                            | <a href="#">UUGG FTR Report</a>  | UUGG                     |
| Collinston and Clarkston Mountain segments, Wasatch fault zone <sup>6</sup>                     | 7                            | <a href="#">UGS Special Study 121</a><br>Map: <a href="#">UGS Open-File Report 638</a>   | UGS                      |
| Sevier and Toroweap faults <sup>5,6</sup>   | 8                            | <a href="#">UGS Special Study 122</a>  | UGS                      |
| Washington fault zone <sup>6</sup>  | 9                            | <a href="#">UGS Miscellaneous Publication 15-6</a><br><a href="#">UGS Open-File Report 583</a>   | UGS                      |
| Cedar City-Parowan monocline (removed 2016) <sup>5,6,7</sup> and Paragonah fault <sup>5,6</sup> | 10                           | Map: <a href="#">UGS Map 270</a><br><a href="#">2016 presentation file</a>   | UGS                      |
| Enoch graben <sup>6</sup>   | 11                           | Map: <a href="#">UGS Open-File Report 628</a>  | UGS                      |
| East Cache fault zone <sup>5,6</sup>  | 12                           | <a href="#">USU FTR Report</a>   | USU                      |
| Clarkston fault <sup>5,6</sup>  | 13                           | <a href="#">UGS Special Study 98</a><br>Fault mapping proposal submitted, awaiting funding.  | UGS                      |
| Wasatch Range back-valley faults  | 14                           | <a href="#">UGS Miscellaneous Publication 11-2</a>   | USBR                     |
| Main Canyon fault <sup>6</sup>  |                              | <a href="#">UGS Miscellaneous Publication 10-5</a>   | USBR                     |
| Hurricane fault zone <sup>5,6</sup>   | 15                           | <a href="#">UGS Special Study 119</a>  | UGS                      |
| Levan segment, Wasatch fault zone <sup>5,6</sup>  | 16                           | <a href="#">UGS Map 229</a><br>Map: <a href="#">UGS Open-File Report 640</a><br>Paleoseismic investigation proposal submitted, awaiting funding. | UGS                      |
| Gunnison fault <sup>6</sup>   | 17                           | No activity  | --                       |
| Scipio Valley faults <sup>6</sup>   | 18                           | No activity  | --                       |
| Faults beneath Bear Lake  | 19                           | No activity  | --                       |
| Eastern Bear Lake fault zone <sup>5,6</sup>   | 20                           | No activity  | --                       |
| Bear River fault zone <sup>5,6</sup>  | 2007                         | AGU Abstracts: <a href="#">2012</a> and <a href="#">2013</a><br>USGS ongoing   | USGS/UGS                 |
| Brigham City segment, Wasatch fault zone <sup>5,6</sup> – most recent event                     |                              | <a href="#">UGS Special Study 142</a>  | UGS/USGS                 |
| Carrington fault, Great Salt Lake fault zone <sup>5</sup>                                       |                              | No activity  | --                       |
| Provo segment, Wasatch fault zone <sup>5,6</sup> – penultimate event                            |                              | No activity  | --                       |
| Rozelle section, East Great Salt Lake fault <sup>6</sup>  |                              | Janecke (2017)   | USU                      |
| Salt Lake City segment, Wasatch fault zone <sup>5,6</sup> – north part                          | 2009                         | <a href="#">UGS Special Study 149</a>  | UGS/USGS                 |
| Warm Springs fault/East Bench fault <sup>5,6</sup> subsurface geometry and connection           | 2010                         | <a href="#">BSU FTR Report</a>   | BSU                      |
| Brigham City segment, Wasatch fault zone <sup>5,6</sup> rupture extent (north and south ends)   | 2011                         | No activity  | --                       |
| Northern Provo segment, Wasatch fault zone <sup>5,6</sup> – long-term earthquake record         |                              | USGS work ongoing<br><a href="#">UGS FTR Report</a>  | USGS/UGS                 |
| Hansel Valley fault zone <sup>5,6</sup>   |                              | <a href="#">McCalpin (1985)</a> , <a href="#">Robinson (1986)</a> ,<br><a href="#">McCalpin and others (1992)</a>                                | UUGG                     |



| Fault or Fault Segment   | UQFPWG Priority <sup>1</sup> | Investigations   |                          |
|--|------------------------------|--|--------------------------|
|  |                              | Status <sup>2,3</sup> (as of 2/2017)   | Institution <sup>4</sup> |
| Acquire new paleoseismic information to address data gaps for the five central segments of the Wasatch fault zone <sup>5,6</sup>   | 2012                         | --   | --                       |
| Nephi segment <sup>5,6</sup> – long-term earthquake record   | 2012                         | <a href="#">UGS FTR Report</a><br>Special Study ongoing  | UGS/USGS                 |
| Provo, Salt Lake City and Nephi segments, Wasatch fault zone <sup>5,6</sup> segmentation   | 2012                         | Ongoing  | --                       |
| Corner Canyon site   |                              | <a href="#">UGS FTR Report</a>   | UGS/USGS                 |
| Flat, Maple, and Alpine sites  |                              | USGS work ongoing<br><a href="#">UGS FTR Report</a>  | USGS/UGS                 |
| Fort Canyon fault <sup>5,6</sup> , Traverse Mountains salient  |                              | Ongoing  | UVU                      |
| Focus on the youngest earthquakes (3-5 ka); large, early Holocene–latest Pleistocene scarps; and secondary faulting (West Valley fault zone and Utah Lake faults and folds).   | Modified 2017                | Ongoing  | --                       |
| Taylorville fault, West Valley fault zone  |                              | UGS ongoing  | UGS/USGS                 |
| Improve the long-term earthquake record for Cache Valley (East and West Cache fault zones <sup>5,6</sup> ).  | 2013                         | No activity  | --                       |
| East Cache fault zone <sup>5,6</sup>   |                              | <a href="#">Evans and McCalpin (2012)</a>  | USU/GEO-HAZ              |
| Use lidar to map portions of the Hurricane <sup>5,6</sup> , Wasatch <sup>5,6</sup> , and West Valley <sup>5,6</sup> fault zones.   | 2014                         | Lidar data of the Wasatch and West Valley fault zones acquired.  | UGS/State of Utah        |
|  |                              | UGS Open-File Reports <a href="#">638</a> and <a href="#">640</a><br>Additional work ongoing.  | UGS                      |
| East <sup>5,6</sup> and West <sup>6</sup> Bear Lake, East and West Cache <sup>5,6</sup> , and Hurricane <sup>5,6</sup> fault zones   | Modified 2017                | East and West Cache fault zones mapping proposal submitted, awaiting funding   | UGS                      |
| Acquire new paleoseismic information to address data gaps for the northern Oquirrh fault zone <sup>5,6</sup> .   | 2015                         | No activity  | --                       |
| Acquire high resolution aerial imagery (Lidar, Structure from Motion [SfM], etc.) and map high-risk (chiefly urban) Utah hazardous faults. Identify future paleoseismic trench sites.  |                              | Lidar: Portions of the Gunlock, Mineral Mountains (West Side), and Ogden Valley faults, and the Hurricane and Washington fault zones acquired in 2016. | UGS/State of Utah        |
| East <sup>5,6</sup> and West <sup>6</sup> Bear Lake, East and West Cache <sup>5,6</sup> , Oquirrh <sup>5,6</sup> , and Hansel Valley <sup>5,6</sup> fault zones  | Modified 2017                | Lidar: Major portions of the East and West Bear Lake, East and West Cache, and Hansel Valley fault zones acquired in 2016.                             | UGS/State of Utah        |
|  |                              | Lidar: East and West Cache fault zones lidar and mapping proposal submitted, awaiting funding.   | UGS                      |
|  |                              | SfM: Portions of the Oquirrh fault zone acquired in 2016, ongoing.   | UVU                      |
| Acquire and analyze information on salt tectonics and its relation to the Main Canyon fault <sup>6</sup> , Sevier detachment/Drum Mountains faults <sup>6</sup> , Bear River fault zone <sup>5,6</sup> , Spanish Valley (Moab area), Joes Valley fault zone <sup>5,6</sup> , Levan <sup>5,6</sup> and Fayette <sup>6</sup> segments of the Wasatch fault zone, Scipio Valley faults <sup>6</sup> , and the Gunnison fault <sup>6</sup> . | 2016                         | Levan and Fayette segments paleoseismic investigation proposal submitted, awaiting funding   | UGS/USGS                 |
| Refine the latest Quaternary earthquake chronology for the Topliff Hills fault <sup>6</sup> .  | 2016                         | No activity  | --                       |

<sup>1</sup> See table 1 for complete working group priority list.

<sup>2</sup> FTR (Final Technical Report) to the USGS, Earthquake Hazards Program ([https://geohazards.usgs.gov/cfusion/external\\_grants/research.cfm](https://geohazards.usgs.gov/cfusion/external_grants/research.cfm)).

<sup>3</sup> Click on URL links to investigation report files available online.

<sup>4</sup> BSU (Boise State University), BYU (Brigham Young University), GEO-HAZ (GEO-HAZ Consulting, Inc.), USBR (U.S. Bureau of Reclamation), USGS (U.S. Geological Survey, Earthquake Hazards Program), UGS (Utah Geological Survey),

USU (Utah State University), UUGG (University of Utah Department of Geology & Geophysics), UVU (Utah Valley University).

<sup>5</sup> Earthquake source on the USGS National Seismic Hazard Maps (<http://earthquake.usgs.gov/hazards/hazmaps/>).

<sup>6</sup> Earthquake source listed in the UGS Hazus Utah fault database ([UGS Open-File Report 631](#)).

<sup>7</sup> Fault removed from the list at the 2016 UQFPWG meeting, based on new information about the structure.



**Table 4.** Utah Quaternary Fault Parameters Working Group 2018 list of highest priority Quaternary faults or fault segments requiring additional investigation to adequately characterize Utah’s earthquake hazard to a minimally acceptable level.

| Fault or Fault Segment (Not in Priority Order)   | Investigations  |                   |
|--|---|-------------------|
|  | Status (as of 2/2017) <sup>1,2</sup>  | Institution       |
| Acquire new paleoseismic information to address data gaps for (a) the five central segments of the Wasatch fault zone <sup>3,4</sup> (including focusing on the youngest earthquakes [3-5 ka]; large, early Holocene–latest Pleistocene scarps; and secondary faulting [West Valley fault zone <sup>3,4</sup> and Utah Lake faults and folds <sup>4</sup> ]), (b) the northern segment of the Oquirrh fault zone <sup>3,4</sup> , (c) refining the latest Quaternary earthquake chronology for the Toplift Hills fault <sup>4</sup> , and (d) the East and West Cache <sup>3,4</sup> fault zones. Examples of paleoseismic data to acquire include extent of surface-faulting rupture, earthquake timing, displacement, and subsurface fault geometry. | Nephi segment, Spring Lake and North Creek sites: <a href="#">UGS FTR Report</a> , Special Study ongoing  | UGS/USGS          |
|  | Provo segment, Flat Canyon site: USGS ongoing, <a href="#">UGS FTR Report</a>   | USGS/UGS          |
|  | Salt Lake City segment, Corner Canyon site: <a href="#">UGS FTR Report</a>  | UGS/USGS          |
|  | Provo segment, Dry Creek and Maple Canyon sites: USGS ongoing, <a href="#">UGS FTR Report</a>   | USGS/UGS          |
|  | Fort Canyon fault, Traverse Mountains salient: ongoing  | UVU               |
|  | Southern segment, East Cache fault zone: <a href="#">FTR Report</a>   | USU/GEO-HAZ       |
| Use recently acquired lidar data to more accurately map the traces of the East <sup>3,4</sup> and West <sup>4</sup> Bear Lake, East and West Cache <sup>3,4</sup> , and Hurricane <sup>3,4</sup> fault zones, and search for and map as appropriate previously undiscovered mid-valley Quaternary faults.  | UGS Open-File Reports <a href="#">638</a> and <a href="#">640</a> East and West Cache fault zones mapping proposal submitted, awaiting funding. | UGS               |
| Acquire earthquake timing information for the Utah Lake faults <sup>4</sup> to investigate the relation of earthquakes on that fault system to large earthquakes on the adjacent Provo segment of the Wasatch fault zone (independent or coseismic ruptures, fault pairs?).  | No activity   | --                |
| Acquire high-resolution aerial imagery (lidar, Structure from Motion, etc.), map high-risk (chiefly urban) Utah hazardous faults (including the East <sup>3,4</sup> and West <sup>4</sup> Bear Lake, East and West Cache <sup>3,4</sup> , Oquirrh <sup>3,4</sup> , and Hansel Valley <sup>3,4</sup> fault zones), and identify new paleoseismic trench sites.  | Lidar: Major portions of the East and West Bear Lake, East and West Cache, and Hansel Valley fault zones acquired in 2016.                      | UGS/State of Utah |
|  | Lidar: East and West Cache fault zones lidar and mapping proposal submitted, awaiting funding.  | UGS               |
|  | SfM: Portions of the Oquirrh fault zone acquired in 2016, ongoing.  | UVU               |
| Acquire and analyze information on salt tectonics and its relation to the Main Canyon fault <sup>4</sup> , Sevier detachment/Drum Mountains faults <sup>4</sup> , Bear River fault zone <sup>3,4</sup> , Spanish Valley (Moab area), Joes Valley fault zone <sup>3,4</sup> , Levan <sup>3,4</sup> and Fayette <sup>4</sup> segments of the Wasatch fault zone, Scipio Valley faults <sup>4</sup> , and the Gunnison fault <sup>4</sup> .   | Levan and Fayette segments paleoseismic investigation proposal submitted, awaiting funding  | UGS               |

<sup>1</sup> FTR (Final Technical Report) to the USGS, Earthquake Hazards Program.

<sup>2</sup> Click on URL link to investigation report files available online.

<sup>3</sup> Earthquake source on the USGS National Seismic Hazard Maps.

<sup>4</sup> Earthquake source listed in the UGS Hazus Utah fault database ([UGS Open-File Report 631](#)).

**Table 5.** Utah Quaternary Fault Parameters Working Group 2018 list of other priority faults or fault segments requiring further investigation to adequately characterize Utah's earthquake hazard to a minimally acceptable level.

| Fault or Fault Segment                                     | UQFPWG Priority <sup>1</sup> | Investigations  |             |
|--|------------------------------|---|-------------|
|  |                              | Status (as of 2/2017) <sup>2</sup>  | Institution |
| Paragonah fault <sup>3,4</sup>                             | 10 <sup>5</sup>              | No activity   | --          |
| Enoch graben <sup>4</sup>                                  | 11                           | Map: <a href="#">UGS Open-File Report 628</a>   | UGS         |
| Clarkston fault, West Cache fault zone <sup>3,4</sup>      | 13                           | <a href="#">UGS Special Study 98</a><br>Fault mapping proposal submitted, awaiting funding. | UGS         |
| Gunnison fault <sup>4</sup>                                | 17                           | No activity   | --          |
| Scipio Valley faults <sup>4</sup>                          | 18                           | No activity   | --          |
| Faults beneath Bear Lake                                   | 19                           | No activity   | --          |
| Eastern Bear Lake fault zone <sup>4</sup>                  | 20                           | No activity   | --          |
| Carrington fault, Great Salt Lake fault zone <sup>4</sup>  | 2007                         | No activity   | --          |
| Rozelle section, Great Salt Lake fault zone <sup>4,6</sup> | 2007                         | Janecke (2017)  | USU         |

<sup>1</sup> See table 1 for complete working group priority list.

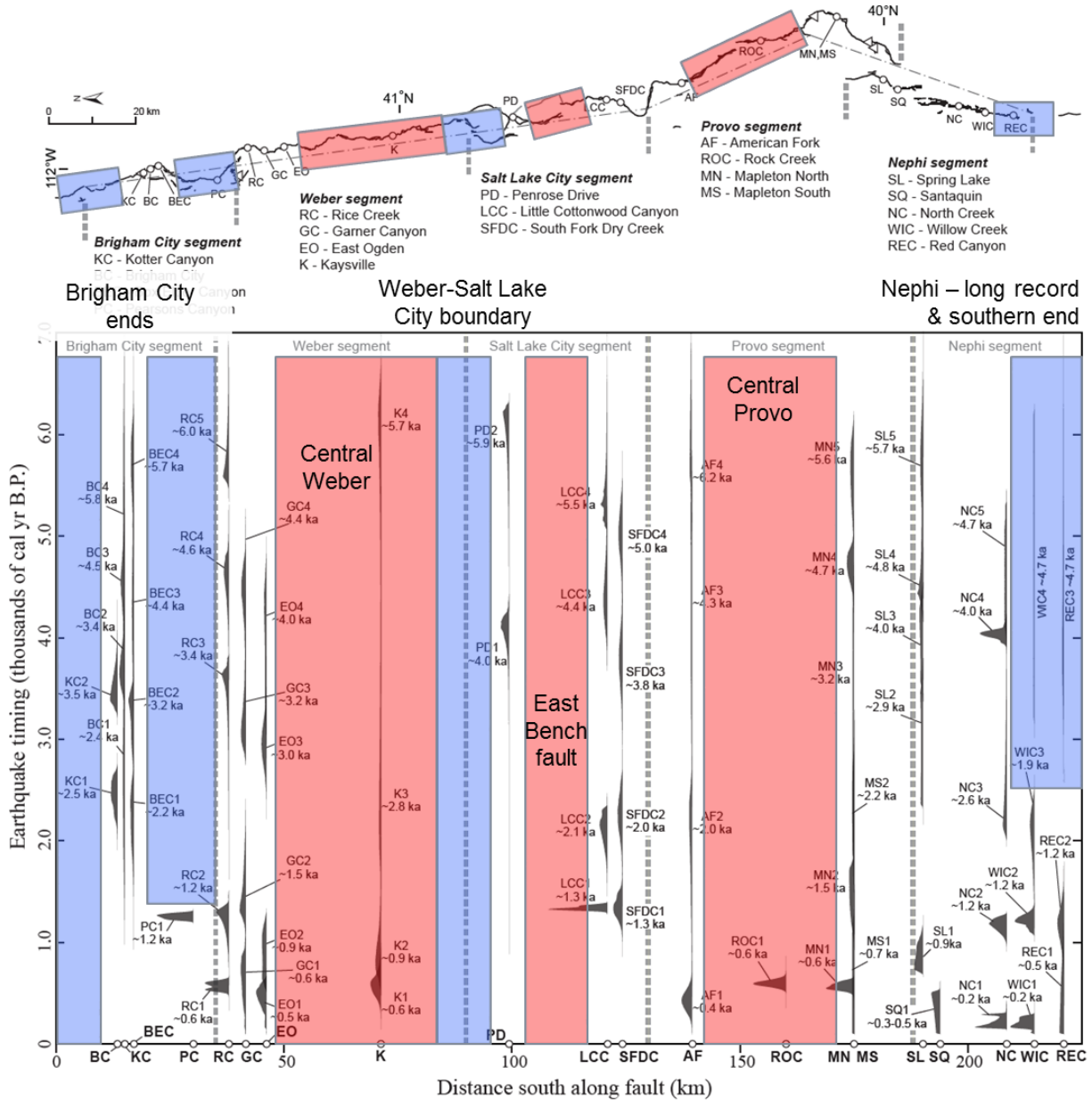
<sup>2</sup> Click on URL link to investigation report files available online.

<sup>3</sup> Earthquake source on the USGS National Seismic Hazard Maps.

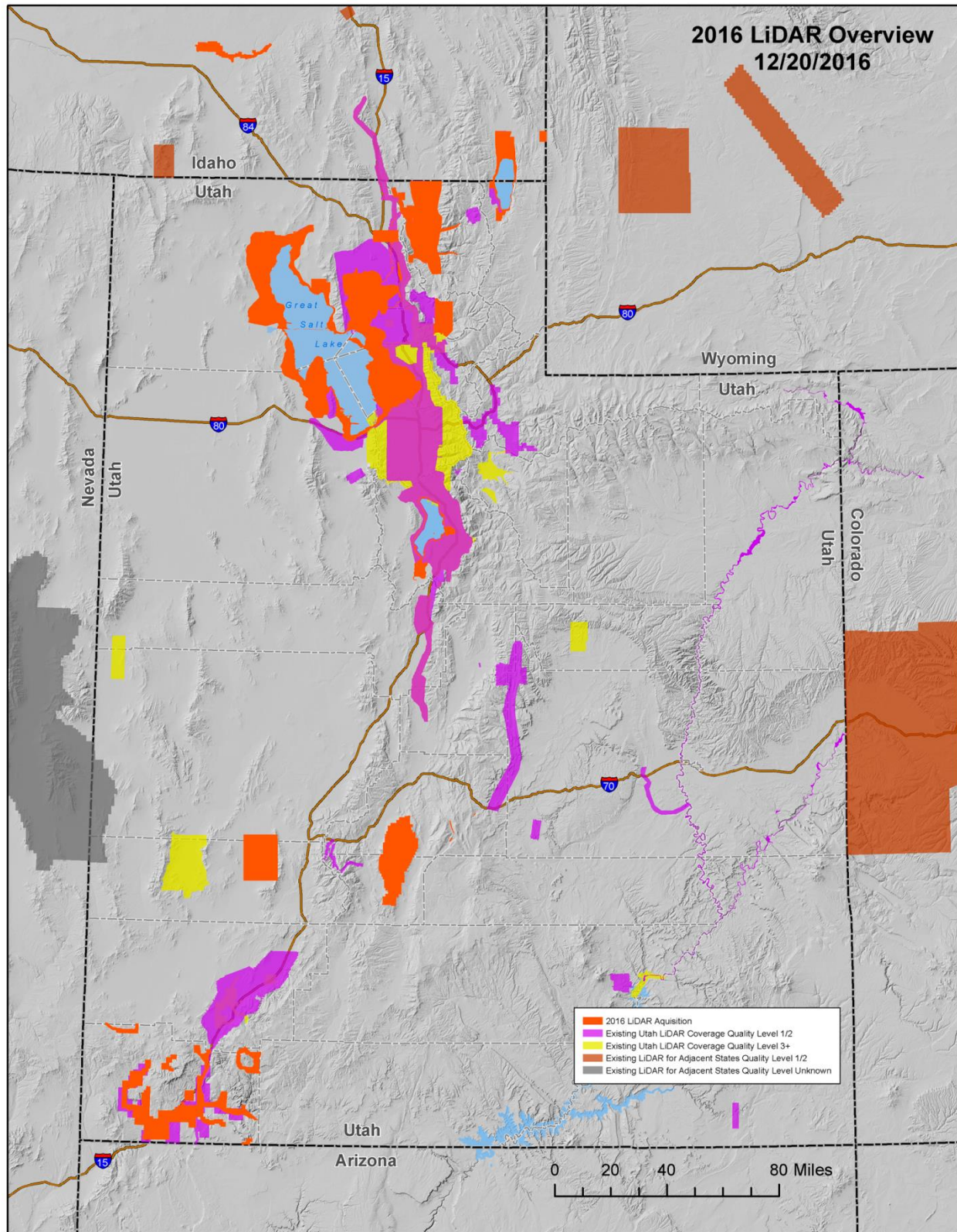
<sup>4</sup> Earthquake source listed in the UGS Hazus Utah fault database ([UGS Open-File Report 631](#)).

<sup>5</sup> The Cedar City-Parowan monocline was removed from Priority 10 in the 2016 meeting, based on new information from geologic mapping in the area ([UGS Map 270](#) and [2016 presentation file](#)).

<sup>6</sup> Previous highest priority fault or fault segment.



**Figure 3.** Recommended Wasatch fault zone future paleoseismic investigations by DuRoss (from 2016 UQFPWG presentation). Red shading denotes areas along faults where additional basic paleoseismic data is needed and blue shading denotes areas near and on segment boundaries where additional paleoseismic data is needed.



**Figure 4.** Map of lidar data availability in Utah and the surrounding area. Data acquired in 2016 (bright orange; to be publically available summer 2017), and data acquired prior to 2016 with USGS Quality Level (QL) 1 (0.5 m) or 2 (1 m) in purple and dark orange, QL 3 or greater ( $\geq 2$  m) in yellow, and unknown QL in dark gray.