

FINAL TECHNICAL REPORT

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**2020 UTAH EARTHQUAKE WORKING GROUPS AND UPDATE OF WORKING-  
GROUP-RELATED DATABASES**

Submitted by

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## **ABSTRACT**

The Utah Geological Survey (UGS) and the U.S. Geological Survey (USGS) continued collaborative earthquake-hazard investigations in Utah under a one-year cooperative agreement (G20AP00009, calendar year [CY] 2020) that builds on the highly successful framework of the Utah Earthquake Working Groups developed under previous cooperative agreements (03HQAG008, 07HQAG0003, G10AC00058, G13AS00001, G15AC00017, and G18AP00023), which extended from CY 2003 to CY 2018. The earthquake research working groups that met in 2020 consist of the Utah Quaternary Fault Parameters Working Group and the Basin and Range Province Earthquake Working Group. The CY 2020 cooperative agreement ensured that the annual Utah Earthquake Working Groups meetings were held to support the USGS in developing Wasatch Front urban seismic-hazard maps and updating the National Seismic Hazard Maps, updating various earthquake-related databases, reviewing and publishing investigation results, updating research priorities and long-term plans, and helping coordinate USGS External Research Support related research in Utah.

During 2020, the UGS also (1) performed several scientific investigations to map and characterize faults, (2) provided assistance to USGS and NEHRP researchers, (3) published reports of completed research, (4) continued earthquake-related public outreach, (5) enhanced our website with updates and/or new pages for the Paleoseismology of Utah publication series and geologic-hazard data, (6) continued updates to the Utah Quaternary Fault and Fold Database, and (7) provided data to the USGS for the 2023 update to the National Seismic Hazard Map (NSHM) of the United States.

## **INTRODUCTION**

The Utah Geological Survey (UGS) and the U.S. Geological Survey (USGS) continued collaborative earthquake-hazard investigations in Utah under a cooperative one-year agreement (G18AP00023, calendar year [CY] 2018) that builds on the efforts of previous cooperative agreements (03HQAG008, 07HQAG0003, G10AC00058, G13AS00001, G15AC00017, and G18AP00023), which extended from CY 2003 to CY 2018. The CY 2020 cooperative agreement ensured that the annual Utah Earthquake Working Groups meetings were held to support the USGS in developing Wasatch Front urban seismic-hazard maps and updating the National Seismic Hazard Maps; updating various earthquake-related databases, such as the Utah Quaternary Fault and Fold Database; reviewing and publishing investigation results; updating research priorities and long-term plans; and helping coordinate USGS External Research Support, National Earthquake Hazards Reduction Program (NEHRP) related research in Utah.

The UGS continued the progress made in earthquake research and engaging community partners in utilizing data and publications supported by the Utah Earthquake Working Groups (UEWG). The current groups consist of the Utah Quaternary Fault Parameters Working Group (UQFPWG), the Utah Ground Shaking Working Group (UGSWG), the Utah Liquefaction Advisory Group (ULAG), and the Basin and Range Province Earthquake Working Group (BRPEWG). Due to limited research funding available and work progress, the UGSWG and ULAG did not meet in 2020. A fifth group, the Working Group on Utah Earthquake Probabilities (WGUEP), is currently inactive due to the final publication of their report (Wong and others, 2016).

In our proposal, we had planned to hold the 2020 Basin and Range Earthquake Summit (BRES), the next iteration of the Basin and Range Province Seismic Hazard Summits (BRPSHS IV). However, we were not able to plan the meeting due to scheduling conflicts, as well as the COVID-19 pandemic, and allocated the funds to working with the USGS to compile data for the 2023 National Seismic Hazard Map

(NSHM). This effort ended up being significant, resulting in the number of Utah faults included as discrete earthquake sources increasing from 24 to 85, a 254% increase. These data reflect the continued work by the UGS to map and characterize active faults in Utah. BRES is being planned for early 2022, when we expect the COVID-19 pandemic to be largely under control.

## RESULTS

### Utah Earthquake Working Groups

The UGS, in cooperation with the USGS, convened the UEWG meetings in February 2020 at the Utah Department of Natural Resources Building in Salt Lake City, Utah. The UQFPWG met on Tuesday, February 4, 2020, to review research activities, reevaluate long-term plans for producing maps, and develop priorities and partnerships for future proposals. The BRPEWG met on Wednesday, February 5, 2020, to review research activities by different states, discuss ongoing issues faced by Basin and Range states, and develop priorities and partnerships for future proposals. Results of the working group meetings are reported in this Final Technical Report (including appendices 1 and 2) and on the UGS website (working group meeting agendas, summaries, and presentations) as described in the Data Availability section below.

The working groups have achieved consensus regarding the types of earthquake-hazard maps needed, new data required, and preferred data collection and mapping techniques. The working groups developed partnerships and identified projects to pursue for funding. These results have been used by the USGS to develop Utah priorities for the annual USGS External Research Support grant opportunity announcement for Intermountain West (IMW panel) projects (see <https://geology.utah.gov/hazards/earthquakes-faults/utah-earthquake-working-groups/>, Utah Priorities for the Annual USGS Earthquake Hazards Program External Research Support Announcement [NEHRP RFP] section).

Because the meetings were held in February, prior to the annual USGS grant opportunity release, discussions and momentum gained at the meetings were transferred to the opportunity release and subsequently translated into proposals by researchers to the USGS. The working groups have made great progress in stimulating earthquake-related research in Utah since 2003. The Western States Seismic Policy Council (WSSPC), in awarding the working groups four times (table 1), has recognized the progress and effectiveness of the Utah Earthquake Working Groups framework.

**Table 1.** *WSSPC Awards in Excellence to the Utah Earthquake Working Groups.*

| <b>Year</b> | <b>Working Group</b>   | <b>Award Category</b>                           |
|-------------|--|---|
| 2005        | Utah Quaternary Fault Parameters Working Group #1                | Research  |
| 2007        | Basin and Range Province Earthquake Working Group                | Research  |
| 2012        | Utah Earthquake Working Groups (as a whole)                      | Research  |
| 2016        | Basin and Range Province Seismic Hazards Summit III <sup>1</sup> | Educational Outreach to Business and Government |

<sup>1</sup> Funded separately from the USGS/UGS Utah Earthquake Working Groups Cooperative Agreements.

Working group members include geologists, engineers, seismologists, and geophysicists from the UGS, USGS, U.S. Bureau of Reclamation, University of Utah, Utah State University (USU), Brigham Young University (BYU), Utah Valley University (UVU), and various consulting companies and state and federal agencies. In addition, representatives from the Utah Seismic Safety Commission, Utah Division of Emergency Management (UDEM), American Society of Civil Engineers, Association of

Environmental and Engineering Geologists, Salt Lake County, Utah Division of Water Rights–Dam Safety Program, Utah Division of Water Resources, Utah Department of Transportation, Nevada Bureau of Mines and Geology, and other organizations were also invited to attend the meetings.

### **Utah Quaternary Fault Parameters Working Group**


The main goal of the UQFPWG is to characterize hazardous earthquake fault sources in Utah. The working group began by developing consensus slip-rate and recurrence-interval data for all Utah trenched faults (Lund, 2005). The working group also developed a priority list of faults requiring additional investigation. The list is updated annually based on each year’s paleoseismic investigations. The UQFPWG along with the UEWG have been instrumental in keeping earthquake research in Utah and the Intermountain West/Great Basin area at an elevated level of interest, in producing viable and successful investigations, reducing duplication of efforts, in developing consensus fault parameters and other data, and in disseminating results and best practices to other researchers, consultants, local governments, and other interested parties.

The following presentations were made on current paleoseismic research and related activities in Utah (presentations are available at: [http://geology.utah.gov/docs/pdf/2020\\_UQFPWG\\_presentations.pdf](http://geology.utah.gov/docs/pdf/2020_UQFPWG_presentations.pdf)).

- Update on Quaternary Fault Mapping in Utah: Adam Hiscock, Utah Geological Survey
- Paleoseismic Investigation of the Levan and Fayette Segments of the Wasatch Fault Zone, Utah: Greg McDonald, Utah Geological Survey
- East Cedar Valley Fault Zone—New Fault Strands and Younger Events: Adam McKean, Utah Geological Survey
- A Field Test of Portable OSL—Using 345 Samples from the Deep Creek Colluvial Wedge Exposure to Explore Earthquake-Timing Uncertainty: Chris DuRoss, U.S. Geological Survey
- Topliff Hill Paleoseismic Site—Six Events Since 69.3 ka on the Topliff Hills Fault: Nathan Toké, Utah Valley University

In the 2020 meeting, the UQFPWG also had a comprehensive update from the USGS on the IMW External Grants program, by Ryan Gold (previous IMW Regional Coordinator, current coordinator is Chris DuRoss), and on input needed from IMW states for the 2023 update of the NSHM’s by Alex Hatem (USGS Mendenhall Postdoctoral Fellow, now Research Geologist). The UQFPWG also had two discussion sessions on urban faults in Utah and the application of geologic hazard mapping in Utah.

On the evening of the UQFPWG meeting, a discussion panel was hosted by the UGS, the Utah Seismic Safety Commission (USSC), Reveley Engineers, the University of Utah College of Architecture and Planning, and the University of Utah Global Change and Sustainability Center, titled “Utah: Life of Elevated Earthquake Risk” (figure 1). Panelists included Bob Carey, Earthquake Program Manager at the Utah Division of Emergency Management; Dr. Lisa Grow Sun, Professor of Law at the J. Reuben Clark Law School at Brigham Young University; Barry Welliver, S.E., Principal Structural Engineer for BHW Engineers; and Ivan Wong, Senior Principal Seismologist at Lettis Consultants International. Mr. Wong had to cancel his trip to Utah at the last minute, so he was not able to participate on the panel.



Please join us for a community discussion:


## Utah: Life of Elevated Earthquake Risk

Tuesday, February 4, 2020  
 5:30 - 6:00 p - Social mixer with light refreshments  
 6:00 - 7:00 p - Panel discussion

Architecture Building, Bailey Gallery  
 University of Utah, Salt Lake City

Panelists:

|                   |  |
|-------------------|--|
| Bob Carey         | Earthquake Program Manager<br>Utah Department Emergency Management       |
| Lisa Grow Sun     | Professor of Law<br>J. Reuben Clark Law School, Brigham Young University |
| Barry H. Welliver | S.E.<br>Principal Structural Engineer<br>BHW Engineers                   |
| Ivan G. Wong, PG  | Senior Principal Seismologist<br>Lettis Consultants International        |



Free parking is available at the Central Garage, 4th floor from 5:30-7:00 pm  
 Campus at <https://map.utah.edu/>

Figure 1 – Flyer for the optional panel held the evening of the UQFPWG meeting.

The panel convened for a 30-minute social followed by an hour-long panel discussion. Dr. Divya Chandrasekhar is an Assistant Professor in the Department of City and Metropolitan Planning at the University of Utah with expertise in community recovery from disasters. She is a leader in the Utah Disaster Resilience initiative with the Center for Ecological Planning and Design within the Global Change and Sustainability Center at the University of Utah, as well as a commissioner on the USSC, and helped plan and facilitate this panel. Dr. Chandrasekar facilitated the social mixer by asking her students to hang posters in the hall where the panel discussion was held. There were about 30 people that attended the panel discussion. The panel was moderated by Emily Kleber, UGS Project Geologist and chair of the UQFPWG.

Some of the themes of questions posed to the panelists included:

- Regarding your work in seismic matters in your field: What are some successes you have had in your career? What have been the roadblocks?
- Are we creating building codes that match the hazard in Utah?
- To what extent is science/policy looking towards science?
- Could you describe a case where you think science has been successfully translated into policy in Utah?
- Could you describe a case where science has missed the mark being translated into policy? What were the reasons for its failure?
- What are the top two things the scientific communities could do to better influence policy?

### **Other Working Groups**

Due to limited research funding available and work progress, the Utah Ground Shaking Working Group (UGSWG) and the Utah Liquefaction Advisory Group (ULAG) did not meet in 2020. A fifth working group, the Working Group on Utah Earthquake Probabilities, was part of previous proposals and is currently inactive due to the final publication of their report (Wong and others, 2016).

### **Basin and Range Province Earthquake Working Group**

The UGS reactivated the BRPEWG in 2018 due to the need for effective communication and collaboration in applied earthquake-hazard research within Basin and Range Province (BRP) states. BRPEWG was previously convened in 2006 and 2011 in response to USGS *National Seismic Hazard Map* update issues, and in 2017 and 2018 to discuss cross-border fault and related issues and was hosted by the UGS. Since BRPEWG was reconvened in 2018, collaborative proposals have been submitted to address cross-border earthquake hazards, including collaborative efforts between Idaho and Utah to map cross-border fault systems near Bear Lake on the Utah-Idaho border, and between Arizona and Utah to map cross-border fault systems along the Arizona-Utah border.

For the 2020 meeting, one person from each BRP state (Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, and Wyoming, as noted in the detailed budget) was provided travel funding to attend the BRPEWG meeting in Salt Lake City, Utah, as part of the UEWG. In addition, invitations were extended to other organizations, such as the U.S. Bureau of Land Management, National Park Service, Natural Resources Conservation Service, U.S. Bureau of Reclamation, U.S. Department of Transportation (Federal Highway Administration, Pipeline and Hazardous Materials Safety Administration, etc.), and the U.S. Forest Service. The following is a list of presentations made at the 2020 BRPEWG meeting:

- USGS Earthquake Geology Intermountain West (IMW) Update: Ryan Gold, former USGS Intermountain West Coordinator
- State of Seismic Hazard Assessment, Arizona: Jeri J. Young, Arizona Geological Survey
- California Seismic Hazard Assessment and Zonation Program: Gordon Seitz, California Geological Survey
- Update and Issues Facing Earthquake Research in Colorado 2020: Jim McCalpin, GeoHaz Consulting
- Idaho Earthquakes and Seismic Hazard Activity: Zach Lifton, Idaho Geological Survey
- Montana Activities 2019: Mike Stickney, Montana Bureau of Mines and Geology
- Paleoseismic and Seismic Studies in New Mexico: Daniel Koning, New Mexico Bureau of Geology and Mineral Resources
- Earthquake Program at NBMG: Rich Koehler, Nevada Bureau of Mines and Geology
- Issues Facing Wyoming: Seth Wittke, Wyoming Geological Survey

- Basin and Range Province Earthquake Working Group—Utah Update: Emily Kleber, Utah Geological Survey
- Initial Paleoseismic Investigation of the Phillips Valley Fault, Teton County, Wyoming: Mark Zellman, BCG Engineering, Inc.

Based on a survey sent out in December 2019, the BRPEWG was interested in learning more about the scientific response to the 2019 Ridgecrest earthquake sequence and discussing implications for the Basin and Range Province. The July 2019 Ridgecrest earthquake sequence occurred near Ridgecrest, California, and the Searles Valley in the northern Mojave Desert. Several members of the BRPEWG were part of the scientific response to the earthquake sequence, mobilizing to collect perishable geologic field data. Gordon Seitz, Rich Koehler, and Ryan Gold led an hour-long discussion about the response. Other BRPEWG members who responded to the Ridgecrest earthquake sequence included Alex Hatem and Chris DuRoss.

The group discussed the possibility of having the BRPEWG meeting in other locations in the future. While everyone seemed in agreement that this was a good idea, some limiting factors to holding the meeting elsewhere are locating a venue and having an easy and affordable city to travel to. The group loosely agreed to continue meeting in Salt Lake City for the foreseeable future.

Cross-border faults in the Basin and Range Province that need improved mapping include (not a complete list of all cross-border faults):

- MT-ID: Hope fault, Lewis and Clark shear zone, Centennial fault
- ID-WY: Grand Valley fault (Prater Mountain Section)
- NV-ID: O’Neil Basin fault zone, faults near Owyhee (unnamed)
- UT-WY: Hogsback faults, Porcupine Mountain faults, Crawford Mountains (west side) faults, and Saleratus Creek fault
- UT-AZ: Bright Angel fault system
- UT-NV: Lime Mountain fault, Snake Valley faults
- UT-ID: Grouse Creek, Dove Creek Mountains faults, and Raft River Mountains fault

## **Database Updates**

### **Utah Geologic Hazards Portal and Utah Quaternary Fault and Fold Database**

The *Utah Geologic Hazards Portal* is a compilation of data from the Utah Geologic Hazards Database, including the *Utah Quaternary Fault and Fold Database*. The portal debuted in 2020 and contains post-2008 UGS geologic-hazard map data and data from other sources for parts of Utah. These data appear as layers in the portal and address earthquake, flood, landslide, and problem soil and rock hazards. This application is intended to provide planners, local government officials, property owners, developers, engineers, geologists, design professionals, and the public with information on the type, location, and relative susceptibility of geologic hazards that may impact existing and future infrastructure and development. The data also provide information that may be used for emergency response and recovery planning and community risk assessment for existing development and infrastructure.

The UGS used funds from this grant to update the *Utah Quaternary Fault and Fold Database* with new fault mapping, fault special study zones, and paleoseismic information up to the year 2020. The *Utah Quaternary Fault and Fold Database* is also distributed as a GIS database (<https://gis.utah.gov/data/geoscience/quaternary-faults/>). This GIS database allows for easy access to the fault data for the public, professionals, and researchers.



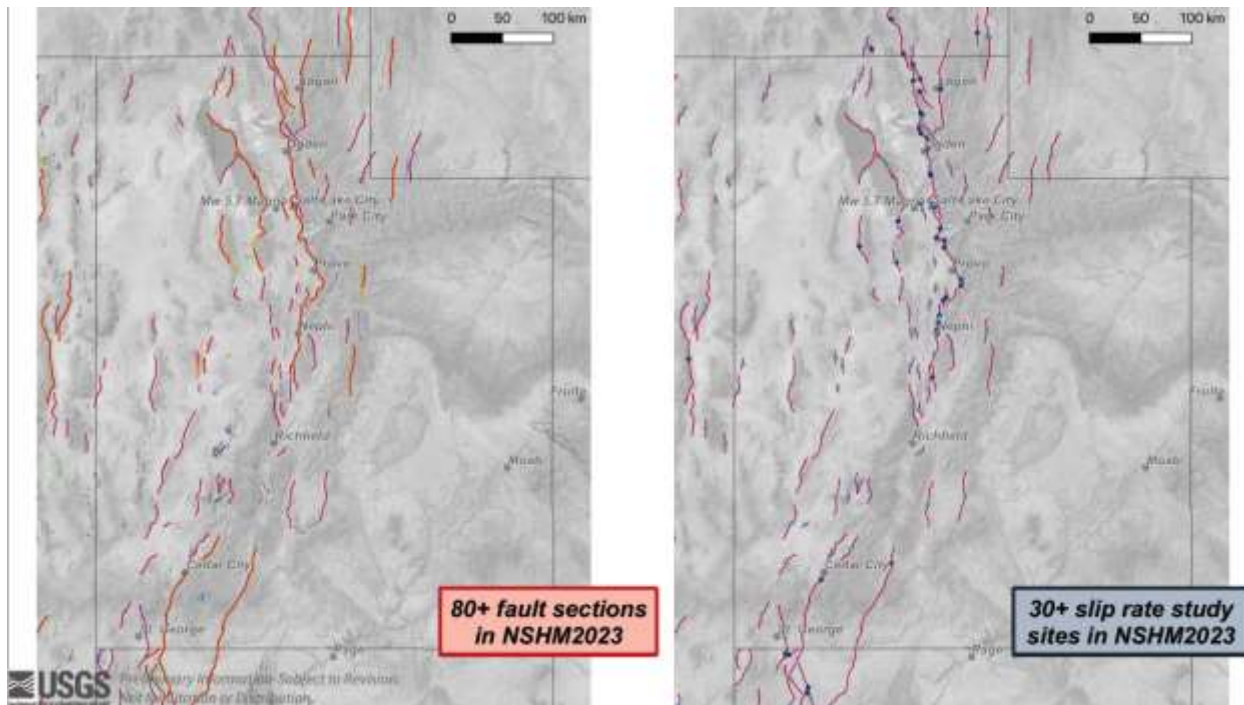
## Utah Geochronology Database

The *Utah Geochronology Database* (<https://geology.utah.gov/apps/geochron> and <https://gis.utah.gov/data/geoscience/geochronology/>) contains ages and related dating information of sampled geologic materials (soil and rock) using argon ( $^{40}\text{Ar}/^{39}\text{Ar}$ ), tephrochronology, fission track, cosmogenic, luminescence (TL, IRSL, and OSL), tritium, radiocarbon ( $^{14}\text{C}$ ), rubidium-strontium ( $^{87}\text{Rb}/^{87}\text{Sr}$ ), or uranium-thorium-lead ( $^{238}\text{U}$ - $^{235}\text{U}/^{206}\text{Pb}$ - $^{207}\text{Pb}$ ) dating methods and were analyzed for a variety of geologic-related projects by the Utah Geological Survey (UGS), U.S. Geological Survey (USGS; incorporates Utah data from the National Geochronology Database) and others. The UGS is continually compiling all our remaining geochronology data (paleoseismic, geologic mapping, and groundwater projects) for inclusion in the database. The database currently contains a significant amount of data from UGS paleoseismic projects, the Utah portion of the legacy USGS *National Geochronological Database*, and Dr. Jack Oviatt's Lake Bonneville related data. Future updates will include data from Utah State University (USU) and the USU Luminescence Laboratory.

## 2023 National Seismic Hazard Map Updates

In 2023, the USGS plans to release an update to the National Seismic Hazard Map (NSHM) for the conterminous United States. As part of the update process for the USGS NSHM in 2023, the USGS revisited the quality and quantity of active faults represented in the source parameters database, including Utah. The IMW has 75% of all faults shown in the USGS *Quaternary Fault and Fold Database of the United States*. There is a huge importance to updating any pertinent geologic data and fault geometry information for IMW faults.

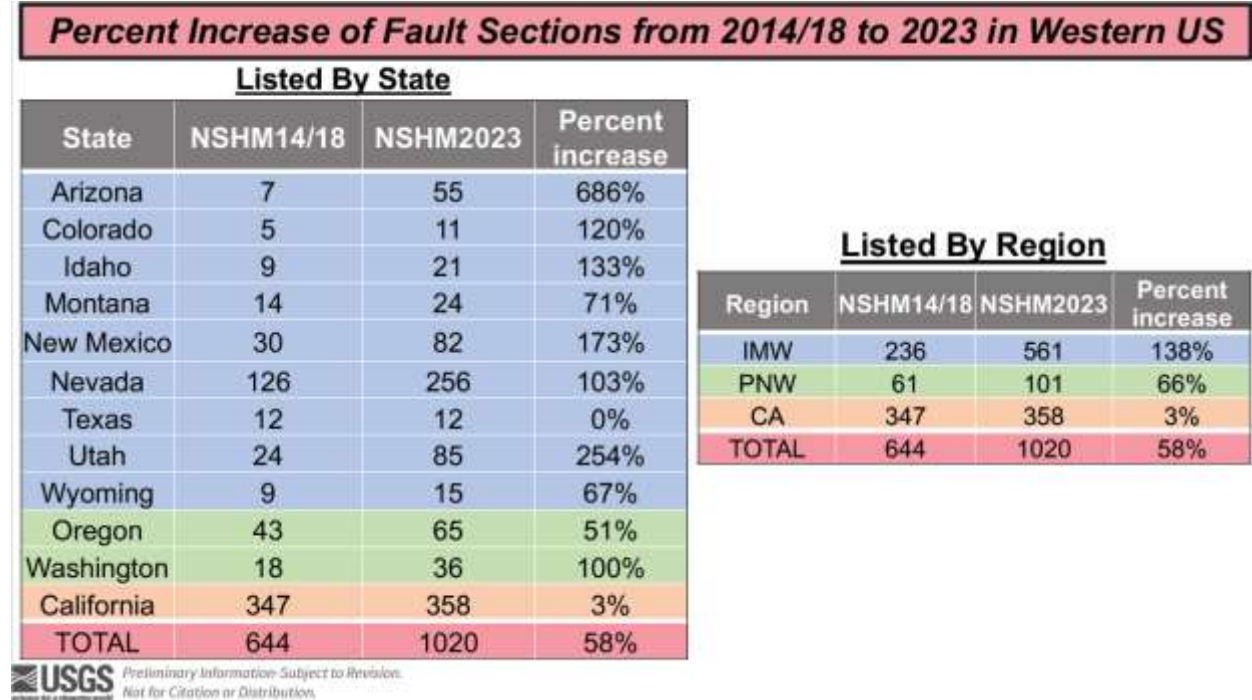
In 2020, the USGS worked on compiling a database of modeled faults they called "HazFaults," which is distinct from the more complex surface traces depicted in the *Quaternary Fault and Fold Database of the United States*, or "QFaults". As part of this effort, the USGS asked the UGS, as well as other IMW states to help compile a database of geologic data (i.e., slip rates, paleoearthquake chronologies, and slip per event estimates) of source faults for use in the 2023 update as well as future iterations of the NSHM. The last large-scale data compilation effort for the geologic data of faults for the NSHM happened over 20 years ago. This effort is critical for consistency within the NSHM, not only for the IMW, but across the conterminous U.S.



*Figure 2 – Map of Utah showing HazFaults data for the 2023 NSHM update. (Left) Red lines indicate faults from the 2014 NSHM model and the purple lines indicate additional fault geometries added to HazFaults for the 2023 update. (Right) Purple lines indicate fault geometries for the 2023 NSHM update, and blue dots indicate slip-rate study sites. Figure used with permission from Alex Hatem, USGS.*

In the spring and summer of 2020, the UGS worked with the USGS to compile and comment on geologic data and fault geometries for the Hazfaults database. In the fall of 2020, the USGS hosted an IMW workshop to go over the results of their data compilation and address any regional concerns. The number and footprint of faults in Utah added to the HazFaults database increased significantly since the last NSHM update (figure 2, table 2). In Utah, the number of faults for consideration in the NSHM increased from 24 to 85, a 254% increase. This data reflects the continued work by the UGS to map and characterize active faults in Utah. The USGS submitted their database of geologic data and fault geometries to the NSHM efforts at the end of CY 2020. The full data release was published in early 2021 (Hatem and others, 2021).

Table 2 – Tables summarizing the percent increase in fault sections from the 2014/2018 NSHM update to the fault sections submitted for the 2023 NSHM update. (Left) The number of fault sections for the NSHM 2014/2018 update by state. (Right) Fault sections increase by region including the Intermountain West (IMW), Pacific Northwest (PNM), and California (CA). Figure used with permission from Alex Hatem, USGS.



## REPORTS PUBLISHED

In 2020, the UGS published and updated several reports that used NEHRP funds including:

- Fault Trace Mapping and Surface-Fault-Rupture Special Study Zone Delineation of the Wasatch Fault Zone, Utah and Idaho (McDonald and others, 2020)
- Guidelines for investigating geologic hazards and preparing engineering-geology reports, with a suggested approach to geologic-hazard ordinances in Utah, second edition (Bowman and Lund, 2020)
- Geologic hazards of the Bullfrog and Wahweap high-use areas of the Glen Canyon National Recreation Area, San Juan, Kane, and Garfield Counties, Utah, and Coconino County, Arizona (Knudsen and others, 2020)
- Detailed mapping of the East and West Cache fault zones, Utah — Using new high-resolution lidar data to reduce earthquake risk (Hiscock and others, 2020)

## DATA AVAILABILITY

We have posted the results of the 2020 UEWG meetings on the UGS website at <https://geology.utah.gov/hazards/earthquakes-faults/utah-earthquake-working-groups/>. These include agendas, meeting summaries, and meeting presentations. Individual web pages for each UEWG, including meeting agendas, summaries, and presentations, are available at:

- Utah Quaternary Fault Parameters Working Group (UQFPWG)  
<https://geology.utah.gov/hazards/info/workshops/working-groups/q-faults/>
- Basin and Range Province Earthquake Working Group (BRPEWG)  
<https://geology.utah.gov/hazards/info/workshops/working-groups/basin-and-range-earthquakes/>

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## APPENDIX 1 – UTAH EARTHQUAKE WORKING GROUP MEETING AGENDAS



### 2020 UTAH EARTHQUAKE WORKING GROUP MEETINGS UTAH QUATERNARY FAULT PARAMETERS WORKING GROUP AGENDA

Tuesday, February 4, 2020


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

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- 8:00 Refreshments
- 8:30 Welcome, Overview of Meeting, and Review of Last Year's Activities: Emily Kleber, Utah Geological Survey
- 8:45 Technical Presentations of Work Completed or In Progress
- 8:45 Update on Quaternary Fault Mapping in Utah: Adam Hiscock, Utah Geological Survey
- 9:00 Preliminary Results of Topliff Hill Paleoseismic Site: Nathan Toke, Utah Valley University
- 9:15 East Cedar Valley Fault Zone, New Fault Strands and Younger Events: Adam McKean, Utah Geological Survey
- 9:30 A Field Test of Portable OSL—Using 345 Samples from the Deep Creek Colluvial-Wedge Exposure to Explore Earthquake-Timing Uncertainty: Chris DuRoss, USGS Geologic Hazards Science Center
- 9:45 Paleoseismic Investigation of the Levan and Fayette Segments of the Wasatch Fault Zone, Utah: Greg McDonald, Utah Geological Survey
- 10:00 Break (30 minutes)
- 10:30 Update on the U.S. Geological Survey (USGS) External Grants Program and Topics Across the Intermountain West Region: Ryan Gold, USGS Geologic Hazards Science Center
- 10:45 Collating Geologic Data for Updates to the National Seismic Hazard Map: Alex Hatem, USGS Geologic Hazards Science Center
- 11:00 Group Discussion – Urban Faults in Utah
- Earthquake Hazard of Seismically Imaged Urban Faults in Utah
  - Special Study Zones
- 12:00 Lunch (1 hour, register at <https://2020uewg.eventbrite.com> for on-site hot lunch)
- 1:00 Group Discussion – Application of Geologic Hazard Mapping in Utah
- Existing Local Government Ordinances
  - Model Hazard Ordinances
- 1:15 Discussion – Working Group 2021 Fault Investigation Priorities

- 2:15 Break (15 minutes)
- 2:30 Discussion – Working Group 2021 Fault Investigation Priorities
- 3:00 Adjourn

Optional Special Evening Event – Free and Open to the Public.



Please join us for a community discussion:






## Utah: Life of Elevated Earthquake Risk

Tuesday, February 4, 2020  
 5:30 - 6:00 p - Social mixer with light refreshments  
 6:00 - 7:00 p - Panel discussion

Architecture Building, Bailey Gallery  
 University of Utah, Salt Lake City

Panelists:

|                        |  |
|------------------------|--|
| Bob Carey              | Earthquake Program Manager<br>Utah Department Emergency Management       |
| Lisa Grow Sun          | Professor of Law<br>J. Reuben Clark Law School, Brigham Young University |
| Barry H. Welliver S.E. | Principal Structural Engineer<br>BHW Engineers                           |
| Ivan G. Wong, PG       | Senior Principal Seismologist<br>Lettis Consultants International        |

Free parking is available at the Central Garage, 4th floor from 5:30-7:00 pm  
 Campus at <https://map.utah.edu/>

### Working Group Members

|                 |  |
|-----------------|--|
| Steve Bowman    | Utah Geological Survey   |
| 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, IW Coordinator |
| Adam Hiscock    | Utah Geological Survey (UQFPWG UGS Liaison)                        |
| Michael Hylland | Utah Geological Survey   |
| Susanne Janecke | Utah State University  |
| Emily Kleber    | Utah Geological Survey (UQFPWG Chair)                              |
| William Lund    | Utah Geological Survey, Emeritus                                   |
| Johnny MacLean  | Southern Utah University   |
| Greg McDonald   | Utah Geological Survey   |
| Jim Pechmann    | University of Utah Seismograph Stations                            |
| Mark Petersen   | U.S. Geological Survey, National Seismic Hazard Maps Liaison       |
| Joanna Redwine  | U.S. Bureau of Reclamation   |
| Nathan Toke     | Utah Valley University   |
| Ivan Wong       | Lettis Consultants International                                   |
| Adolph Yonkee   | Weber State University   |





**2020 UTAH EARTHQUAKE WORKING GROUP MEETINGS  
BASIN AND RANGE PROVINCE EARTHQUAKE WORKING GROUP  
AGENDA**

**Wednesday, February 5, 2020**

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

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- 8:00 Refreshments
- 8:30 Welcome and Overview of Meeting: Emily Kleber, Utah Geological Survey
- 8:45 Update on the U.S. Geological Survey (USGS) External Grants Program and Topics Across the Intermountain West Region: Ryan Gold, USGS Geologic Hazards Science Center

State Presentations on Technical Issues Facing the Basin and Range Province (15 minutes each)

- 9:00 Arizona – Jeri J. Young, Arizona Geological Survey
- 9:15 California – Gordon Seitz, California Geological Survey
- 9:30 Colorado – James McCalpin, GeoHaz Consulting
- 9:45 Break (30 minutes)
- 10:15 Idaho – Zach Lifton, Idaho Geological Survey
- 10:30 Montana – Mike Stickney, Montana Bureau of Mines and Geology
- 10:45 New Mexico – Daniel Koning, New Mexico Bureau of Geology and Mineral Resources
- 11:00 Nevada – Rich Koehler, Nevada Bureau of Mines and Geology
- 11:15 Wyoming – Seth Wittke, Wyoming Geological Survey
- 11:30 Utah – Emily Kleber, Utah Geological Survey
- 11:45 Upcoming Events in the IMW – Group Discussion
- 12:00 Working Lunch - register at <https://2020uewg.eventbrite.com> for on-site hot lunch).  
Short presentation focused on the scientific side of the Ridgecrest earthquake sequence, to prepare for the afternoon discussion – Gordon Seitz, California Geological Survey and others

Technical Presentations and Discussion

- 1:00 Fault Databases and Hazard Estimates – Ivan Wong, Lettis Consultants International, Inc.
- 1:15 Initial Paleoseismic Investigation of the Phillips Valley Fault – Mark Zellman, BGC Engineering Inc.

- 1:30 Source Fault Model Update for USGS 2023 National Seismic Hazard Model – Alex Hatem & Ryan Gold, USGS Geologic Hazards Science Center
- Overview of update process, which consists of three primary tasks: 1) create UCERF3-style database with separate fault and geologic site databases, 2) identify new data – external input needed, and 3) update fault network to better represent potential fault connectivity.
  - Timeline: New data submissions requested by May 29, 2020.
  - Discussion
- 2:30 Break (30 minutes)
- 3:00 Group Discussion – Ridgecrest Earthquake Response  
Panel: Gordon Seitz, California Geological Survey; Rich Koehler, UNR/NBMG; Chris DuRoss, USGS
- 4:00 Discussion – Basin and Range Province Earthquake Hazards Issues and Investigation Priorities
- Quaternary fault databases and cross-border Quaternary fault issues.
  - Coordination and funding opportunities for collaborative work on cross-border faults, lidar data collection, paleoseismic trenching, etc.
  - Input and planning for the February 1 – 5, 2021 Basin and Range Earthquake Summit (BRPSHSIV)
- 5:00 Adjourn

### Working Group Members

|                |   |
|----------------|---|
| Steve Bowman   | Utah Geological Survey  |
| Chris DuRoss   | U.S. Geological Survey, Earthquake Hazards Program                                    |
| Ryan Gold      | U.S. Geological Survey, Earthquake Hazards Program, Intermountain West<br>Coordinator |
| Alex Hatem     | U.S. Geological Survey, Earthquake Hazards Program                                    |
| Adam Hiscock   | Utah Geological Survey (BRPEWG UGS Liaison)   |
| Emily Kleber   | Utah Geological Survey (BRPEWG Chair)   |
| Dan Koning     | New Mexico Bureau of Geology and Mineral Resources                                    |
| Rich Koehler   | Nevada Bureau of Mines and Geology  |
| Zach Lifton    | Idaho Geological Survey   |
| William Lund   | Utah Geological Survey, Emeritus  |
| James McCalpin | Geohaz Consulting, Inc.   |
| Matt Morgan    | Colorado Geological Survey  |
| Gordon Seitz   | California Geological Survey  |
| Mike Stickney  | Montana Bureau of Mines and Geology   |
| Seth Wittke    | Wyoming Geological Survey   |
| Jeri J. Young  | Arizona Geological Survey   |

## APPENDIX 2 – UTAH EARTHQUAKE WORKING GROUP MEETING SUMMARIES



### 2020 UTAH EARTHQUAKE WORKING GROUP MEETINGS UTAH QUATERNARY FAULT PARAMETERS WORKING GROUP SUMMARY

Tuesday, February 4, 2020

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

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#### WELCOME AND INTRODUCTION

Emily Kleber (Utah Geological Survey [UGS]) called the 2020 Utah Quaternary Fault Parameters Working Group (UQFPWG) meeting to order at 8:30 a.m. After welcoming Working Group members and guests and allowing time for introductions, she summarized the UQFPWG's past activities and outlined the Working Group's purpose and goals for the future.

#### UQFPWG Purpose and Goals

- Serves as one of two 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.
- Identifies and prioritizes future Utah Quaternary fault paleoseismic investigations.

#### TECHNICAL PRESENTATIONS

The following presentations were made on current paleoseismic research and related activities in Utah (presentations are available at:

[http://geology.utah.gov/docs/pdf/2020\\_UQFPWG\\_presentations.pdf](http://geology.utah.gov/docs/pdf/2020_UQFPWG_presentations.pdf)).

- Update on Quaternary Fault Mapping in Utah: Adam Hiscock, Utah Geological Survey
- Paleoseismic Investigation of the Levan and Fayette Segments of the Wasatch Fault Zone, Utah: Greg McDonald, Utah Geological Survey
- East Cedar Valley Fault Zone— New Fault Strands and Younger Events: Adam McKean, Utah Geological Survey
- A Field Test of Portable OSL— Using 345 Samples from the Deep Creek Colluvial Wedge Exposure to Explore Earthquake-Timing Uncertainty: Chris DuRoss, U.S. Geological Survey
- Topliff Hill Paleoseismic Site— Six Events Since 69.3 ka on the Topliff Hills Fault: Nathan Toké, Utah Valley University

## **U.S. Geological Survey Update and National Seismic Hazard Map Effort**

Ryan Gold, Intermountain West (IMW) Coordinator for the U.S. Geological Survey (USGS) Earthquake Hazards Program, gave a summary of ongoing collaborations of earthquake geology investigations in IMW states, including Utah. In 2023, the USGS plans to update the National Seismic Hazard Model (NSHM), which will require input from the intermountain states. Ryan gave funding updates for the fiscal years 2019 and 2020 Earthquake Hazards Reduction Program from the USGS External Grants Program, budget projections for 2021, and general advice.

Alex Hatem, USGS Mendenhall Postdoctoral fellow at the USGS Earthquake Hazards Program, presented more details about the effort to incorporate additional geologic data into the 2023 update of the NSHM. She presented information about the timeline for data submissions and discussed some areas of improvement in Utah for the NSHM.

### **GROUP DISCUSSION ITEMS**

Emily Kleber led a discussion addressing issues or topics of interest that were brought up throughout the morning and afternoon sessions. Prior to the meeting, working group members were polled about some of the topics that they would be interested in discussing as the working group. These topics included: fault special-study zones, seismic hazard of buried urban faults, and city ordinances related to faults. The poll results showed participants were the most interested in discussing all three.

The special-study zone discussion was led by Emily Kleber and Adam McKean. The conversation started with Adam McKean giving a brief presentation about the usefulness of being well connected with geotechnical consultants. When possible, some consultants provide reports and invitations for site visits during sub-surface investigations. These site visits are invaluable to Adam's geologic mapping of Quaternary units in urban areas. The conversation then moved to asking the consultants about their process using the special-study zones. Consultants in the room use fault special-study-zone maps generated by the city and county first, then look to other sources. They seemed to be interested in using the UGS-generated special-study zones that will soon be available for the Wasatch and West Valley fault zones through the UGS Geologic Hazards Portal.

New fault mapping and special-study zones are nearing publication by the UGS, so the conversation turned to how the information will be disseminated, and what stakeholders to get in touch with following the publication. Darlene Batatian recommended the Utah League of Cities and Towns as a good place to start networking with local officials. The group also discussed having a workshop for local officials and/or geotechnical companies to discuss special-study zones.

The discussion then moved to seismically imaged faults. This discussion was rather short because two key scientists contributing scientific work to this area, Lee Liberty of Boise State and Ivan Wong of Lettis Consultants International, were not able to attend the 2020 meeting. The group discussed the possibility of having a confidence threshold for geophysical faults and issues surrounding connecting geophysical faults with little geologic evidence.

### **UQFPWG 2021 FAULT INVESTIGATION PRIORITIES**

The Working Group's list of highest priority fault investigations for 2021 includes (not in priority order) (table 1):

- Acquire new paleoseismic information for areas with ongoing lidar fault mapping projects:
  - Cache Valley faults— East Cache fault zone and West Cache fault zone
  - Five central segments of the Wasatch fault zone
  - West Valley fault zone
  - Oquirrh fault zone
  - Sevier fault
  
- “Salvage paleoseismology” (i.e., earthquake timing investigations as rapid development is encroaching on un-modified paleoseismic trenching sites):
  - Faults in Cache Valley
  - West Valley fault zone
  
- Use recently acquired lidar data to more accurately map the traces of the:
  - Scipio Valley faults
  - Beaver Basin faults (partial coverage)
  - Hansel Valley
  - Mineral Mountains West-side faults
  - Stansbury fault zone

This does not include other priorities that have carried over from previous years. Those are identified in table 2.

## **WORKING GROUP PRODUCTS AND RELATED DATA**

The final agenda, speaker presentations, and this summary document are available on the UQFPWG web page at <https://geology.utah.gov/hazards/earthquakes-faults/utah-earthquake-working-groups/quaternaly-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 <https://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 ([https://ugspub.nr.utah.gov/publications/misc\\_pubs/mp-13-3/mp13-03.pdf](https://ugspub.nr.utah.gov/publications/misc_pubs/mp-13-3/mp13-03.pdf)).

### **Utah Quaternary Fault and Fold Database**

The UGS updated the *Utah Quaternary Fault and Fold Database* in May 2019, incorporating new mapping and fault attributes. Ongoing updates are being reviewed by the UGS for Quaternary faults mapped in peer-reviewed publications from 2013 to 2019. 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 (<https://gis.utah.gov/data/geoscience/quaternaly-faults/>). This single, comprehensive feature class will be periodically updated as new or updated data become available and replaces the six previously available feature classes of variable completeness. A web mapping application for the database is available at <https://geology.utah.gov/resources/data-databases/qfaults/>.

### **Utah Lidar Elevation Data Availability**

A significant coverage of high-resolution ( $\leq 1$  meter) lidar elevation data in the state of Utah is now available totaling over 44,896 square miles (mi<sup>2</sup>) from AGRC (<https://gis.utah.gov/data/elevation->

[terrain-data/](#)) and OpenTopography (<http://opentopography.org>). UGS and AGRC led partnerships of multiple, diverse local, state, and federal agencies, and non-governmental organizations have been instrumental in acquiring new, high-quality public domain lidar data. Figure 1 shows the existing and planned lidar data available in Utah. The UGS is currently using lidar data to map fault traces of the East and West Cache fault zones (USGS G17AP00071, report due June 2020), the East and West Bear Lake, Oquirrh, and Topliff Hills fault zones (USGS G19AP00072, report due September 2020), and the Sevier, Washington, and Hurricane Faults in southern Utah (G20AP00008, report due March 2021). This mapping is being completed at a scale of 1:10,000, where possible, or 1:24,000, where the ground surface has been significantly disturbed by urbanization and other activities. The mapping is used to define special-study zones around fault traces, where paleoseismic investigations are highly recommended by the UGS for new development (see Lund and others, 2016, *Guidelines for Evaluating Surface-Fault-Rupture Hazards in Utah*, UGS Circular 122, pages 33 to 58, <https://ugspub.nr.utah.gov/publications/circular/c-122.pdf>).

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

|                 |  |
|-----------------|--|
| Steve Bowman    | Utah Geological Survey   |
| Michael Bunds   | Utah Valley University   |
| Chris DuRoss*   | U.S. Geological Survey, Earthquake Hazards Program                 |
| Ryan Gold*      | U.S. Geological Survey, Earthquake Hazards Program, IW Coordinator |
| Adam Hiscock*   | Utah Geological Survey (UQFPWG UGS Liaison)                        |
| Michael Hylland | Utah Geological Survey   |
| Emily Kleber    | Utah Geological Survey (UQFPWG Chair)                              |
| William Lund    | Utah Geological Survey, Emeritus                                   |
| Greg McDonald*  | Utah Geological Survey   |
| Jim McCalpin    | Geo-Haz Consulting   |
| Jim Pechmann    | University of Utah Seismograph Stations                            |

**Guests (\* Speaker)**

|                  |   |
|------------------|---|
| Zack Anderson    | Utah Geological Survey  |
| Darlene Batatian | Terracon Consultants, Inc.                                      |
| Jack Bloom       | Retired   |
| Camille Collette | U.S. Geological Survey  |
| Jordan Culp      | Gordon Geotechnical Engineering                                 |
| Gordon Douglass  | Utah Geological Survey  |
| Patrick Emery    | Gordon Geotechnical Engineering                                 |
| Rich Giraud      | Utah Geological Survey  |
| Alex Hatem*      | U.S. Geological Survey  |
| Julia Howe       | U.S. Bureau of Reclamation                                      |
| Bill Keach       | Utah Geological Survey  |
| Rich Koehler     | Nevada Bureau of Mines and Geology / University of Nevada, Reno |
| Zach Lifton      | Idaho Geological Survey   |
| James Mauch      | Wyoming Geological Survey                                       |
| Adam McKean*     | Utah Geological Survey  |
| Matthew Morriss  | Utah Geological Survey  |
| Gordon Seitz     | California Geological Survey                                    |
| Mike Stickney    | Montana Bureau of Mines and Geology                             |
| Grant Willis     | Utah Geological Survey  |
| Seth Wittke      | Wyoming Geological Survey                                       |



### **History of the Utah Quaternary Fault Parameters Working Group Since 2005**

The main goal of the UQFPWG is to characterize hazardous earthquake fault sources in Utah. The working group began in 2003 by developing consensus slip-rate (SR) and recurrence-interval (RI) data for all Utah trenched faults, based on a comprehensive evaluation of paleoseismic-trenching data available at that time for Utah's Quaternary faults, and where the data permitted, assigned consensus preferred RI and vertical SR estimates for the faults and/or fault sections reviewed. Trenching data were available for 33 of Utah's known 211 Quaternary faults/fault sections and related structures.

In 2005, the UQFPWG developed a list of Quaternary faults and fault segments (Lund, 2005, table 2; figure 2) that the working group identified as requiring additional investigation to adequately characterize Utah's earthquake hazard to a minimally acceptable level. 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, 2018, 2019, and 2020. Table 1 lists the faults and fault segments (earthquake sources) incorporated in the USGS National Seismic Hazard Maps, and/or the UGS Hazus Utah fault database (updated through 2013, UGS Open-File Report 631). Faults not listed may need additional investigation.



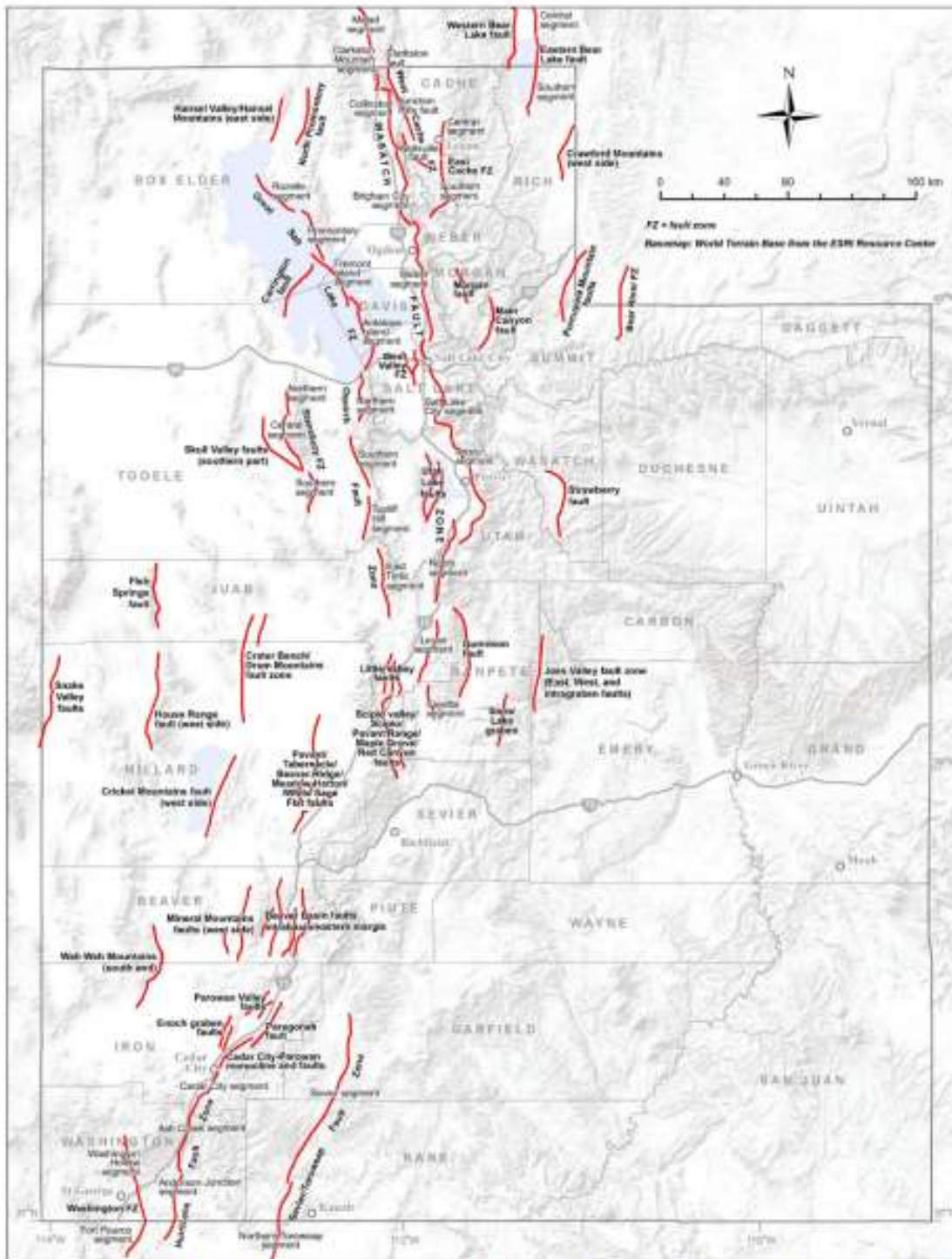


Figure 2. Faults included in the UGS Hazus Utah fault database, except the Cedar City-Parowan monocline and faults were removed in 2016 (see table 1; database updated through 2013, [UGS Open-File Report 631](#)).

**Table 1.** 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](#)). These faults may warrant additional investigation.

| Utah Fault or Fault Segments  | 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        |
| 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 Mountains (south end)   | --          | Yes        |
| West Cache fault, Wellsville section                                | Yes         | Yes        |
| Western Bear Lake fault   | --          | Yes        |

**Table 2.** Status of proposed and published paleoseismic-related investigations based on priorities developed by the UOPFWG since 2005. If there are any missing publications, please send the reference to [ekleber@utah.gov](mailto:ekleber@utah.gov).

| Study Type        | Utah Fault or Fault Segment       | UOPFWG Priorities |              | Investigation Status<br>(as of 3/2020)  |
|-------------------|-----------------------------------|-------------------|--------------|---|
|                   |                                   | 2005              | Additions    |   |
| Earthquake Timing | Nephi segment, Wasatch fault zone | 1                 | 2012<br>2017 | <a href="#">UGS FTR Report, 05HOCR0098 (2005)</a><br><a href="#">USGS SI Map 2966 (2007)</a><br><a href="#">UGS Special Study 124 (2008)</a><br><a href="#">UGS FTR Report, G12AP00076 (2014)</a><br><a href="#">UGS Special Study 151 (2014)</a><br><a href="#">UGS Special Study 159 (2017)</a><br><a href="#">UGS FTR, G17AP00001 (2018)</a> |
|                   |                                   | 2                 | 2017         | <a href="#">UGS Special Study 149 (2014)</a>  |
|                   |                                   |                   | 2011<br>2017 | <a href="#">UGS FTR, G15AP00117 (2017)</a>  |
|                   |                                   | 3<br>4            | 2012<br>2017 | <a href="#">UGS Miscellaneous Publication 05-8 (2006)</a><br><a href="#">UGS FTR, 07HOCR0093 (2007)</a><br><a href="#">UGS Special Study 130 (2009)</a>   |
|                   |                                   | 5                 | 2015<br>2017 | <a href="#">U/UGG FTR Report, G08AP0016 (2014)</a>  |
|                   |                                   | 6                 | 2007         | <a href="#">U/UGG FTR Report, G08AP0016 (2014)</a><br><a href="#">Janecke and Evans (2017)</a><br><a href="#">UGS Special Study 121 (2007)</a><br><a href="#">UGS Open-File Report 638 (2015)</a>   |
|                   |                                   | 7                 | --           | <a href="#">UGS Special Study 122 (2008)</a>  |
|                   |                                   | 8                 | 2016         | <a href="#">UGS Open-File Report 583 (2011)</a><br><a href="#">UGS Miscellaneous Publication 15-6 (2015)</a>  |
|                   |                                   | 9                 | --           | <a href="#">UGS Map 270 (2015)</a><br>2016 presentation file<br><a href="#">Paragonah fault, no activity</a>  |
|                   |                                   | 10                | --           | <a href="#">UGS Open-File Report 628 (2014)</a>   |
|                   |                                   | 11                | --           | <a href="#">USU FTR Report, 07HOCR0079 (2012)</a>   |
|                   |                                   | 12                | 2013         | <a href="#">UGS Special Study 98 (2000)</a><br><a href="#">UGS Special Study 121 (2007)</a><br><a href="#">UGS Open-File Report 638 (2015)</a><br><a href="#">UGS FTR, G17AP00001 (2018)</a>  |
|                   |                                   | 13                | --           |   |

| Study Type                         | Utah Fault or Fault Segment | UOFPWG Priorities  |   | Investigation Status<br>(as of 3/2020) |  |
|------------------------------------|-----------------------------|--|---|--|--|
|                                    |                             | 2005   | 2011  |  |  |
| High Res. Mapping & Trench Site ID | Earthquake Timing           | Wasatch Range back-valley faults (includes Morgan fault and Main Canyon fault) | 14  | --                                     | UGS Miscellaneous Publication 11-2 (2011)<br>UGS Miscellaneous Publication 10-5 (2010) |
|                                    |                             | Hurricane fault zone   | 15  | --                                     | UGS Special Study 119 (2007)   |
|                                    |                             | Levan and Fayette segments, Wasatch fault zone                                 | 16  | --                                     | UGS Map 229 (2008)<br>UGS Open-File Report 640 (2015)<br>UGS FTR G17AP00071 (2019)     |
|                                    |                             | Gunnison fault   | 17  | --                                     | No activity  |
|                                    |                             | Scipio Valley faults   | 18  | 2017                                   | No activity  |
|                                    |                             | Faults beneath Bear Lake   | 19  |  | No activity  |
|                                    |                             | Eastern Bear Lake fault zone   | 20  | --                                     | No activity  |
|                                    |                             | Provo segment, Wasatch fault zone  |   |  |  |
|                                    |                             |  |   | 2007                                   | UGS Map 02-7 (2002)  |
|                                    |                             |  |   | 2011                                   | UGS FTR Report 02HCGR0109 (2011)   |
|                                    |                             |  |   | 2012                                   | UGS FTR Report G13AC00165 (2015)   |
|                                    |                             |  |   | 2017                                   | Bonnett and others, 2018 (BSSA)  |
|                                    |                             |  |   | 2012                                   | UVU FTR G16AP00164 (2017)  |
|                                    |                             |  |   |  |  |
|                                    |                             |  |   | 2007                                   | UGS Special Study 142 (2012)   |
|                                    |                             |  |   | 2011                                   |  |
|                                    |                             |  |   | 2009                                   |  |
|                                    |                             |  |   | 2012                                   | UGS FTR Report G10AP00068 (2010)<br>UGS Special Study 149 (2014)                       |
|                                    |                             |  |   | 2012                                   | UGS FTR Report G14AP00057 (2014)   |
|                                    |                             | 2007   | AGU Abstracts: 2012 and 2013  |  |  |
|                                    |                             | 2012   | DuRoss and Hyland, 2015 (BSSA)  |  |  |
|                                    |                             | 2012   | DuRoss and others, 2018 (GRL)   |  |  |
|                                    |                             | 2016   | Trenching by Tokc, Bunds, and UVU students, ongoing   |  |  |
|                                    |                             | 2015   | Bunds and others, <a href="#">Poster 1</a> and <a href="#">Poster 2</a>                     |  |  |
|                                    |                             | 2017   |   |  |  |
|                                    |                             | 2014   | UGS Open-File Report 638 (2015)   |  |  |
|                                    |                             | 2017   | UGS Open-File Report 640 (2015)<br>UGS FTR G17AP00090 (2018)<br>UGS RL-280 (in press, 2020) |  |  |
|                                    |                             | 2011   | No activity   |  |  |

| Study Type   | Trib Fault or Fault Segment  | LOFPWG Priorities |                      | Investigation Status<br>(as of 3/2020)  |
|--|--|-------------------|----------------------|---|
|  |  | 2005              | Additions            |   |
| High Resolution Fault Mapping and Paleoseismic Trench Identification | Eastern Bear Lake fault zone   | --                | 2015<br>2017         | USGS/UCS co-op award G19AAP00072 (FTR due Fall 2020)  |
|  | East and West Cache fault zones  | --                | 2015<br>2017         | USGS/UCS co-op award G17AP00071 (summer 2020)   |
|  | Hurricane fault zone   | --                | 2014<br>2017         | USGS/UCS co-op award G20AAP00008 (FTR due 2021)   |
|  | Oquirrh fault zone   | --                | 2015<br>2017<br>2018 | Bands and others, <a href="#">Poster 1</a> , <a href="#">Poster 2</a> , and <a href="#">Poster 3</a> , and <a href="#">in-situ</a> Bands, USGS/UCS co-op award G19AAP00072 (FTR due September 2020) |
|  | Southern Utah faults   |                   |                      |   |
|  | Sevier Toroweap faults   |                   | 2018                 | USGS/USG/AZGS co-op award G20AAP00008 (FTR due Spring 2021)   |
|  | Mineral Mountains (West Side) faults   |                   | 2018                 | None  |
|  | Beaver Basin   |                   | 2018                 | None  |
|  | Crater Bench/Drum Mountain   |                   | 2018                 | None  |
|  | Scipio   |                   | 2018                 | None  |
| Little Valley  |  | 2018              | None                 |   |
| Salt Tectonics   | Levan and Fayette segments of the Wasatch fault zone   | --                | 2016                 | <a href="#">UCS FTR G17AP00071 (2019)</a>   |
|  | Main Canyon fault<br>Sevier detachment/Drum Mountains fault zone<br>Bear River fault zone<br>Spanish Valley (Moab area)<br>Jones Valley fault zone<br>Scipio Valley faults<br>Gunnison fault | --                | 2016                 | Scipio Valley and Bear River lidar data collected in 2018   |
| Other  | Warm Springs fault/East Bench fault subsurface geometry and connection   | --                | 2010                 | <a href="#">BSU FTR G15AP00054 (2015)</a><br><a href="#">BSU FTR G17AP00055 (2017)</a>  |



## 2020 BASIN AND RANGE PROVINCE EARTHQUAKE WORKING GROUP MEETING SUMMARY

Wednesday, February 5, 2020

Utah Department of Natural Resources Building, Auditorium (1<sup>st</sup> Floor)

1594 West North Temple, Salt Lake City, Utah

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### WELCOME AND INTRODUCTION

The Basin and Range Province Earthquake Working Group (BRPEWG) aims to bridge the gap between Basin and Range Province (BRP) and Intermountain West (IMW) state geological survey earthquake research programs to address the need for effective communication and collaboration in applied earthquake-hazard research in the region. BRPEWG previously convened at the Utah Department of Natural Resources building in 2006, 2011, 2018, and 2019. The 2019 meeting of BRPEWG was not funded by the U.S. Geological Survey (USGS) External Grants Program, but the meeting was still held due to the need to build on a successful meeting in 2018. After welcoming Working Group members and guests, Emily Kleber (Utah Geological Survey [UGS]) summarized the BRPEWG's past activities and outlined the Working Group's purpose and goals for the future.

#### BRPEWG Purpose and Goals

- Establish and coordinate earthquake-hazard research agenda in the BRP, especially collaborative work across state lines.
- Provide a space and resource for Basin and Range states to determine and discuss technical issues related to fault behavior in the Basin and Range Province.
- Share best practices and reports of ongoing earthquake research at state geological surveys in the Basin and Range.
- Identify and prioritize BRP cross-border Quaternary faults and future paleoseismic investigations in order to attribute fault characteristics in Basin and Range state fault databases and the USGS *Quaternary Fault and Fold Database of the United States*.

### TECHNICAL PRESENTATIONS AND DISCUSSIONS

- USGS Earthquake Geology Intermountain West (IMW) Update: Ryan Gold, U.S. Geological Survey Intermountain West
- State of Seismic Hazard Assessment, Arizona: Jeri J. Young, Arizona Geological Survey
- California Seismic Hazard Assessment and Zonation Program: Gordon Seitz, California Geological Survey
- Update and Issues Facing Earthquake Research in Colorado 2020: Jim McCalpin, GeoHaz Consulting
- Idaho Earthquakes and Seismic Hazard Activity: Zach Lifton, Idaho Geological Survey



- Montana Activities 2019: Mike Stickney, Montana Bureau of Mines and Geology
- Paleoseismic and Seismic Studies in New Mexico: Daniel Koning, New Mexico Bureau of Geology and Mineral Resources
- Earthquake Program at NBMG: Rich Koehler, Nevada Bureau of Mines and Geology
- Issues Facing Wyoming: Seth Wittke, Wyoming Geological Survey
- Basin and Range Province Earthquake Working Group—Utah Update: Emily Kleber, Utah Geological Survey
- Initial Paleoseismic Investigation of the Phillips Valley Fault, Teton County, Wyoming: Mark Zellman, BCG Engineering, Inc.

### **Ridgecrest Earthquake Response**

The July 2019 Ridgecrest earthquake sequence occurred in the area of Ridgecrest, California, and the Searles Valley, northern Mojave Desert. Several members of the BRPEWG were part of the scientific response to the earthquake sequence, mobilizing to collect perishable geologic field data. Based on a survey sent out in December 2019, the BRPEWG was interested in learning more about the scientific response to the earthquake sequence and discussing implications for the Basin and Range Province. Gordon Seitz, Rich Koehler, and Ryan Gold led an hour-long discussion about the response. Other BRPEWG members who responded to the Ridgecrest earthquake sequence included Alex Hatem and Chris DuRoss.

The panel represented the state survey where the earthquake happened (Seitz), a responding state survey (Koehler), and the USGS (Gold). Seitz started by giving some scientific context for the earthquake sequence and the multi-method approach used in scientific response. He emphasized the importance of open access to data and strong communication to improve the characterization of surface fault rupture, which will inform future efforts in mitigation and zoning in California. Koehler then presented the work completed by his team from the Nevada Bureau of Mines and Geology (NBMG), ASU, CSU Fullerton, PG&E, and the Geotechnical Engineering Earthquake Response (GEER) to measure and characterize surface fault rupture outside of the Naval Air Weapons Station, China Lake. Koehler talked about experiencing the M 7.1 mainshock earthquake and the chaos immediately after the mainshock around Ridgecrest. He emphasized the importance of scientific response not interfering with emergency services. After the M 7.1 mainshock, Koehler's team went to several sites where they had previously observed road damage from the M 6.4 foreshock. Roads and infrastructure are important and perishable data post-earthquake, since road crews tend to repair quickly. Finally, Gold offered the USGS response perspective. The Ridgecrest sequence is unique since a majority of the surface fault rupture occurred on a Federal Naval base, which was most easily accessed by federal agencies, including the USGS. Some of the challenges Gold pointed out were then discussed with the group included field communication, coordinating teams, data collection standards, long and warm days in the summer heat, data ownership, and data access. Gold highlighted that the working relationship between the CGS and the USGS was strong before, during, and after the event.

### **U.S. Geological Survey Update and National Seismic Hazard Map Effort**

Ryan Gold, Intermountain West (IMW) Coordinator for the USGS Earthquake Hazards Program, gave a summary of ongoing collaborations of earthquake geology investigations in IMW states. In 2023, the USGS plans to update the National Seismic Hazard Model (NSHM), which will require input from the

intermountain states. The IMW has 75% of all faults in the *USGS Quaternary Fault and Fold Database of the United States*. There is a huge importance to updating any pertinent geologic data and fault geometry information for IMW faults.

Alex Hatem, USGS Mendenhall Postdoctoral fellow at the USGS Earthquake Hazards Program presented more details about the effort to incorporate additional geologic data into the 2023 update of the NSHM. The importance of this update for the IMW is that there will be more geologic data incorporated into the 2023 model. Data like geologic slip rates, paleoearthquake timing, slip-per-event, and detailed fault geometries will improve the data used for IMW faults in the last model (2015). Hatem presented information about the timeline for data submissions and discussed some areas of improvement among Basin and Range states for the NSHM.

### **WORKING GROUP PRIORITIES DISCUSSION**

After state update presentations and discussions about the Ridgecrest earthquake response, the BRPEWG discussed several items relevant to the current and future work of Basin and Range states. Overall, this group benefits from annual meetings to discuss science, share partnerships, and keep up to date with earthquake investigations in neighboring states. Additionally, the introduction of newer state survey representatives for earthquake geology programs are imperative to the transfer of knowledge in Basin and Range states.

On February 1–5, 2021, the Basin and Range Earthquake Summit (BRES), formally the Basin and Range Province Seismic Hazard Summit (BRPSHS) will convene at the Utah Department of Natural Resources building in Salt Lake City. The BRPEWG agreed to attend the conference and hold a lunch meeting to discuss BRPEWG priorities for 2022. Emily and Zack are currently exploring funding opportunities to include other state surveys

The group discussed the possibility of having the BRPEWG meeting in other locations in the future. While everyone seemed in agreement that this was a good idea, some limiting factors to holding the meeting elsewhere are locating a venue and having an easy and affordable city to travel to. The group loosely agreed to continue meeting in Salt Lake for the foreseeable future.

Cross-border faults in the Basin and Range Province that need improved mapping (not a complete list of all cross-border faults):

- MT-ID: Hope fault, Lewis and Clark shear zone, Centennial fault
- ID-WY: Grand Valley (Prater Mountain Section)
- NV-ID: O'Neil Basin fault zone, faults near Owyhee (unnamed)
- UT-WY: Hogsback faults, Porcupine Mountain faults, Crawford Mountains (west side) faults, Saletatus Creek fault
- UT-AZ: Bright Angel fault system
- UT-NV: Lime Mountain fault, Snake Valley faults
- UT-ID: Grouse Creek and Dove Creek Mountains faults, Raft River Mountains fault

### **WORKING GROUP PRODUCTS AND RELATED DATA**

The final agenda, speaker presentations, and this summary document are available on the BRPEWG web page at <https://geology.utah.gov/hazards/info/workshops/working-groups/basin-and-range-earthquakes/>.

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

|                 |   |
|-----------------|---|
| Jeri Ben Horin* | Arizona Geological Survey   |
| Steve Bowman    | Utah Geological Survey  |
| Chris DuRoss    | U.S. Geological Survey, Earthquake Hazards Program                  |
| Ryan Gold*      | U.S. Geological Survey, Earthquake Hazards Program, IMW Coordinator |
| Julia Howe      | U.S. Bureau of Reclamation  |
| Emily Kleber*   | Utah Geological Survey (BRPEWG Chair)                               |
| Rich Koehler*   | Nevada Bureau of Mines and Geology                                  |
| Daniel Koning*  | New Mexico Bureau of Mines and Geology                              |
| Zach Lifton*    | Idaho Geological Survey   |
| William Lund    | Utah Geological Survey, Emeritus                                    |
| James McCalpin* | GeoHaz Consulting (representing the Colorado Geological Survey)     |
| Gordon Setiz*   | California Geological Survey  |
| Mike Stickney*  | Montana Bureau of Mines and Geology                                 |
| Seth Wittke*    | Wyoming Geological Survey   |

**Guests**

|                  |  |
|------------------|--|
| Camille Collette | U.S. Geological Survey, Earthquake Hazards Program |
| Gordon Douglass  | Utah Geological Survey                             |
| Rich Giraud      | Utah Geological Survey                             |
| Alex Hatem*      | U.S. Geological Survey, Earthquake Hazards Program |
| Michael Hylland  | Utah Geological Survey                             |
| Bill Keach       | Utah Geological Survey                             |
| James Mauch      | Wyoming Geological Survey                          |
| Greg McDonald    | Utah Geological Survey                             |
| Adam McKean      | Utah Geological Survey                             |
| Matthew Morriss  | Utah Geological Survey                             |
| Jim Pechmann     | University of Utah Seismograph Stations            |
| Grant Willis     | Utah Geological Survey                             |
| Mark Zellman*    | BCG Engineering, Inc.                              |