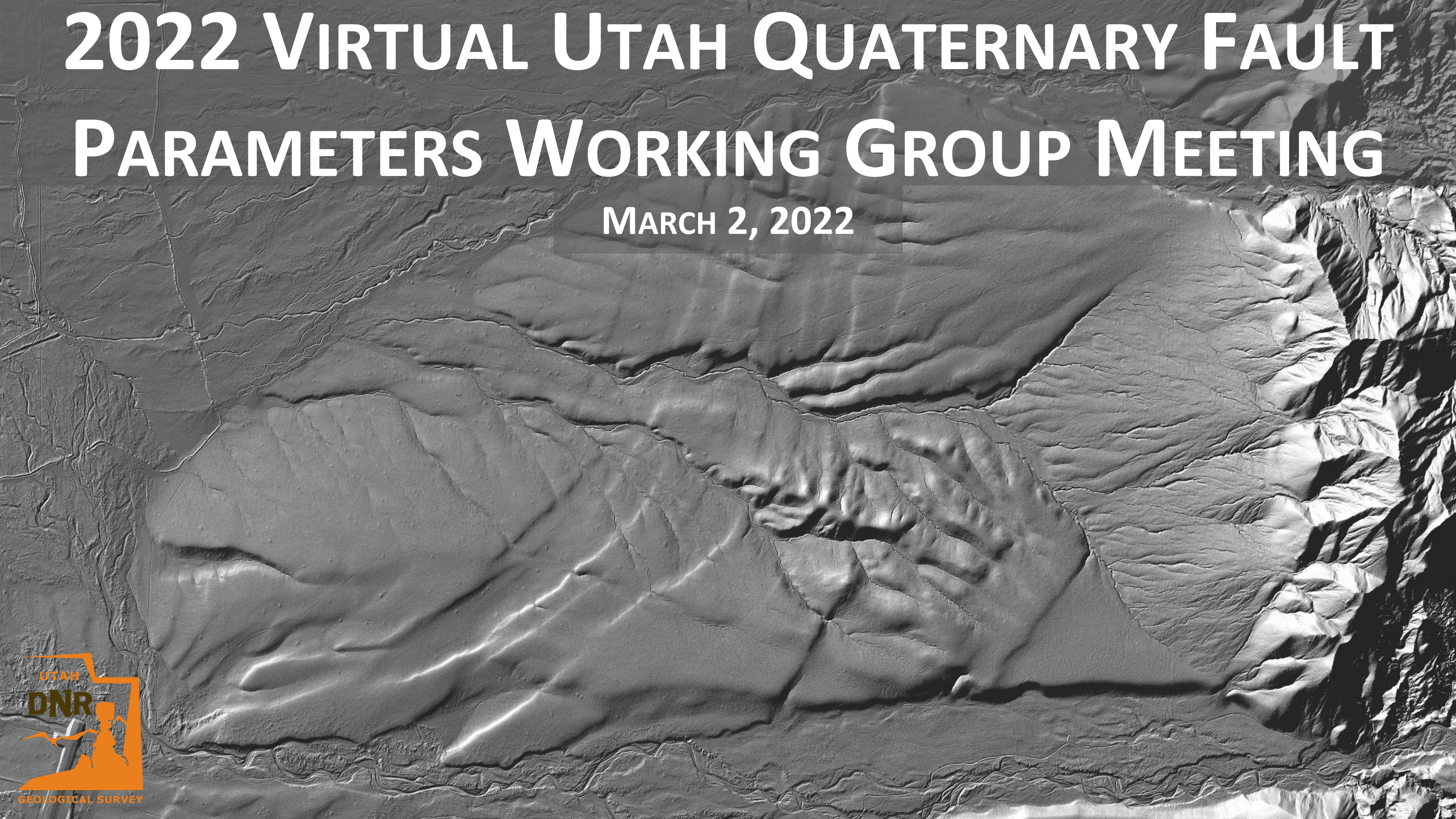
2022 Virtual Utah Quaternary Fault Parameters Working Group Meeting

March 2, 2022



UTAH DNR GEOLOGICAL SURVEY

2022 UQFPWG Meeting - Agenda

General Utah Earthquake Geology Updates - 10-minute Lightning Talks

- *Emily Kleber – Utah Geological Survey - Welcome and Introduction*
- *Chris DuRoss – U.S. Geological Survey - Earthquake Hazards Program – External Grants Update*
- *Alex Hatem – U.S. Geological Survey - National Seismic Hazard Maps Update*
- *Nathan Toke – Utah Valley University - Timpanogos and Provo Peak Massifs – New Fault Mapping*
- *Ivan Wong – Lettis Consultants International - Warm Springs Fault - East Bench Fault Stepover - New Research*
- *Adam Hiscock – Utah Geological Survey - Utah Geological Survey Quaternary Fault Mapping Update*

15-Minute Break

30+ Minutes (Remainder of Meeting) – Discussion of Priority Faults for 2023

UTAH DNR GEOLOGICAL SURVEY

Zoom Review - General

- You will be muted upon entering the meeting.
- To save bandwidth for all attendees, please leave your camera off unless you are speaking.
- The hosts reserve the right to mute participants who have left their microphones on, or who are being disruptive to the meeting.
- If you are having technical issues, **PRIVATELY** message Adam Hiscock, or Emily Kleber. Should be labeled as "Host"

Utah Quaternary Fault Parameters Working Group

Serves as a standing committees to help set and coordinate Utah's earthquake hazard research agenda.

Reviews ongoing paleoseismic and fault-related 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 investigation

GEOLOGIC HAZARDS

UTAH QUATERNARY FAULT PARAMETERS

The 2022 Utah Quaternary Fault Parameters Working Group Meeting will take place virtually on March 2, 2022 from 1-3 PM MST. Register Here!

The main goal of the Utah Quaternary Fault Parameters Working Group (UQFPWG) is to characterize active fault sources in Utah.

The working group began by developing consensus slip-rate and recurrence-interval data for all Utah trenched faults (Lund, 2005) in 2003 and 2004. The working group also developed an initial priority list of faults requiring additional study and, based on each year's paleoseismic investigations, has updated the list annually.

As new paleoseismic data became available, the working group modified its consensus slip-rate and recurrence-interval values as necessary. The UQFPWG started annual meetings in 2005.

MEETING SUMMARIES	MEETING AGENDAS	MEETING PRESENTATIONS
Organization [None]	Organization	Organization [None]
May 2003 [None]	May 2003	May 2003
August 2003 [None]	August 2003	August 2003 [None]
2005	2005	2005
2006	2006	2006

GEOLOGIC HAZARDS

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2007	2007	2007
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2009	2009	2009
2010	2010	2010
2011	2011	2011
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2014	2014	2014
2015	2015	2015
2016	2016	2016
2017	2017	2017
2018	2018	2018
2019	2019	2019
2020	2020	2020
2021	2021	2021

MEETING SUMMARIES	MEETING AGENDAS	MEETING PRESENTATIONS
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August 2003 [None]	August 2003	August 2003 [None]
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.utah.gov/?page_id=5253

Utah Quaternary Fault Parameters Working Group 2021 presentations

- US Geological Survey update
  - Update on USGS External Grants Program: Chris DuRoss, Intermountain West Regional Coordinator, U.S. Geological Survey
  - Earthquake Geology Database Updates for the 2023 National Seismic Hazard Model: Alex Hatem, U.S. Geological Survey

Utah Quaternary Fault Parameters Working Group 2021 presentations

- Recent studies in Utah
  - Preliminary Evaluation of Quaternary Activity on the Duchesne-Pleasant Valley Fault, Uinta Basin, Utah: Julia Howe, U.S. Bureau of Reclamation
  - Paleoseismic Results from the Topliff Hills Fault, Rush Valley, Utah: Nathan Toke, Utah Valley University
  - Recent Quaternary Fault Mapping in Utah: Adam Hiscock, Utah Geological Survey
  - Fault Investigation Along the Central Weber Segment of the Wasatch Fault, Layton, Utah: Evidence for 4-5 Recent Paleoseismic Events: Robert Givler, Lettis Consultants International

Utah Quaternary Fault Parameters Working Group 2021 presentations

- Technical Session: Buried Urban faults and Special Study Zones
  - Is There a Potential Surface Fault Deformation Hazard in Downtown Salt Lake City?: Ivan Wong, Lettis Consultants International
  - Seismic Land Streamer Results Highlight Earthquake Risks for the Salt Lake City Urban Center: Lee Liberty, Boise State University
- Group Discussion: What is the potential for primary and secondary surface fault displacement and deformation in downtown Salt Lake City?

Utah Quaternary Fault Parameters Working Group 2021 presentations

- Technical Session: 2020 Magna Earthquake
    - Backprojection Imaging of the 2020 Magna, Utah, Earthquake Using a Local Dense Strong Motion Network: Maria Messimeri, University of Utah Seismograph Stations
    - Coseismic Fault Slip and Afterslip Associated with the 18 March 2020 M 5.7 Magna, Utah, Earthquake: Fred Pollitz, U.S. Geological Survey
    - Hypothetical Structural Model for the March 18 M 5.7 Magna, Utah, Earthquake: Adam McKean, Utah Geological Survey
    - Alternative Models for the Subsurface Geometry of the Wasatch Fault in Light of the 2020 Magna, Utah, Earthquake: James C. Pechmann, University of Utah Seismograph Stations

Utah Quaternary Fault Parameters Working Group 2021 presentations

- Technical Session: 2020 Magna Earthquake (continued)
- Group discussion
    - What is the likelihood that the Magna earthquake occurred on a subsidiary fault in the hanging wall of the Wasatch fault? And if it did, does this model require that the underlying Wasatch fault have a shallower dip than the subsidiary fault on which the Magna earthquake occurred?
    - Does the existence of the active West Valley fault zone require a listric geometry for the Wasatch fault, i.e., a decrease in the dip of the Wasatch fault below its intersection with the West Valley fault zone? Or are there alternative structural models for the presumed intersection between these two faults?

2022 UQFPWG Priorities Summary

Acquire new paleoseismic information for areas with ongoing or completed lidar fault mapping projects:

- **West Valley fault zone – Granger and Taylorsville faults**
- Cache Valley faults – East Cache fault zone and West Cache fault zone
- Five central segments of the Wasatch fault zone – Brigham City, Weber, Salt Lake City,
- Provo, and Nephi segments
- Oquirrh fault zone
- Sevier fault

2022 UQFPWG Priorities Summary

"Salvage paleoseismology" (i.e., earthquake timing investigations as rapid development is encroaching on un-modified paleoseismic trenching sites:

- **West Valley fault zone – Granger and Taylorsville faults**
- Cache Valley faults – East Cache fault zone and West Cache fault zone

2022 UQFPWG Priorities Summary

Use recently acquired lidar data to more accurately map the traces of the:

- Scipio Valley faults
- Beaver Basin faults
- **Hansel Valley faults**
- **Paunsaugunt fault**
- Mineral Mountains west side faults
- Stansbury fault zone

2022 UQFPWG Priorities Summary

Opportunistic trenching sites – Funding for dating samples left over from other projects that have been stored and would be useful

Post-Magna earthquake research – Use new geophysical methods to collect more data about the subsurface of the Salt Lake Valley

2023 UQFPWG Priorities

Coming up after presentations! Be ready with suggestions.

USGS Earthquake Hazards Program External Grants Update

Christopher DuRoss

USGS Intermountain West Regional Coordinator

cduross@usgs.gov

USGS science for a changing world

USGS External Grants Program, FY2021 (last year)

- **FY21 Earthquake Hazards Program (EHP) funding**:
  - $3.6M split among five regions and four topical areas

- **FY21 Intermountain West (IMW) funding**:
  - **$405k** (11 proposals)
  - Previously: $433k (FY20), $520k (FY19), $398k (FY18), $439k (FY17), $235k (FY16); 16-yr mean: $398k

Regional/Topical Area	FY21 Funded Amount	%	FY21 # of new grants funded
CEUS	$423.7k	12%	8
EP/IS	$396.1k	11%	5
ESI	$420.5k	12%	6
IMW	$404.5k	11%	11
NAT	$479.6k	13%	7
NC	$393.5k	11%	8
PNA	$398.9k	11%	5
SC	$310.0k	9%	3
EEW	$382.3k	10%	4
Totals	**$3.61M**	**100%**	**57**

CEUS – Central and Eastern United States
IMW – Intermountain West
NC – Northern California
SC – Southern California
PNA – Pacific Northwest and Alaska
EP/IS – Earthquake Physics/Induced Seismicity
ESI – Engineering Seismology and Impacts
NAT – National
EEW – Earthquake Early Warning

USGS
science for a changing world

IMW External Grants FY2022 (in progress)

- **FY22 IMW proposals:**
  - 13 submitted in FY22 (22 in FY21)
  - Total request: $849.2k (1.2M in FY21)
  - Average request:
    - Fund or "fund if possible": $48.5k ($46.7k in FY21)
    - All others: $66.9k ($52.3k in FY21)

- **Current status** (Feb. 2022):
  - Two proposals funded (~$96.9k)
  - *Possible* that ~$400k total will be funded (~7 proposals)
  - Federal budget: Third FY22 continuing resolution – extending through March 11, 2022
  - Final award letters anticipated Spring 2022

Funding by state

- UT: 2 grants funded; 3 in "hold" status
- MT: 1 grant in "hold" status
- E Calif: 1 grant in "hold" status

FY23 Program Announcement

- March 2022; proposals due May 2022
- Note new "common priorities" for the EHP
- Panel: ~August 2022. Contact me (cduross@usgs.gov) if you're interested in serving
- Contact Jill Franks (jfranks@usgs.gov) for more information on the announcement

Evidence for Recent Faulting ~1000 m above the Bonneville High Stand, Along the Northern Provo Segment of the Wasatch Fault

UTAH VALLEY UVU UNIVERSITY

Department of EARTH SCIENCE

Nathan Toké,
Kristen Smith, and David Johnson

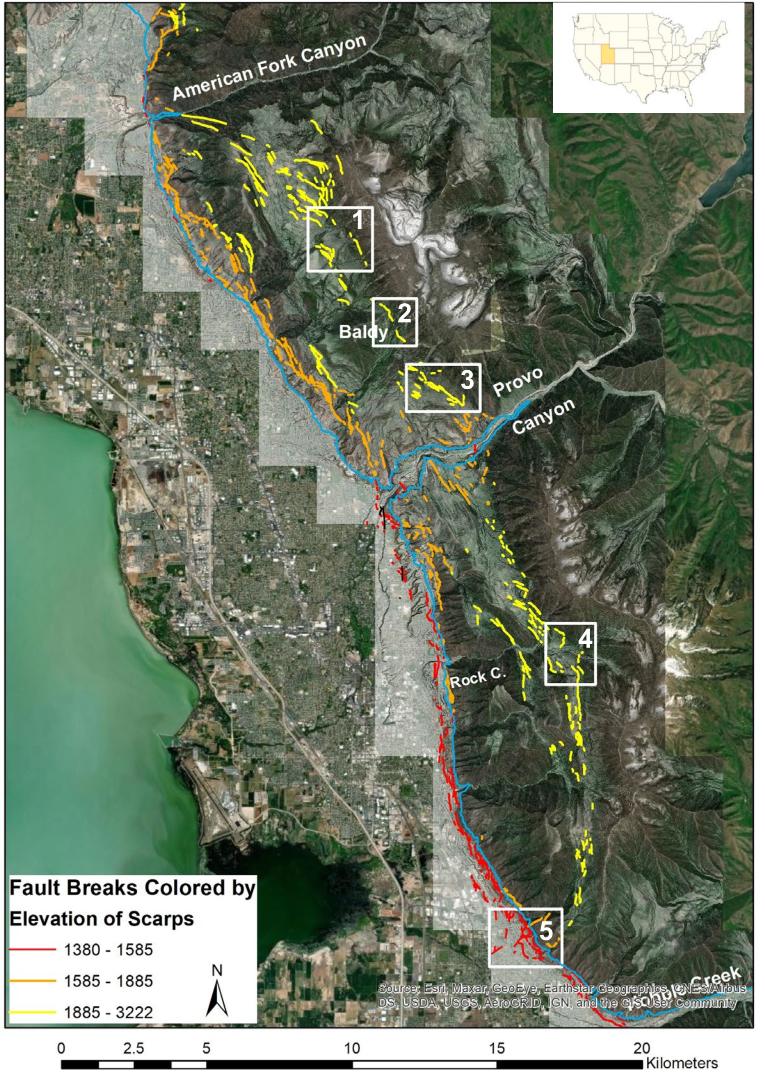
- **Mapping with 2018 Central Utah (3DEP?) lidar data along the Timpanogos and Provo Peak Massif from Hobble Crk to Am. Fork Canyon reveals Holocene to Late Pleistocene faulting.**

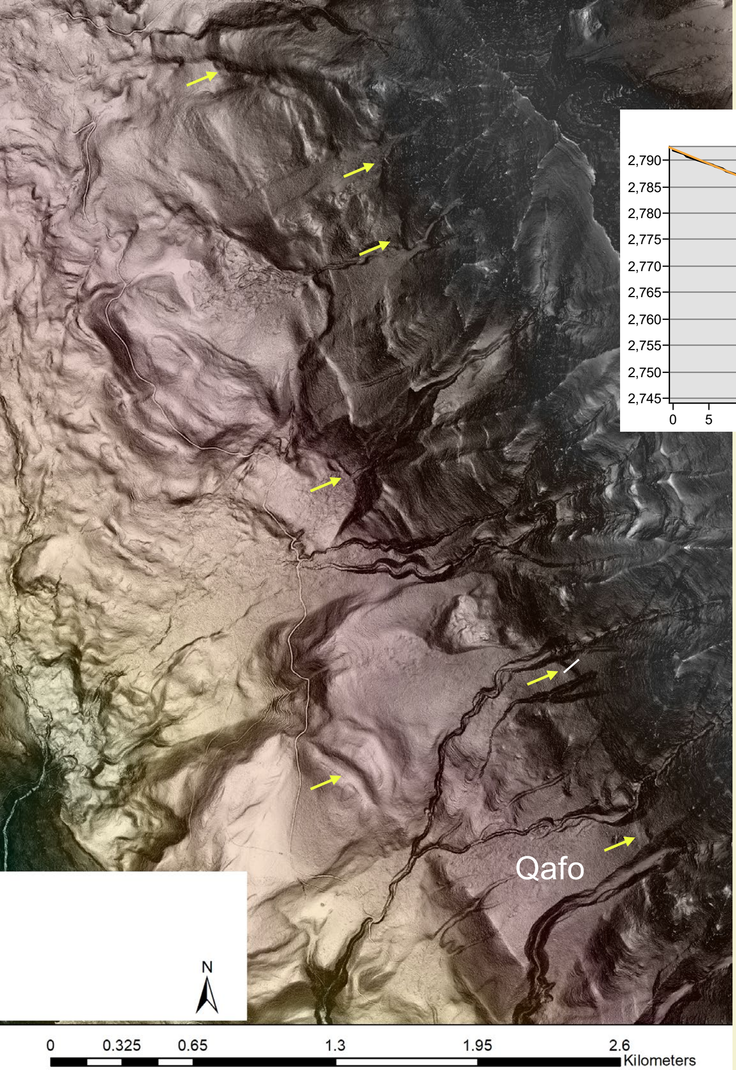
- **Surface breaks cut high geomorphic surfaces including glacial moraines, talus cones, and old alluvial fans.**

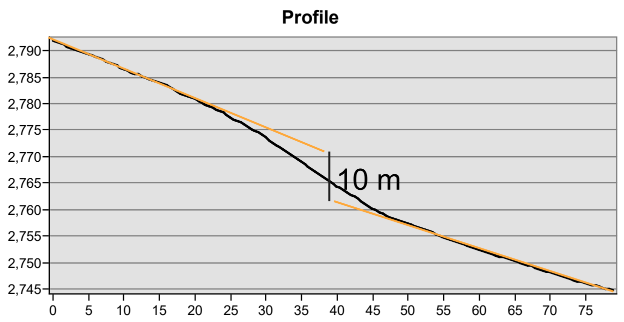
- **Surface breaks are largely within or along the edges of the Manning Canyon Shale unit which is problematic because of the co-location of mass wasting.**

- **The Springville Fault aligns with the emergence of this structure at the piedmont in the south. No similar valleyward structure is observed in the north.**

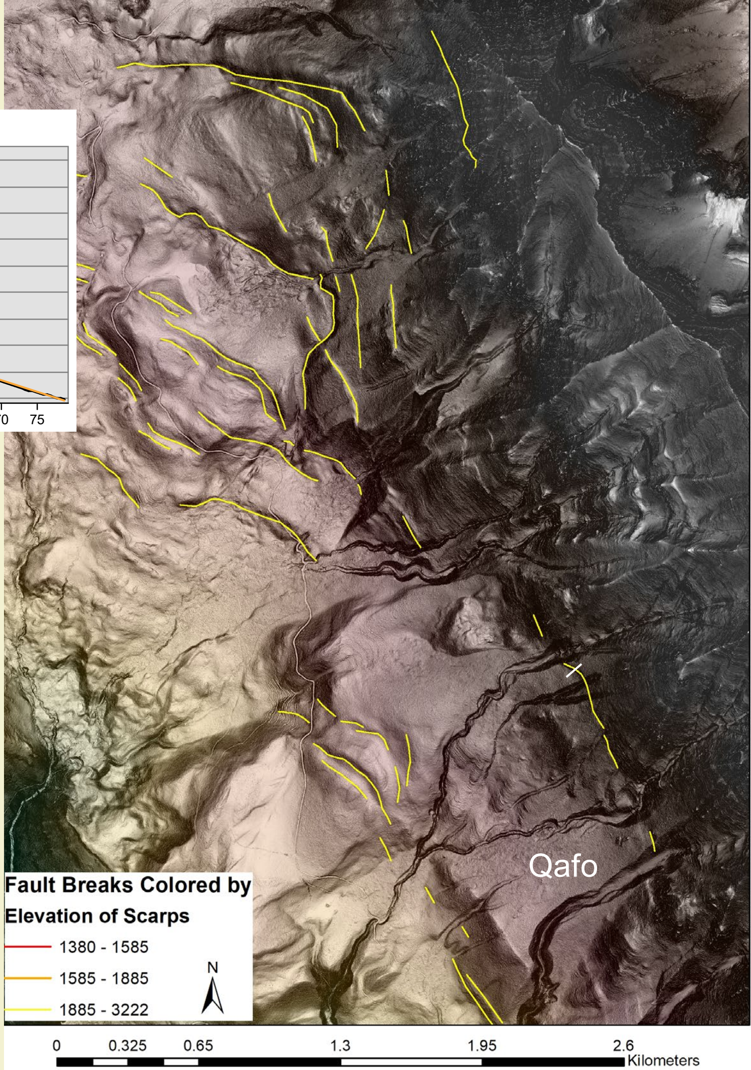
- **We propose that some proportion (20%?) of the ruptures along the Wasatch fault are reactivating the underlying thrust sheets eastward of the mountain front and that normal faults within the overlying Manning Canyon shale are activated.**

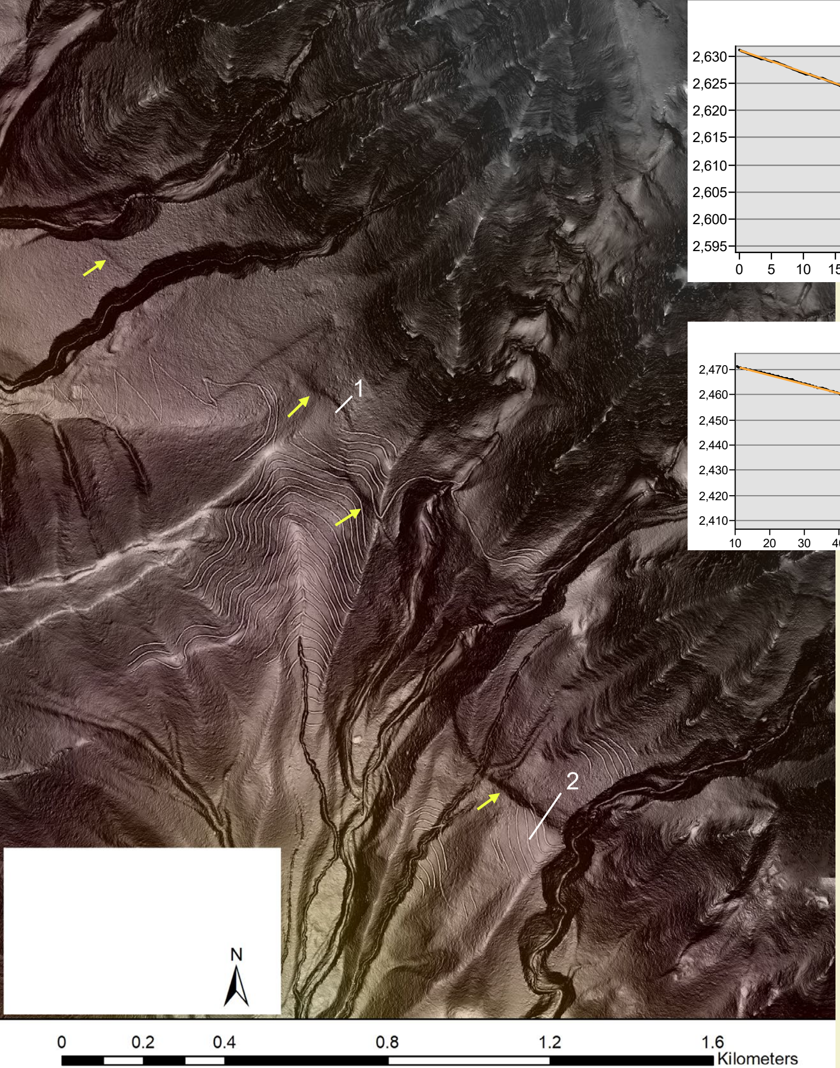


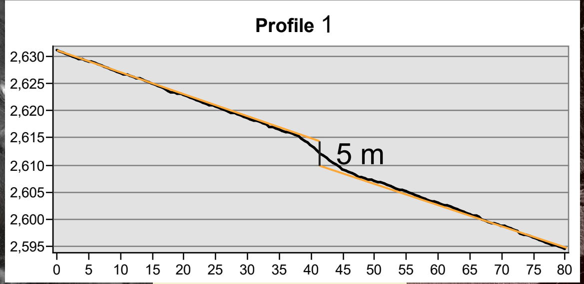


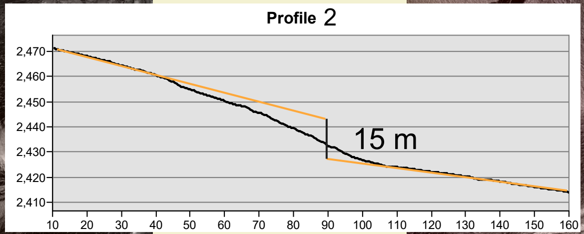


Site 1 – North of Baldy along Timpanogos

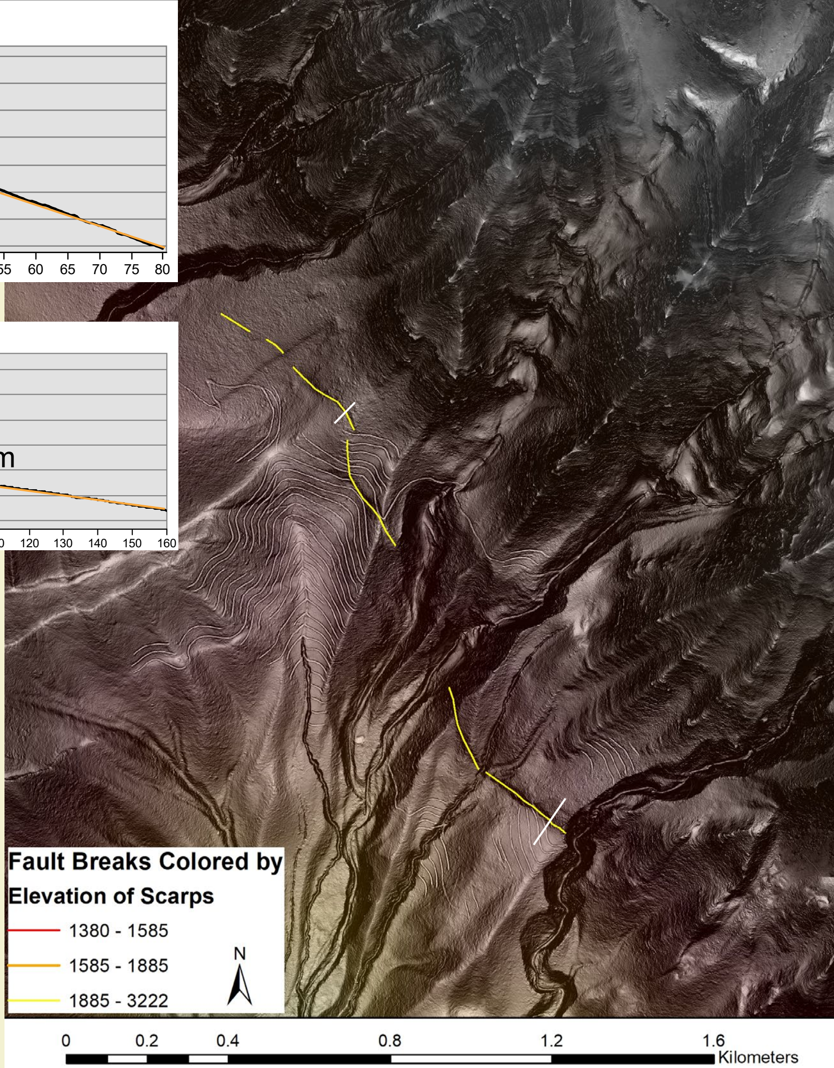




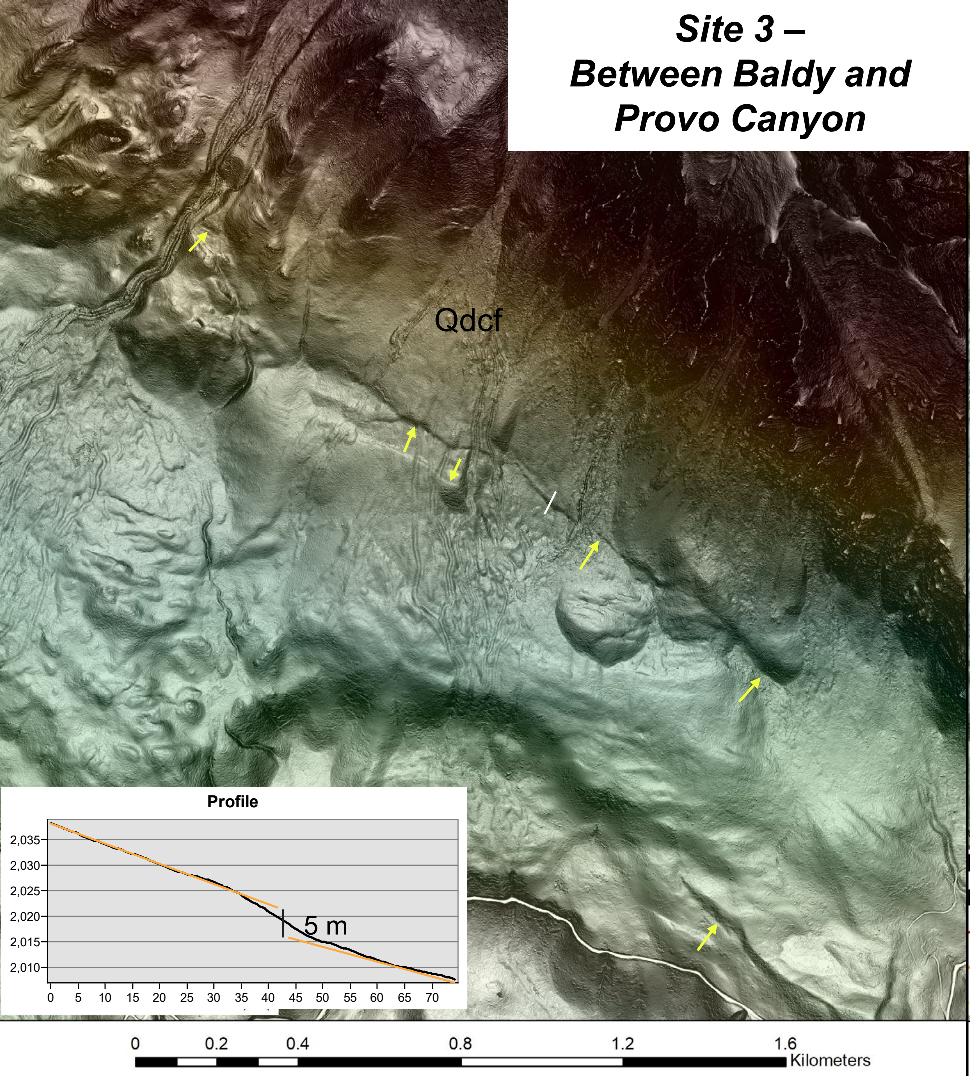


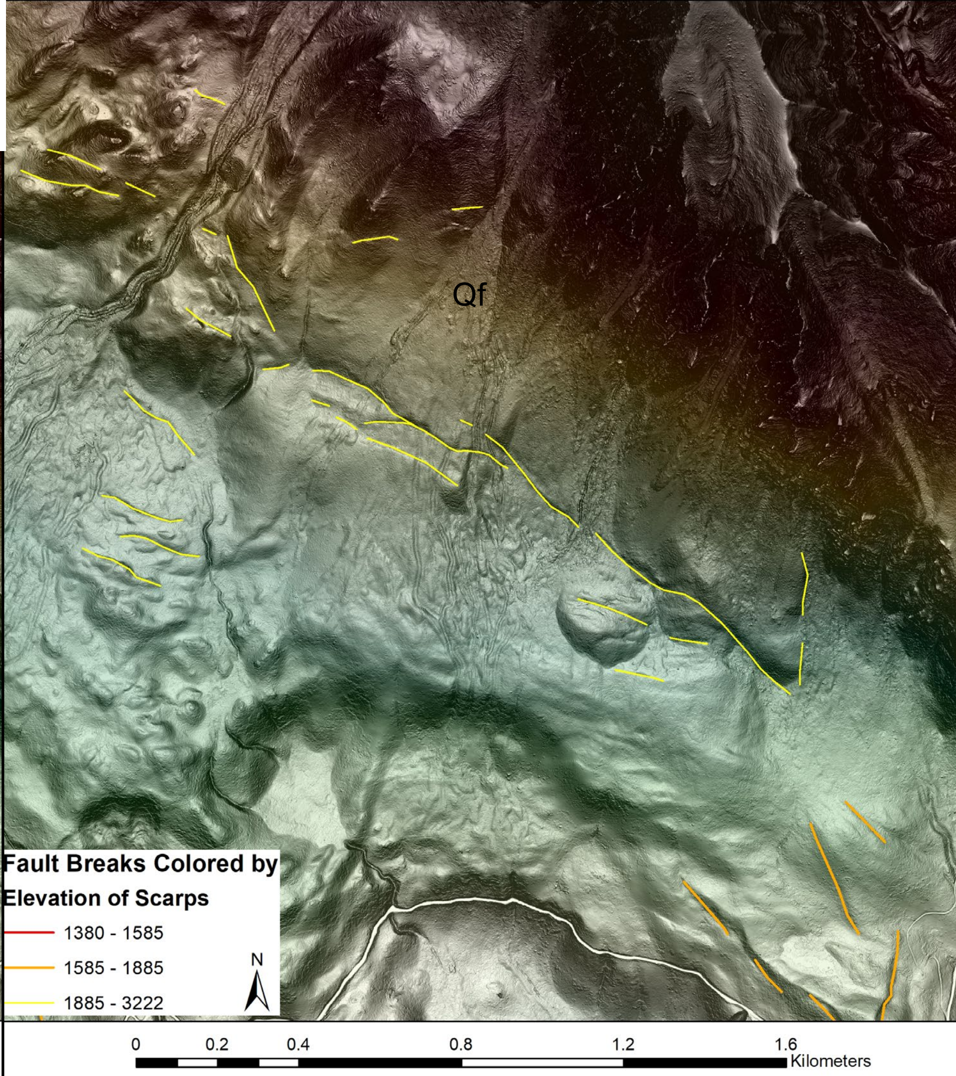


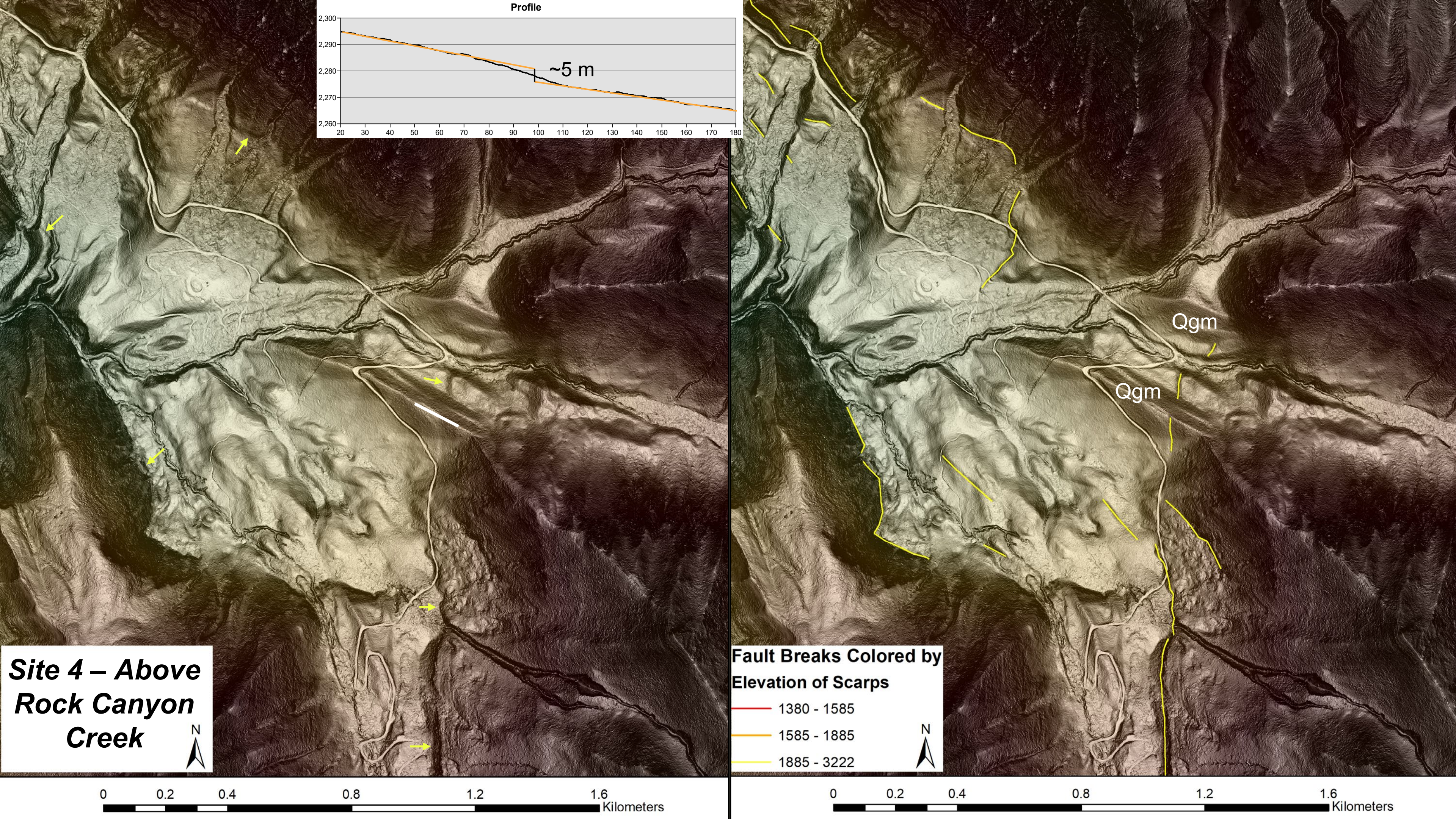
Site 2 – At Baldy



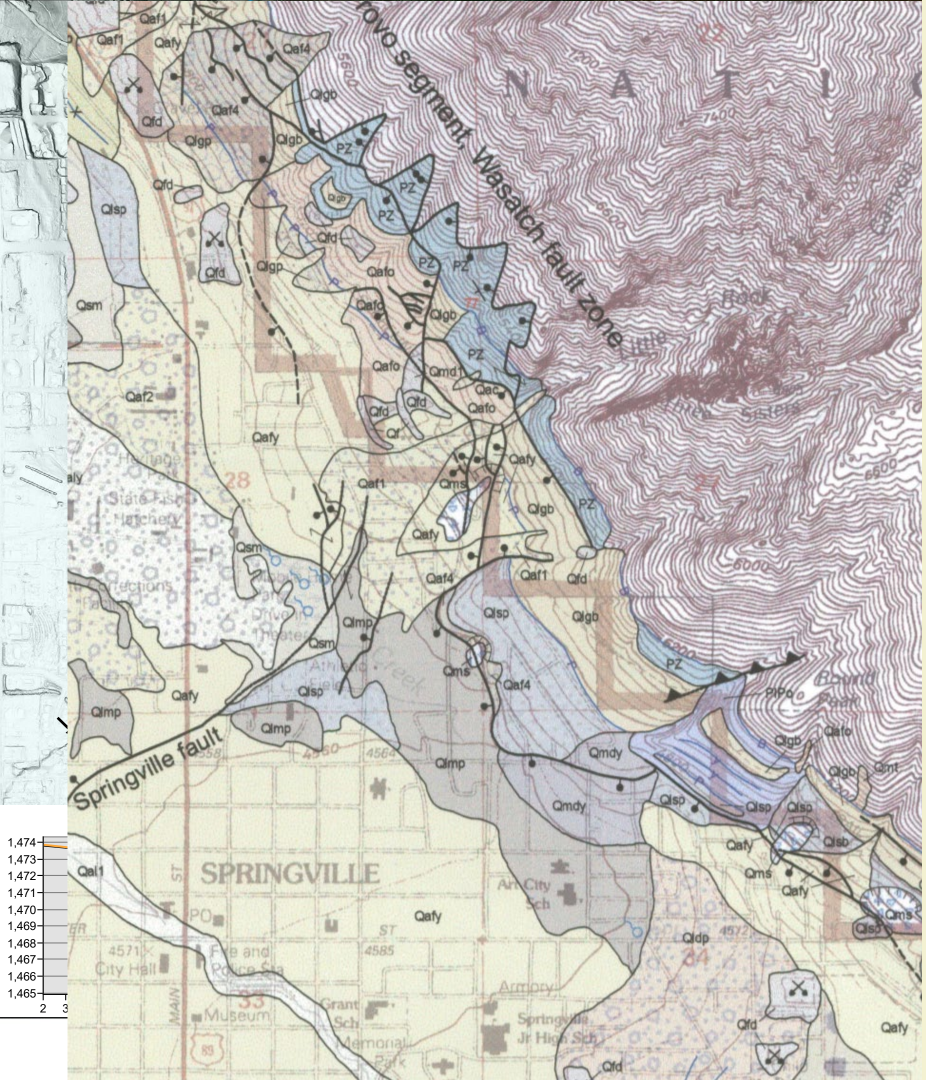
Site 3 – Between Baldy and Provo Canyon

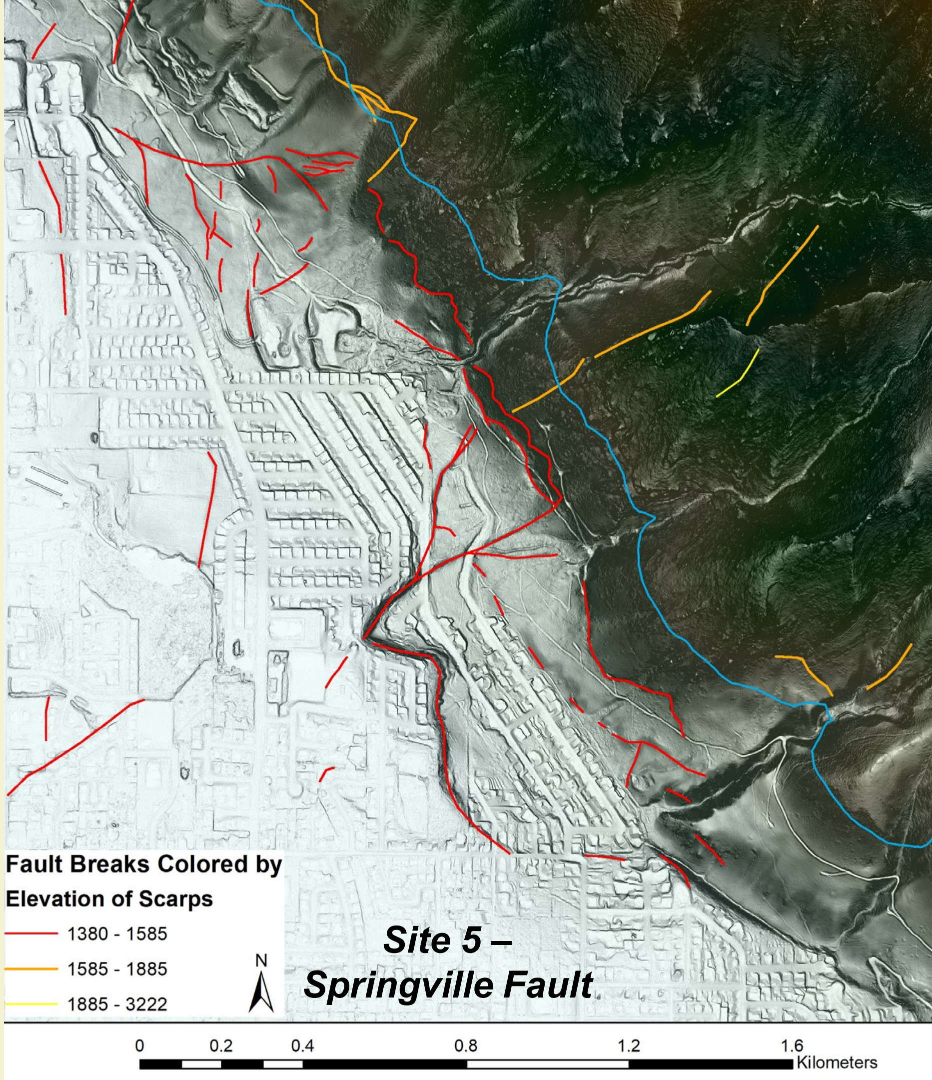






Profile
2,300
2,290
2,280
2,270
2,260
20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180
~5 m
Site 4 – Above Rock Canyon Creek
N
Qgm
Qgm
Fault Breaks Colored by Elevation of Scarps
1380 - 1585
1585 - 1885
1885 - 3222
N
0 0.2 0.4 0.8 1.2 1.6 Kilometers
0 0.2 0.4 0.8 1.2 1.6 Kilometers


Provo segment, Wasatch fault zone
Springville fault
SPRINGVILLE
City Hall
Museum
Armory


Fault Breaks Colored by Elevation of Scarps
1380 - 1585
1585 - 1885
1885 - 3222
N
Site 5 – Springville Fault
0
0.2
0.4
0.8
1.2
1.6
Kilometers

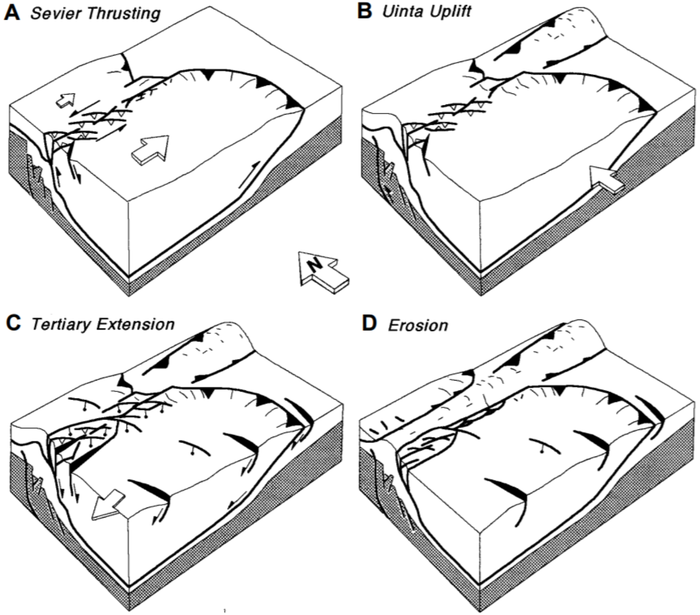


Figure 9. Simplified schematic diagram showing the main stages in the structural evolution of the Charleston transverse zone. Shaded region represents Precambrian crystalline basement.

Paulson and Marshak, 1998

Harris and Robeck, in Bruhn et al., 2005

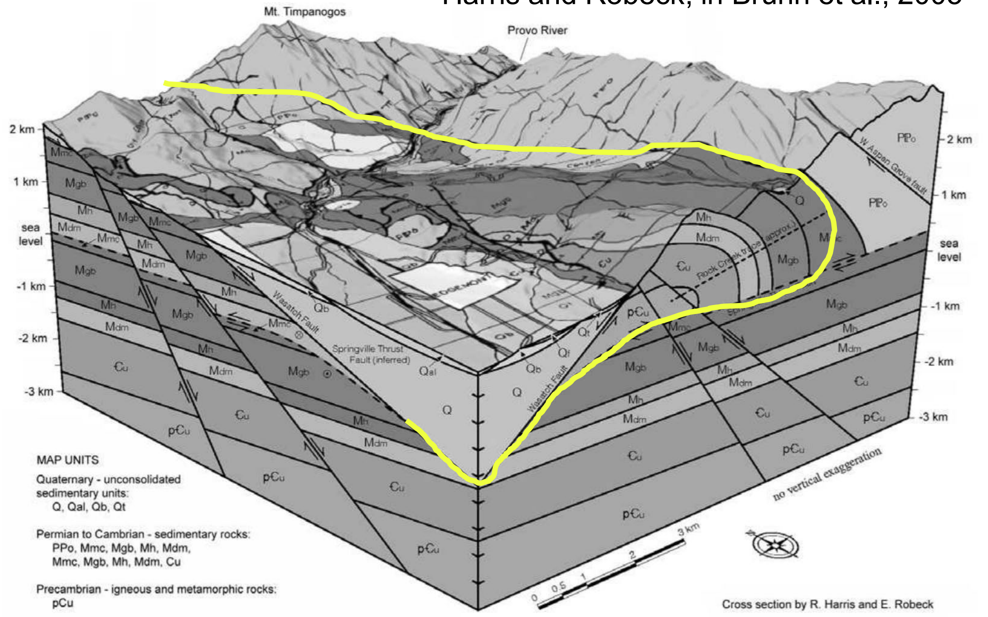


Figure 6. Block diagram of the Wasatch Front and Utah Valley near Rock Canyon (E-W line) and Lindon (N-S) line. The Wasatch fault cuts through the back limb of the Rock Canyon anticline, which plunges north. The ramp associated with this fault propagation–type fold may have been reactivated as part of the Wasatch fault. A series of antithetic faults with top-down-to-the-east slip offset the folded rocks in the footwall. Cross section constructed by R. Harris and E. Robeck.

Provo Segment Mountain Front:

1.5-2.0	mm/yr slip rate
1.3	ky average recurrence
0.5-3.5	m of slip per event

High Mountain Expression of the Provo Segment:

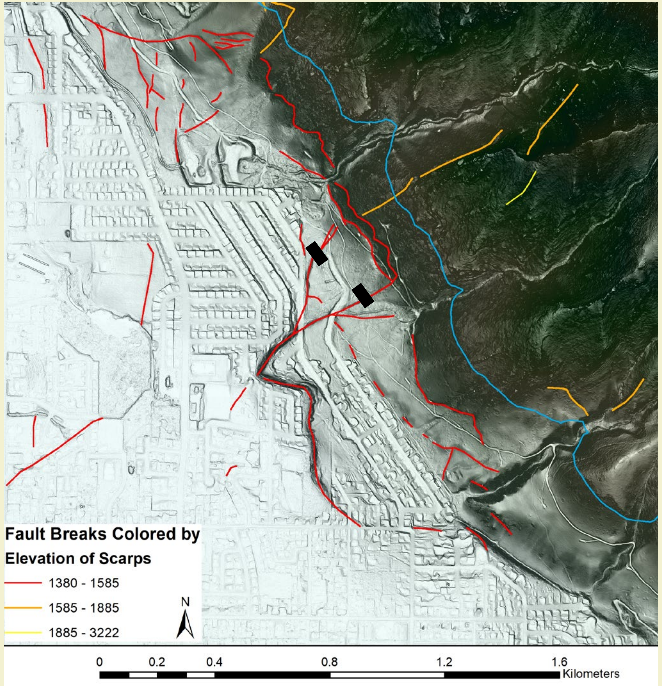
~0.3-0.4	mm/yr slip rate (5 m since glacial retreat)
~4-5	ky recurrence (~3 events since retreat)
1.5	m/event (presuming 3 events)

References

- Bruhn, R.L., C.B. DuRoss, R.A. Harris, and W.R Lund, 2005, Neotectonics and Paleoseismology of the Wasatch fault, Utah, GSA Field Guide 6, 231-250.
- Paulsen, T. and S. Marshak, 1998, Charleston transverse zone, Wasatch Mountains, Utah: Structure of the Provo salient's northern margin, Sevier fold-thrust best, GSA Bulletin, v. 110, 512-522.
- Solomon, B.J. and M.N. Machette, 2008, Interim Geologic Map of the Southwest (Utah Valley) Part of the Springville Quadrangle, Utah County, Utah, Utah Geological Survey – OFR 524.
- 2018 Central Utah Lidar Dataset
- 2014 Wasatch Front Lidar Dataset

Upcoming Work (Summer 2022):

- Trenching (possibly) in Springville (UVU Internal Funding)
- Field Visits to the sites shown (especially 2-4)
- NEHRP Proposal to Follow…

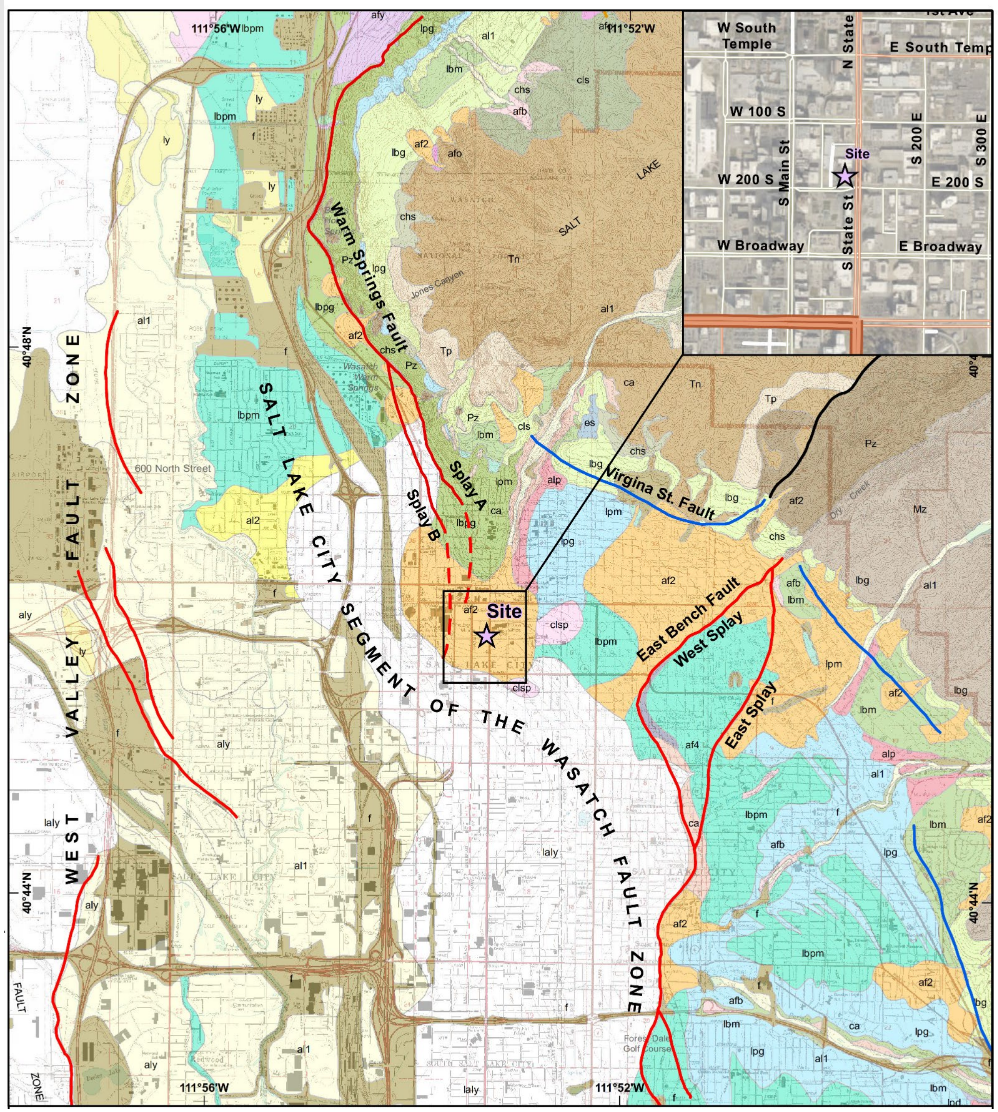


Challenges in Quantifying the Ground Shaking and Surface Faulting Hazards in the Warm Springs Fault – East Bench Fault Crossover in Downtown Salt Lake City

Ivan G. Wong
Lettis Consultants International

Utah Quaternary Fault Parameters Working Group
2 March 2022

The Stepover



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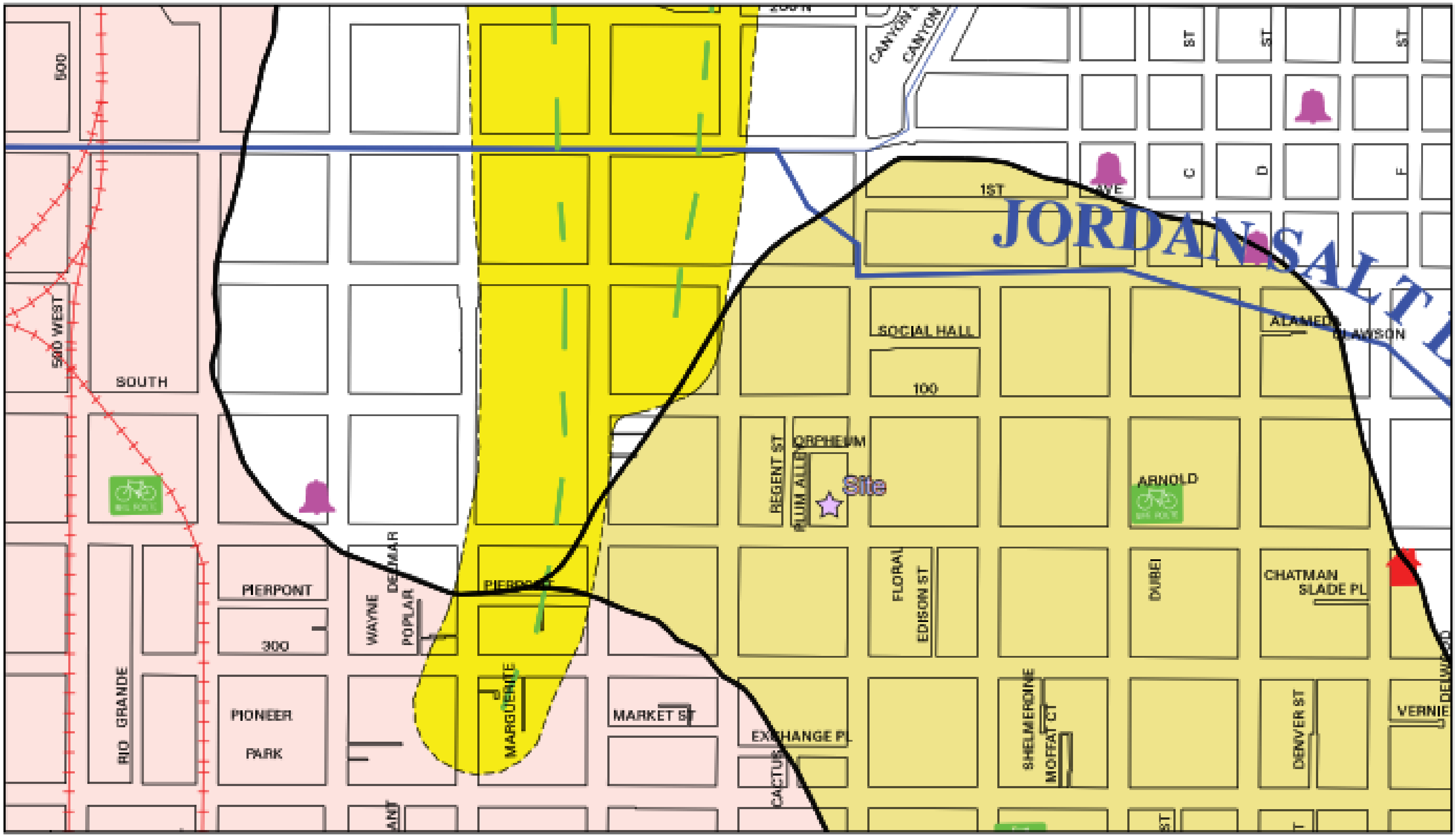
Introduction

- How is slip transferred in a large earthquake from the East Bench to Warm Springs fault?
- The Magna earthquake has highlighted the role of the Warm Springs fault as being a seismic source.
- The downtown area is undergoing another urban renewal with high-rise office and condominium buildings being designed and constructed (it's good to be in tech).
- So, is there a surface faulting hazard in downtown Salt Lake City?
- In the past two decades the issue of surface fault rupture has focused on the Warms Spring fault and how far it extends southward into the downtown area.

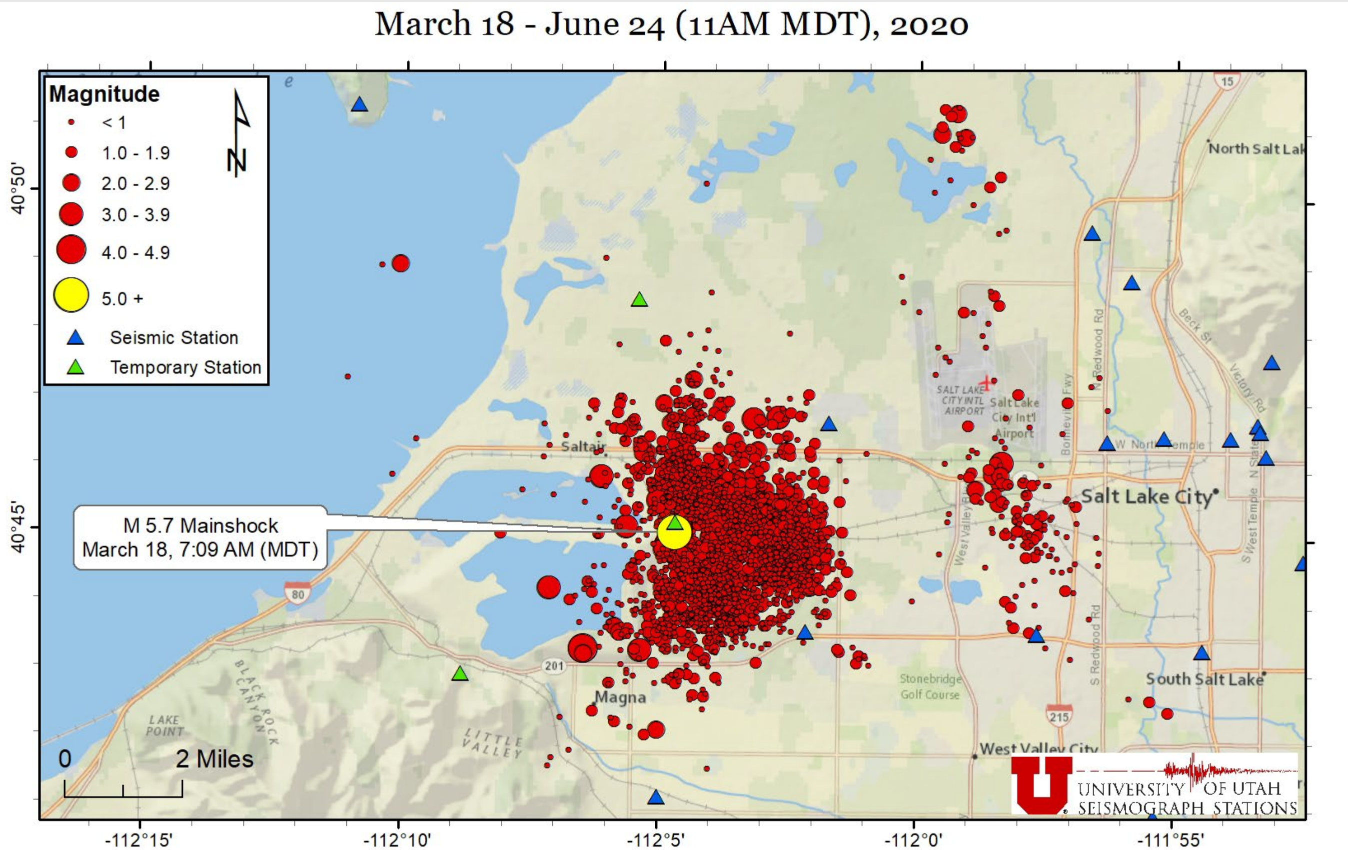
Introduction

- Inspection of a *few* deep excavations have shown no evidence for surface faulting.
- Now the BSU geophysical results (thanks Lee) indicate that secondary faults are distributed throughout the downtown area so do they represent a surface faulting hazard?
- How do we model the stepover in terms of ground shaking?
- Previously in ground motion modeling, we have considered the Warm Springs and East Bench faults to be connected at depth by a cross fault.
- Hanging wall effects are important in ground motion modeling and the downtown area is in the hanging wall of at least the East Bench fault.
- It is unclear which sections of the Salt Lake City segment should contribute to those effects.

Salt Lake City Surface Rupture Special Study Areas Near the Site

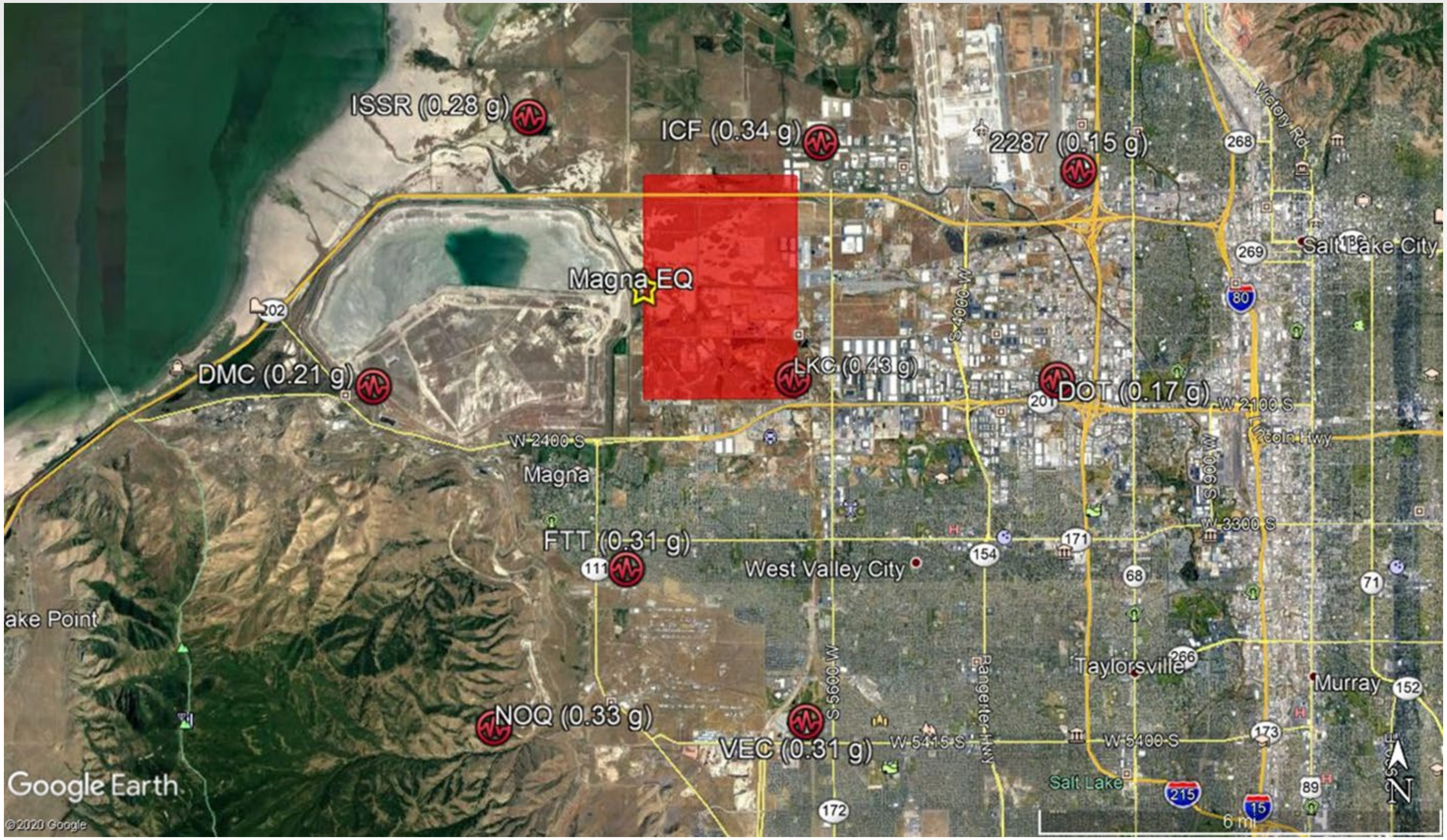


2020 Magna Earthquake Sequence



Courtesy of UUSS

Proposed Rupture Plane and Near-Field Strong Motion Stations



Rupture Plane
5 km long
4 km wide
Dip 35°
Depth 10 km

(Courtesy of Jim Pechmann, UUSS)

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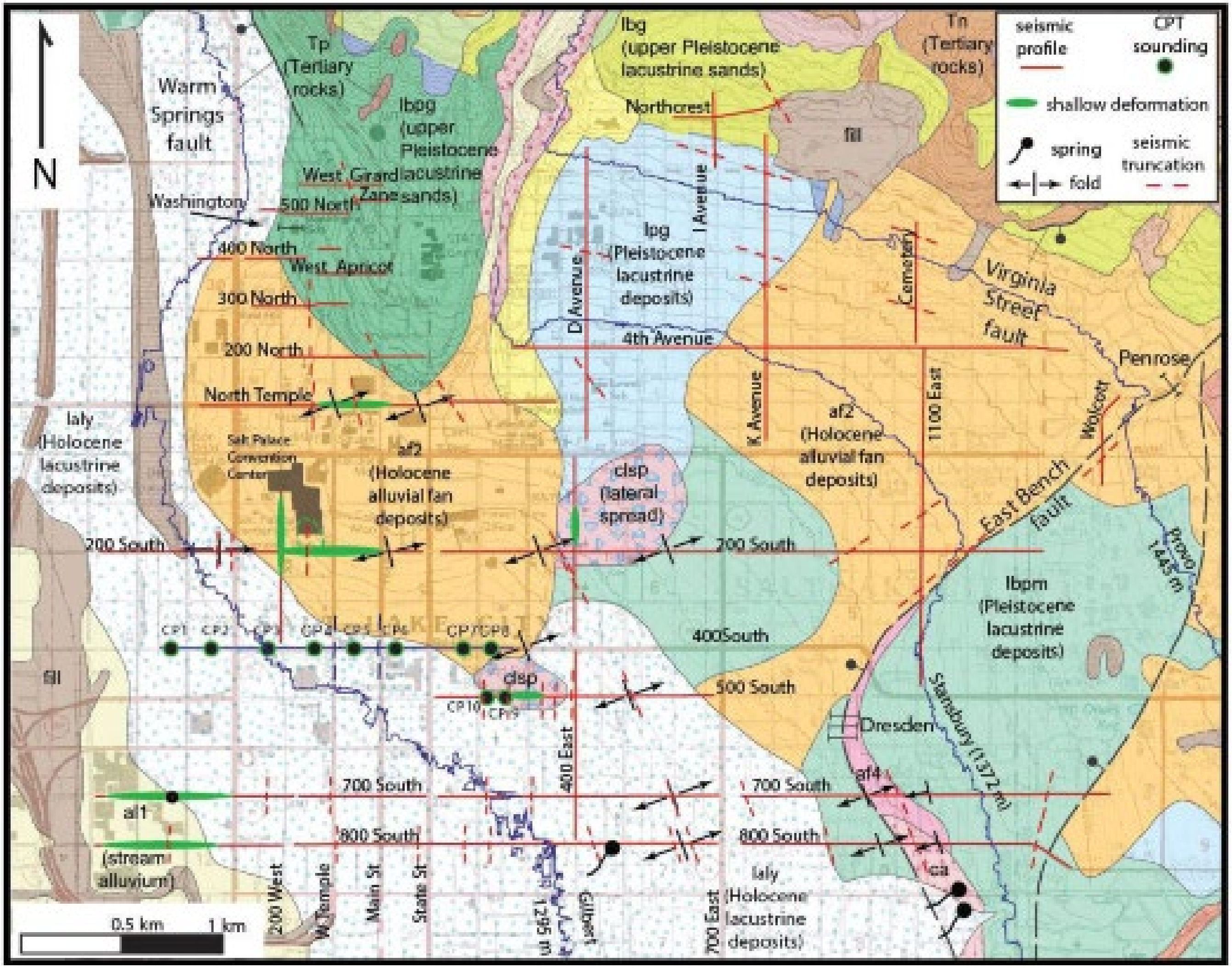
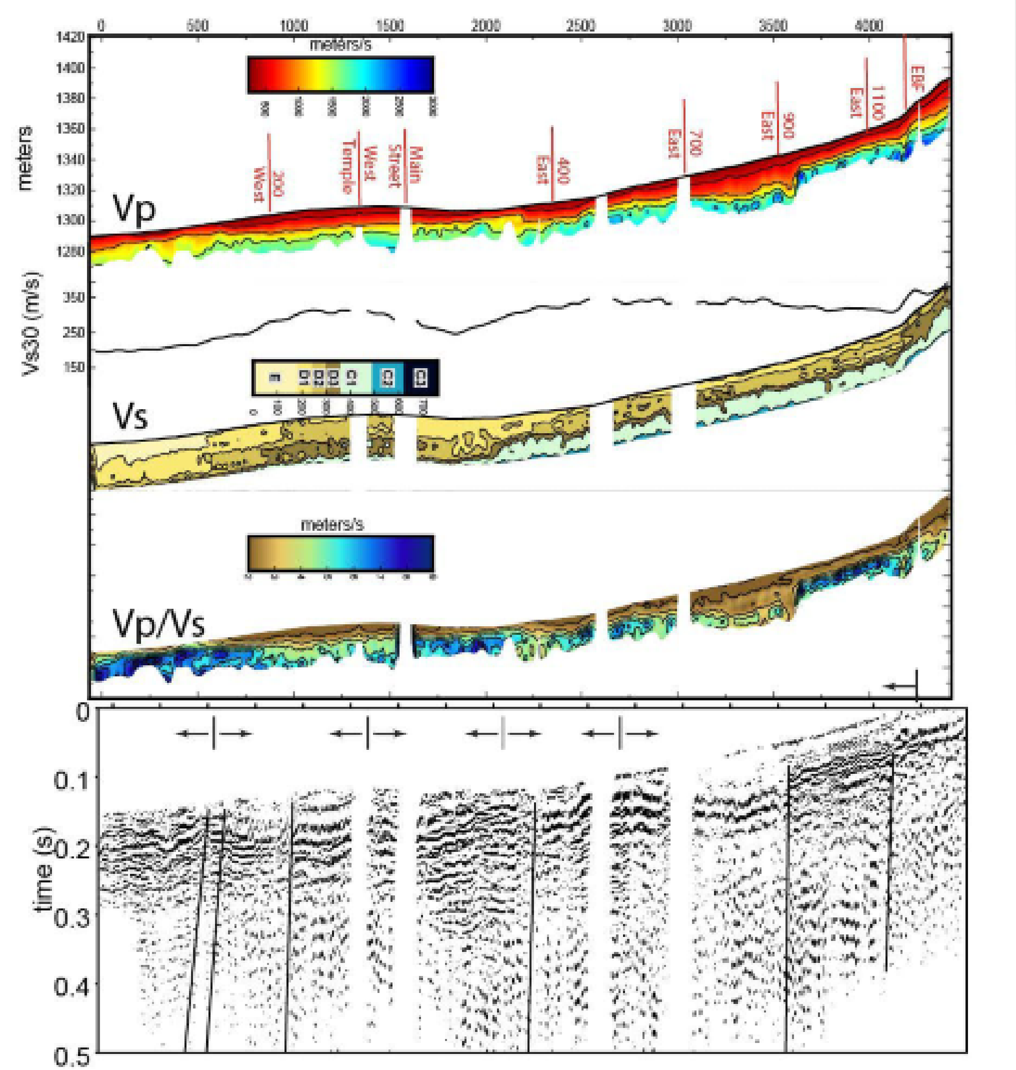
Locations of BSU Seismic Profiles



BSU Seismic Reflection Results for the 200 South Profile



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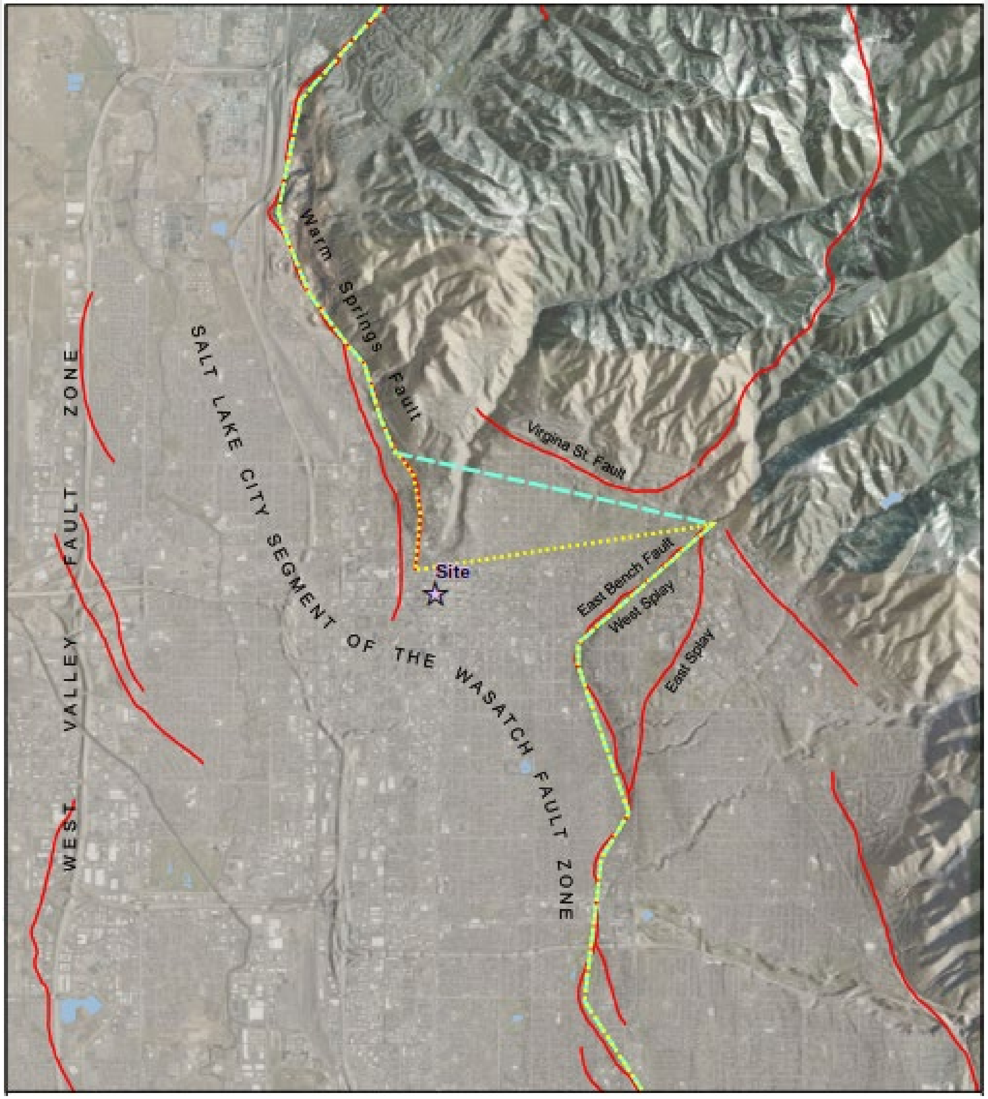
Rupture Scenarios A and B for the Warm Springs-East Bench Fault Stepover



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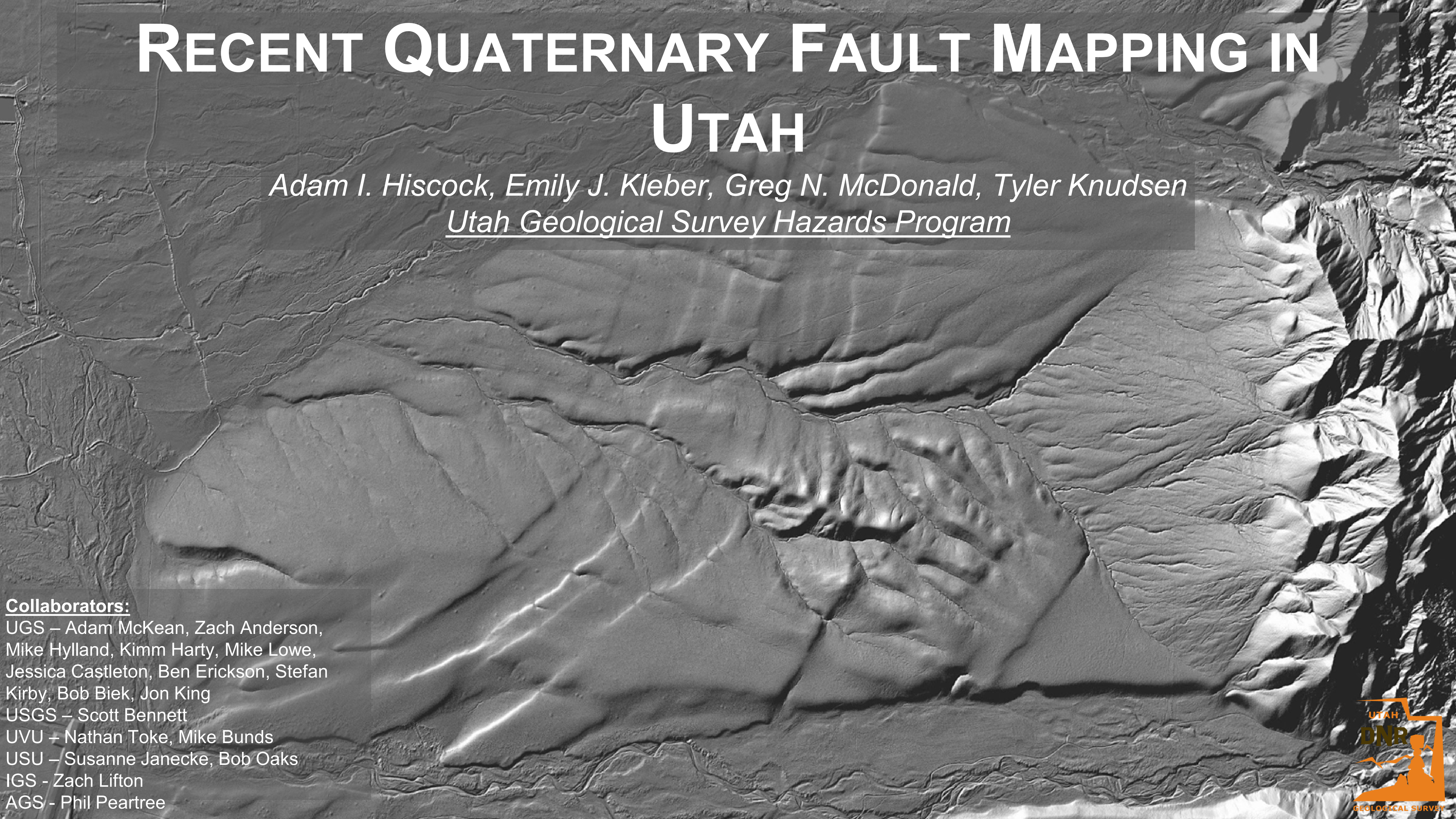
Summary

- We need to pay greater attention to the surface faulting hazard in the downtown area.
- Every deep excavation in the downtown area needs to be inspected for the presence of faulting.
- Shallow high-resolution seismic imaging should be performed to assess whether the faulting imaged by BSU reaches the ground surface.
- Kinematic modeling of the stepover should be performed to assess how slip might be distributed across the stepover and how it should be incorporated into hazard calculations.



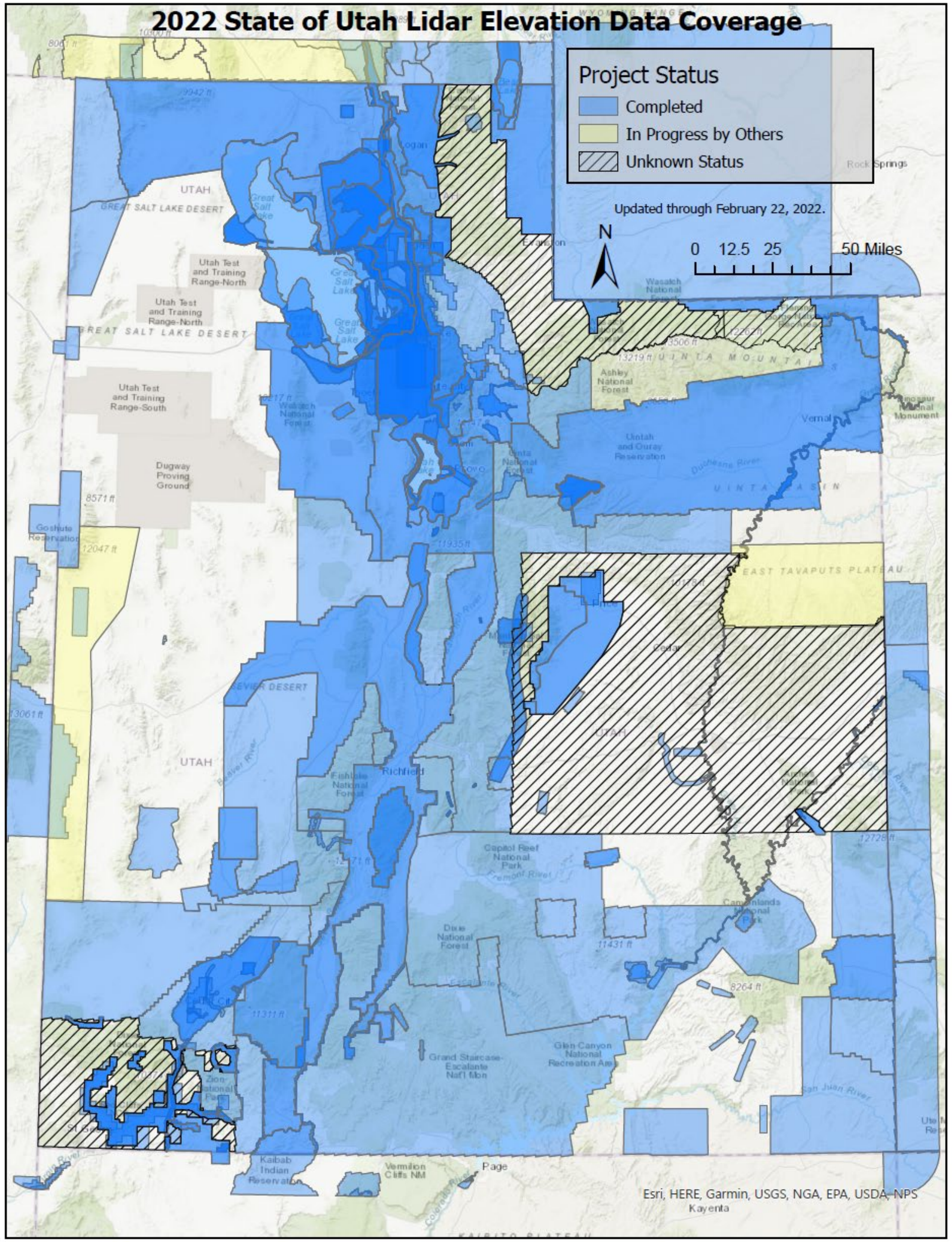
Recent Quaternary Fault Mapping in Utah

Adam I. Hiscock, Emily J. Kleber, Greg N. McDonald, Tyler Knudsen
Utah Geological Survey Hazards Program

Collaborators:
UGS – Adam McKean, Zach Anderson, Mike Hylland, Kimm Harty, Mike Lowe, Jessica Castleton, Ben Erickson, Stefan Kirby, Bob Biek, Jon King
USGS – Scott Bennett
UVU – Nathan Toke, Mike Bunds
USU – Susanne Janecke, Bob Oaks
IGS - Zach Lifton
AGS - Phil Peartree

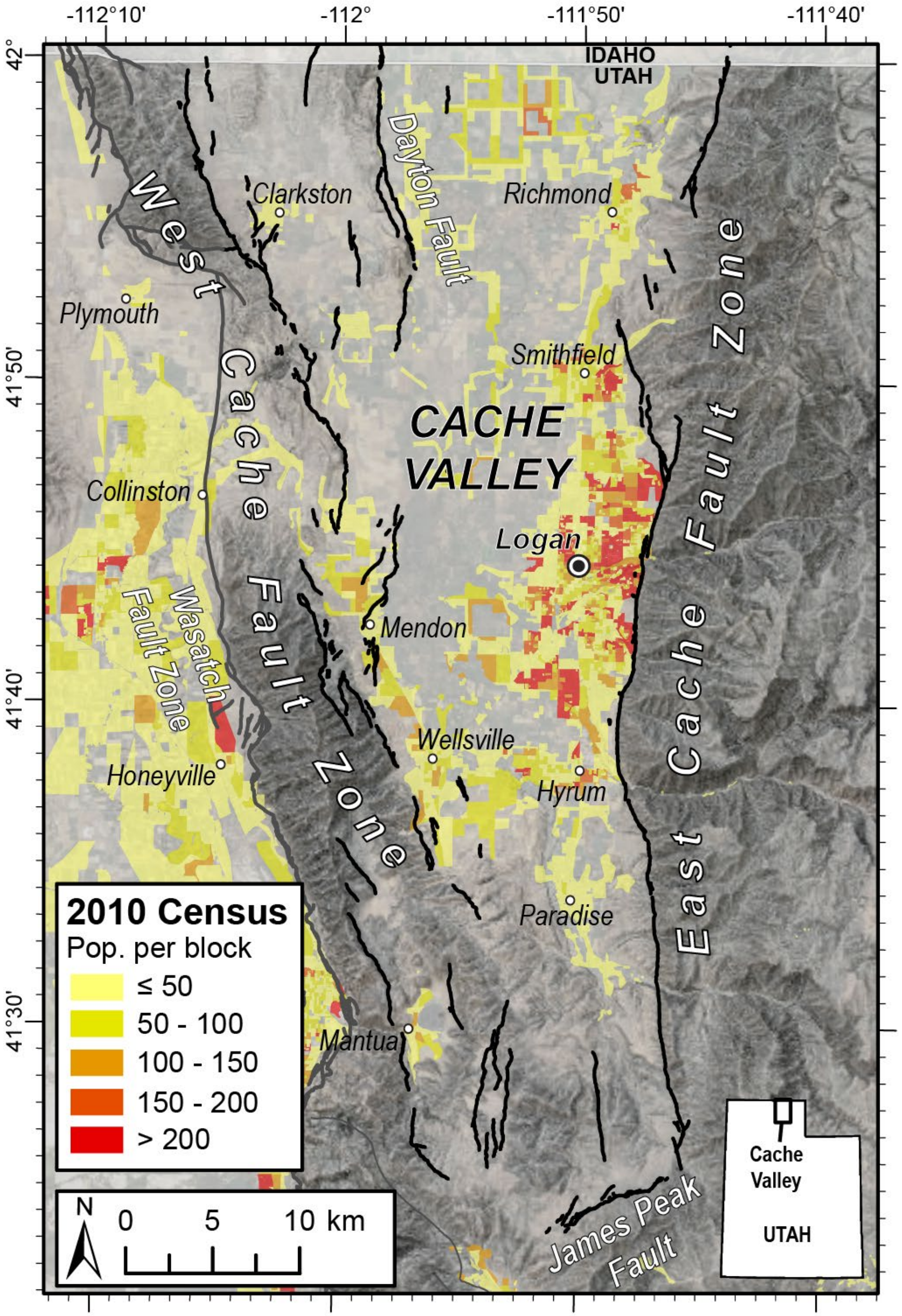
Objectives

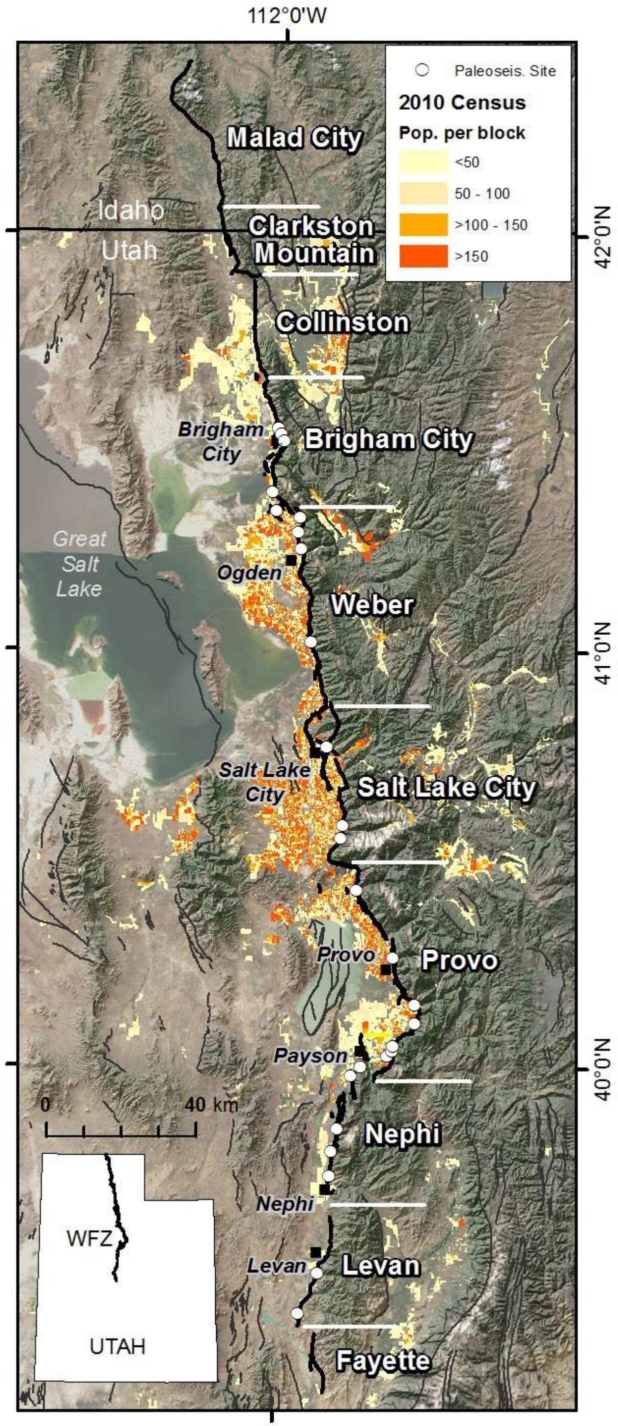
- Availability of high resolution lidar data has expanded greatly in the past decade - great tool for characterizing and identifying active faults
- The UGS has been involved in multiple USGS External Grants funded fault mapping projects since 2014
- New mapping available through the UGS's *Utah Geologic Hazards Portal,* and will be used for updates to the USGS National Sesimic Hazard Maps.
- Necessary to help characterize and identify active faults in rapidly growing and urbanizing parts of Utah
- Identify potential paleoseismic trenching sites



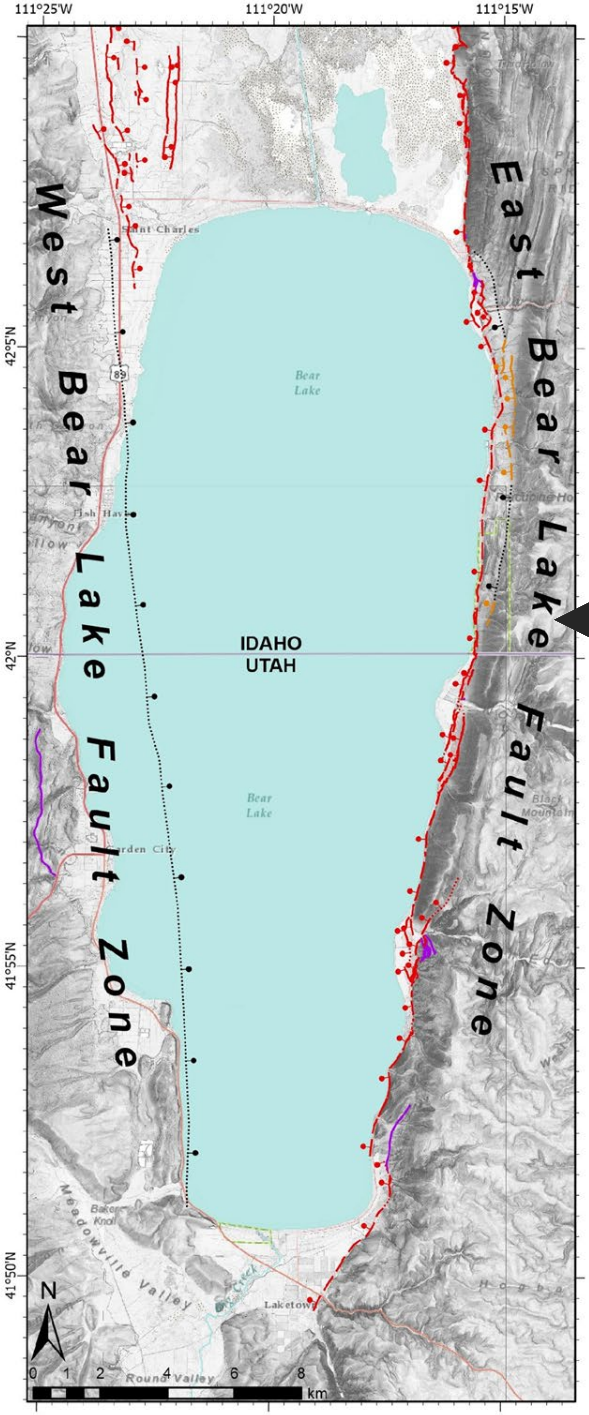
Recently Completed Fault Mapping

- Wasatch Fault Zone (UGS RI-280): re-mapped at 1:24,000 scale (or better) – available in UGS's *Utah Geologic Hazards Portal*
- East and West Cache Fault Zones (USGS FTR): re-mapped 14 1:24,000 scale quadrangles.



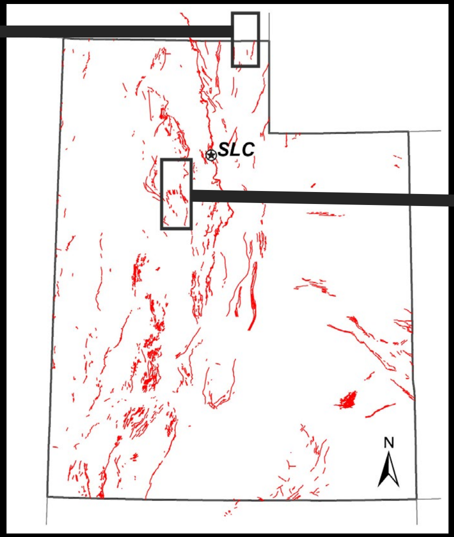


East and West Bear Lake Faults & Oquirrh-Topliff Hills Fault Zones

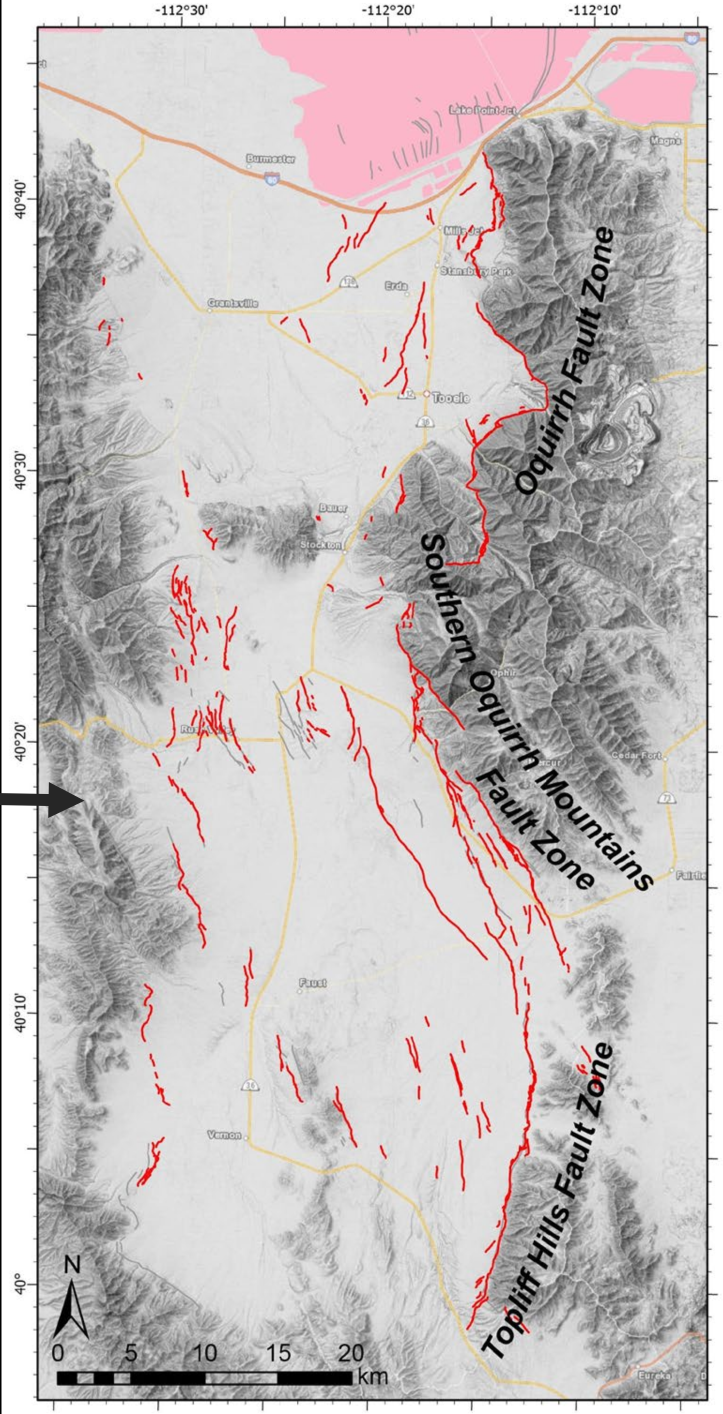


- Collaborative project with Idaho Geological Survey (Z. Lifton)
- Consistent cross-border fault geometry & attributes (BRPEWG Priority)

- Available in UGS's *Utah Geologic Hazards Portal*

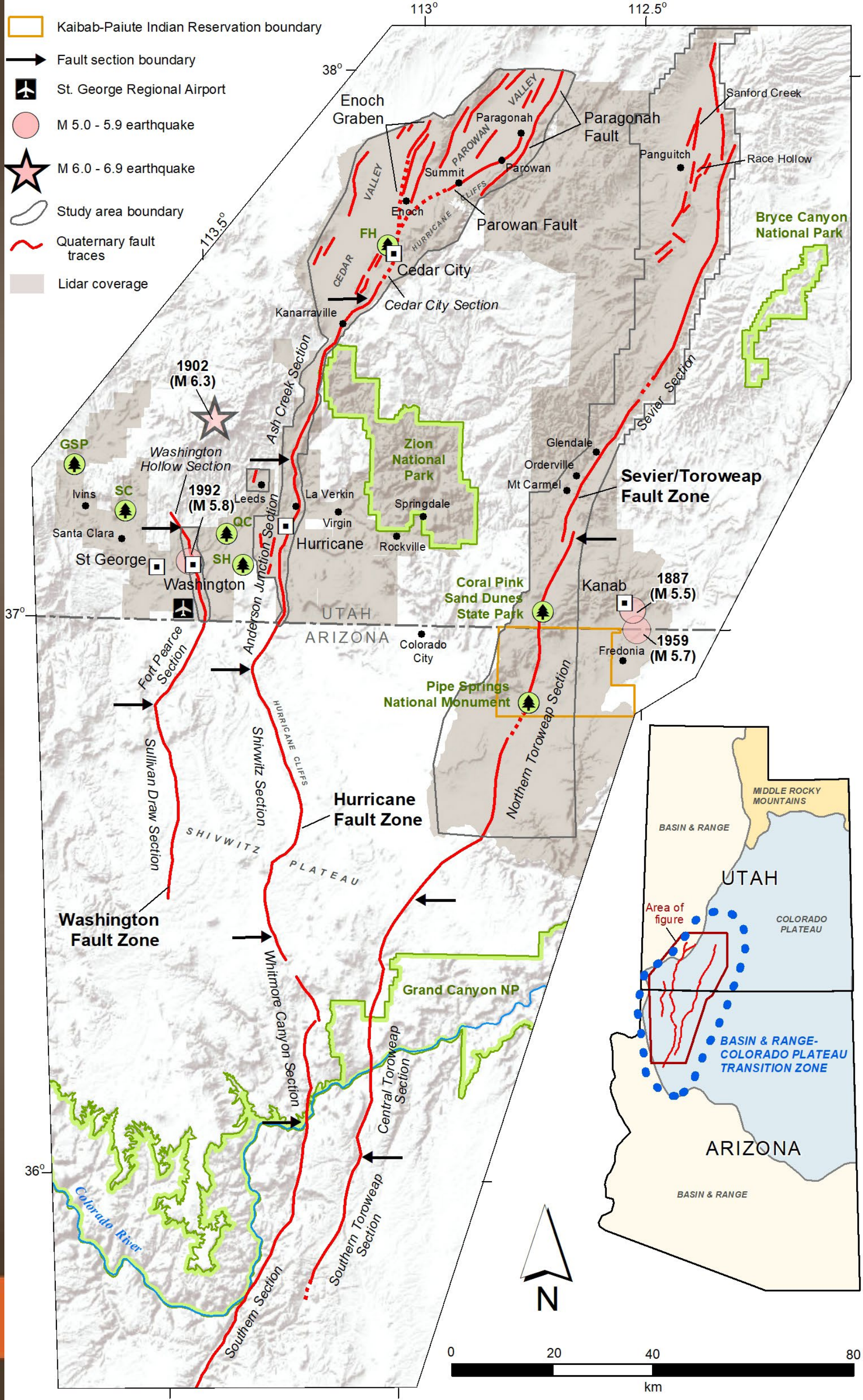


- Identified and extended many intra-basin faults in the Tooele and Rush Valleys

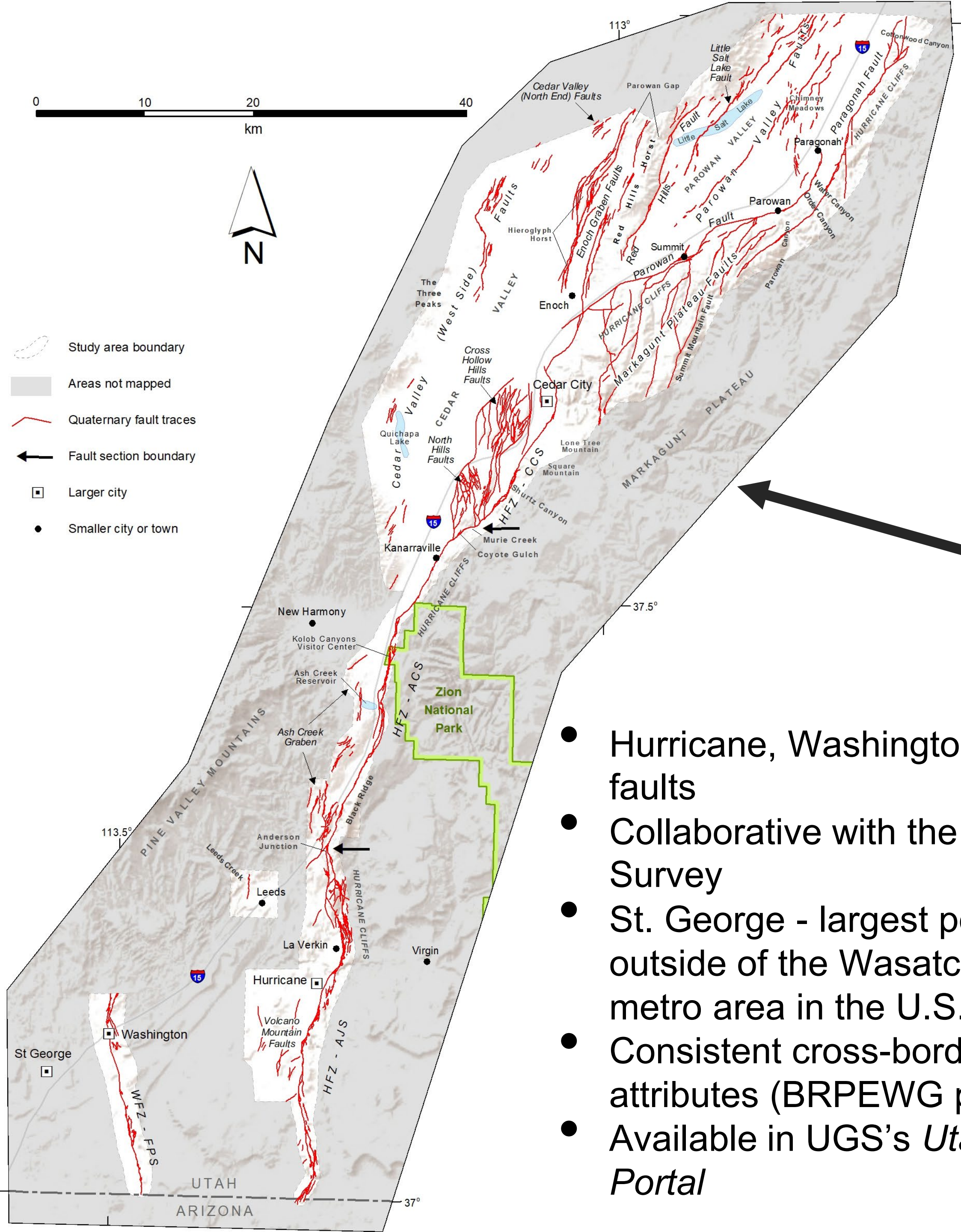


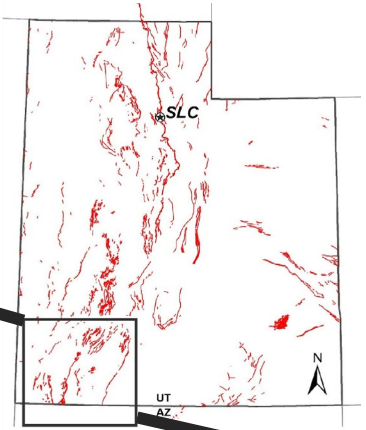
Southern Utah Fault Mapping

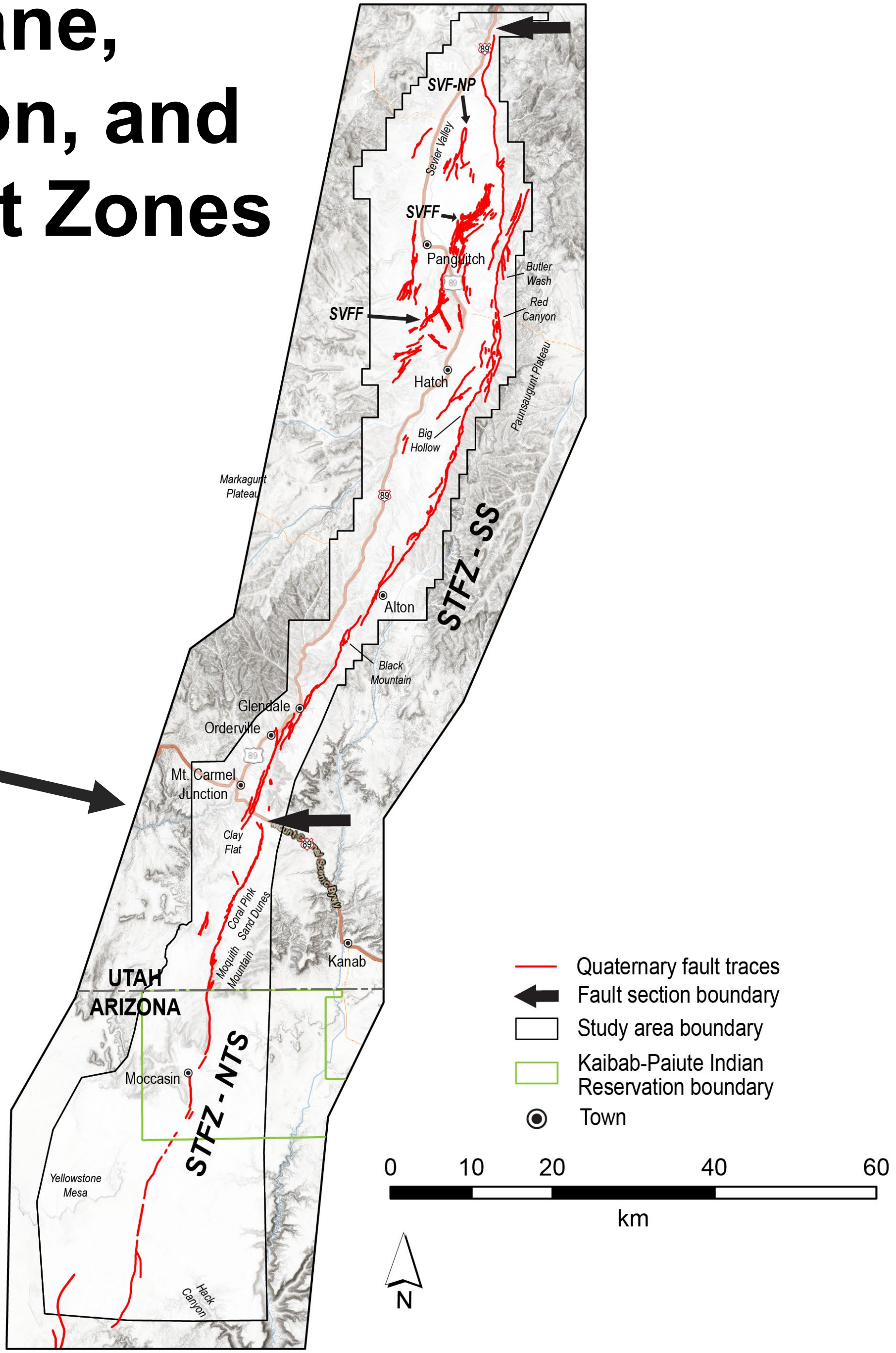
- Hurricane, Washington, and Sevier/Toroweap faults
- Collaborative with the Arizona Geological Survey
- St. George - largest population center in Utah outside of the Wasatch front, fastest growing metro area in the U.S. (2000-2006)
- Consistent cross-border fault geometry & attributes (BRPEWG priority)
- Available in UGS's *Utah Geologic Hazards Portal*



Hurricane, Washington, and Sevier Fault Zones







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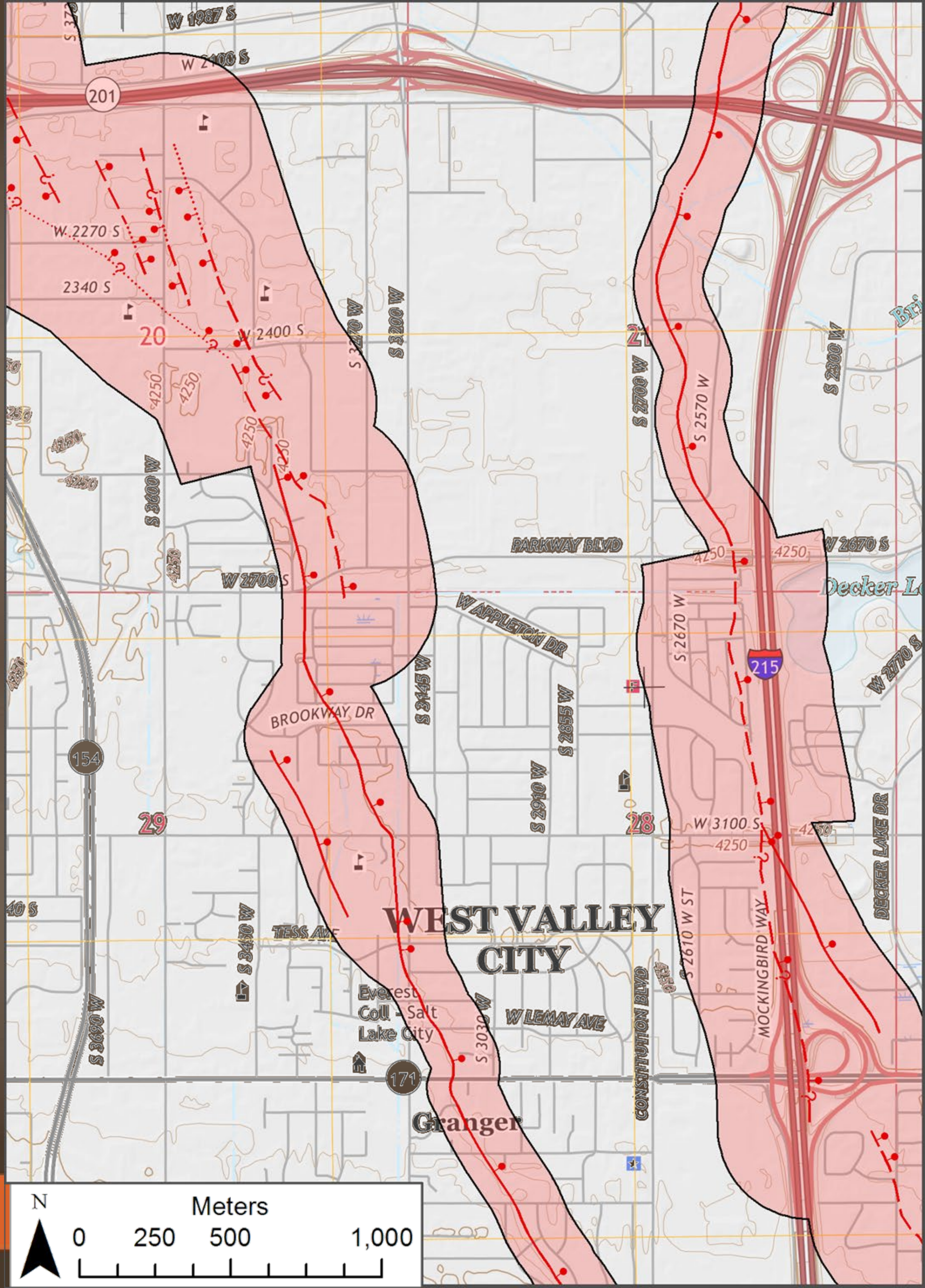
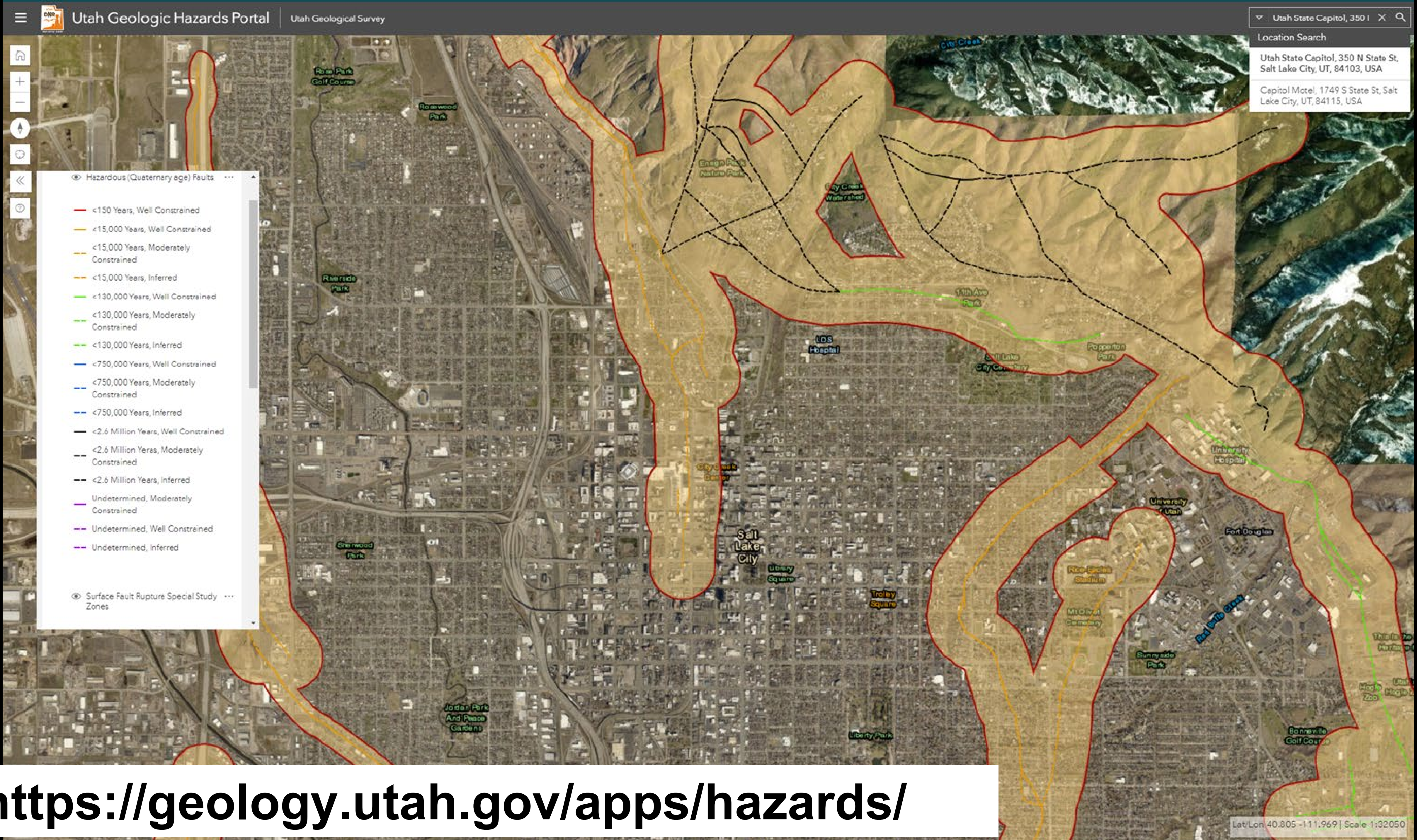
Special-Study-Zones

- Special-study-zones are delineated around each mapped trace
- Assist local governments with urban planning and developing hazard ordinances
- Help facilitate understanding of the hazard by triggering additional surface faulting studies





https://geology.utah.gov/apps/hazards/

Additional & Future Mapping

- USGS GeMS Program – funding for many quads around the state of Utah
  - UGS Mapping Program - Geologic mapping around the state of Utah, specifically along the Wasatch Front
  - Identifying new faults, integrating with UGS Hazards Portal when published
- UGS Hazard Mapping - working on other various 7.5 minute quads (Cedar Fort, Saratoga Springs, Jordan Narrows, Lehi, etc.)
- INGENIOUS Project – Recon level fault mapping/compilation across the Great Basin