CONVERSION OF A FIELD GEODESY MODULE ON THE NEOTECTONICS OF THE NORTHERN ROCKY MOUNTAINS INTO AN ONLINE EXERCISE

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Motivation

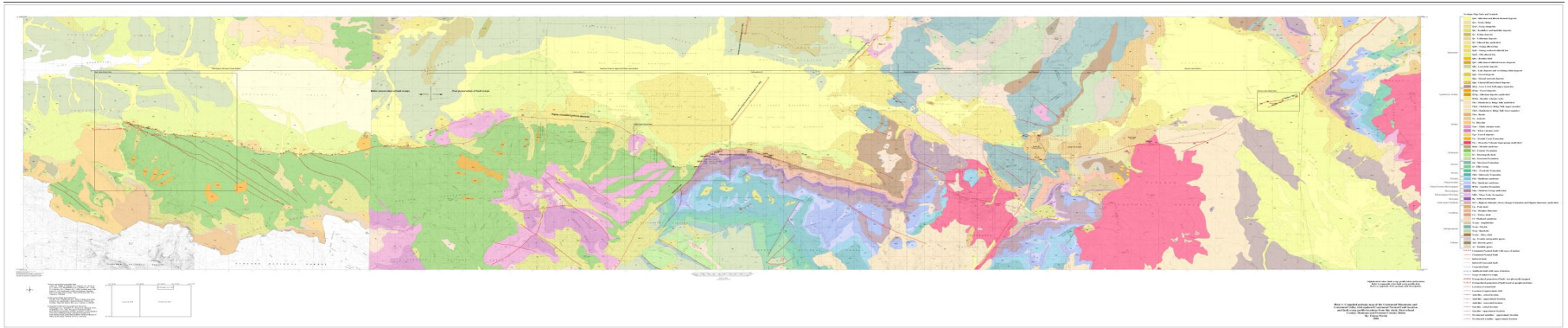
- COVID-19 pandemic
- Virtual field camp rooted in data and analytics
- Virtual methods included:
    - Remote sensing, GIS software, and geodetic data




Presenters: Hunter Martin, Macdennis Nwaeze, Rachel Ronquille, Olivia Wren

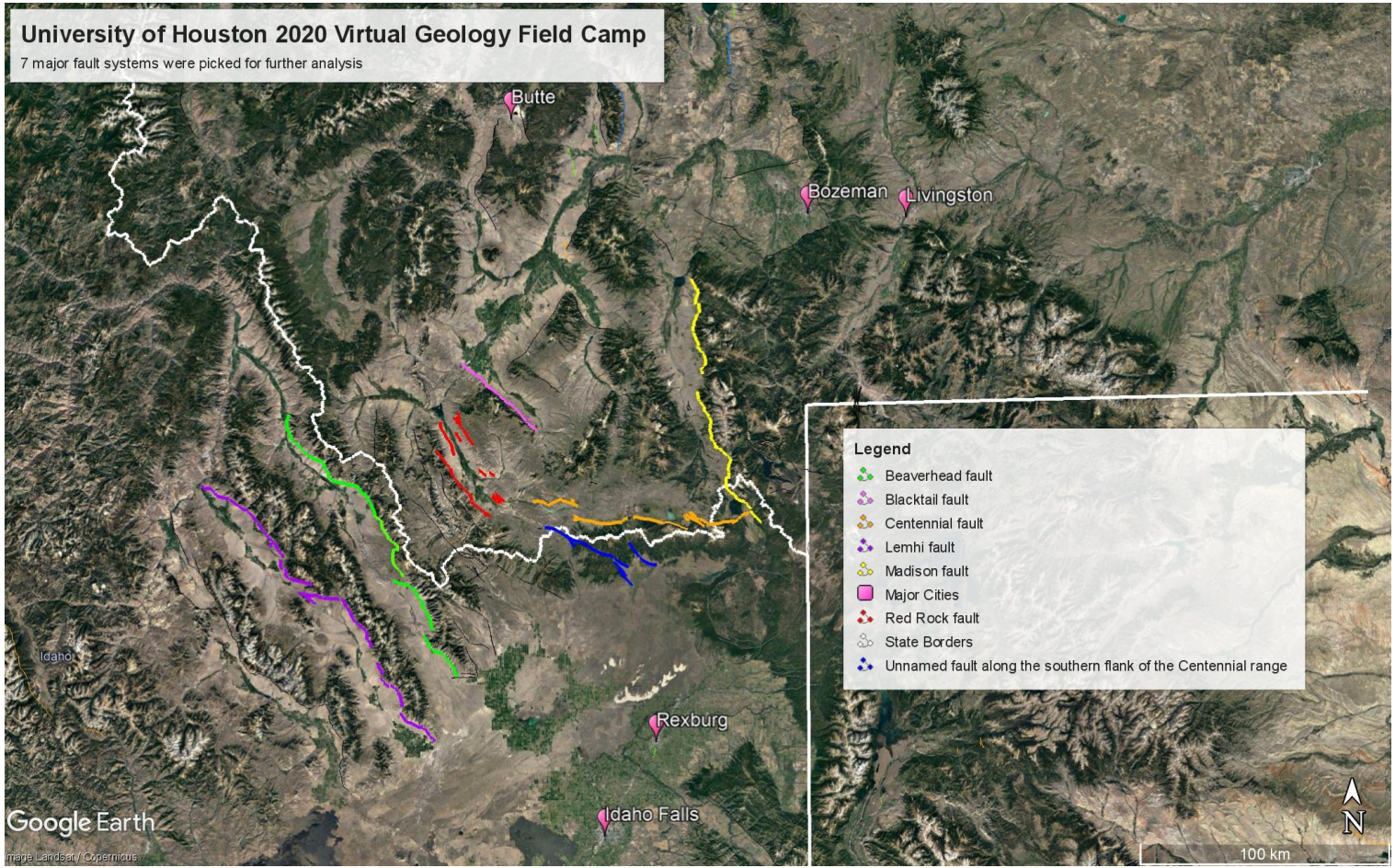
Literature Review

- 1st step in fault analysis was searching for useful data
- Virtual field camp had heavy emphasis on published literature
- Afternoon sessions were spent in group sessions reviewing published material



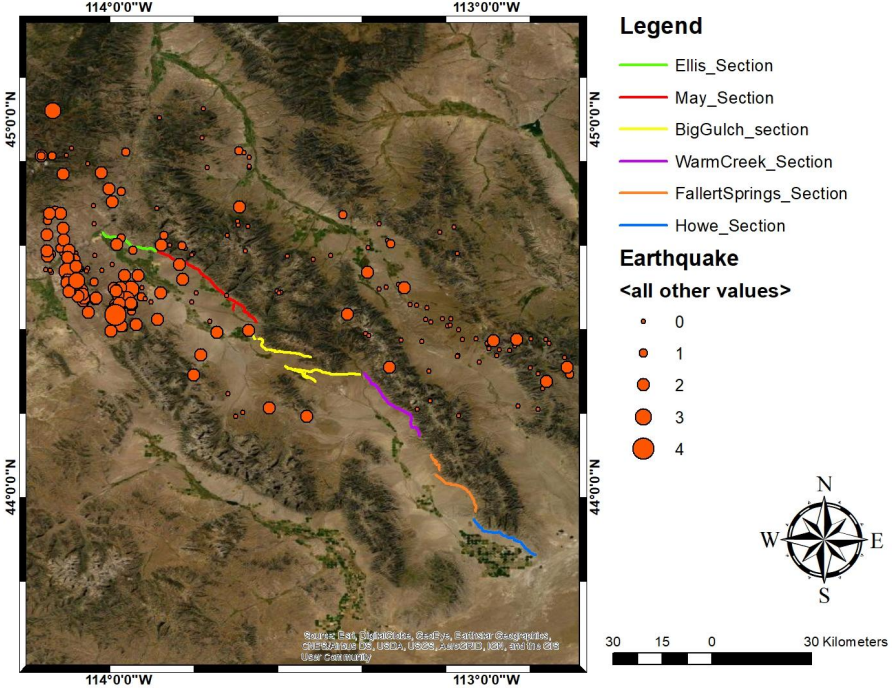
Petrik (2008)

7 Major Quaternary Faults



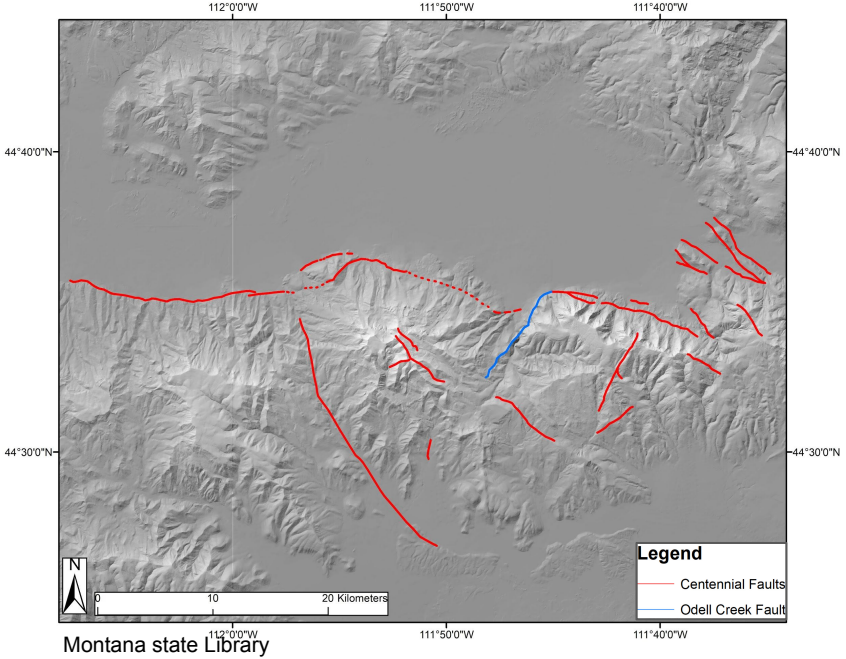
Surface image analysis and fault trace mapping on DEMs, hillshade images, and orthophotos using Google Earth and ArcGIS

Orthomosaic imagery showing different segments of the Lemhi fault



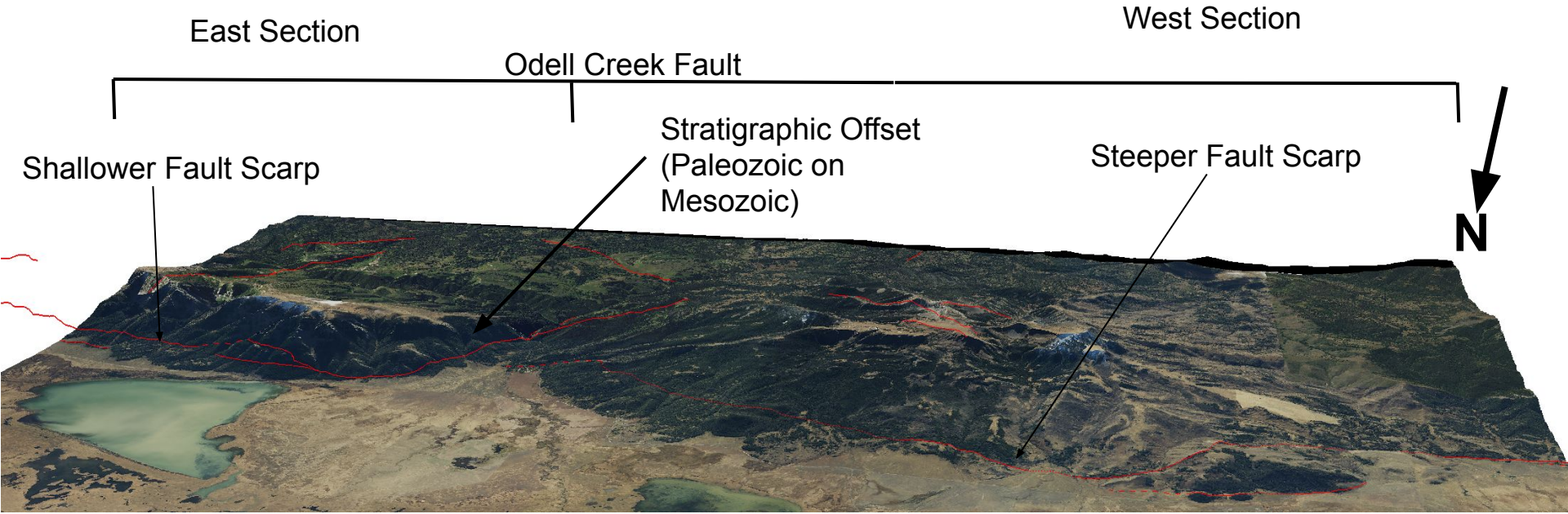
Montana state Library

Hillshade imagery showing the Centennial normal fault

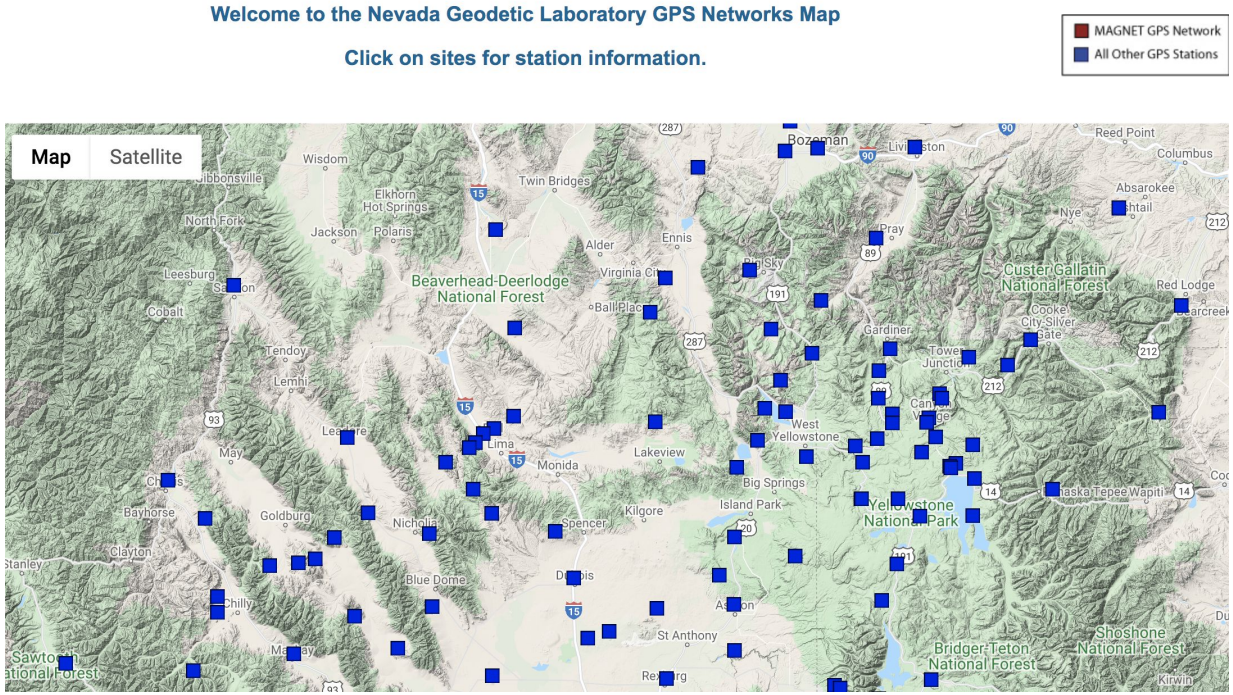


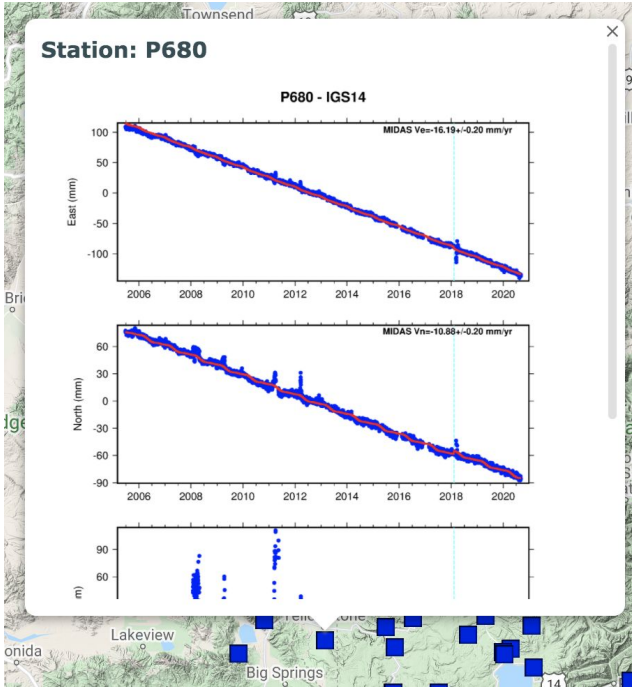
Montana state Library

3D Models from DEM's and Orthomosaics

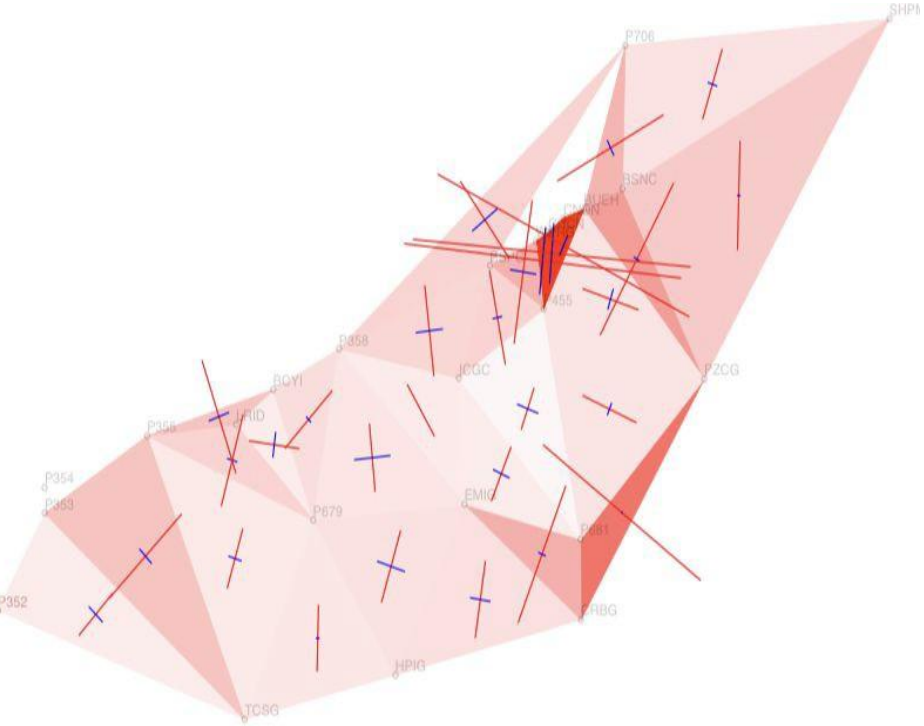


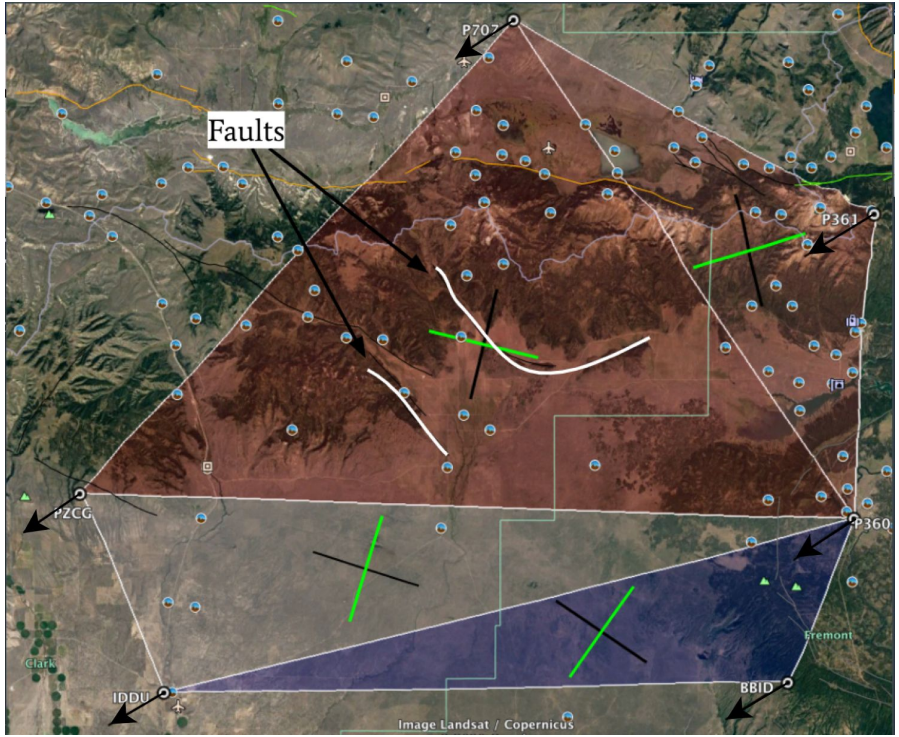
Geodesy using ready-to-go GPS from the University of Nevada-Reno Geodesy Lab





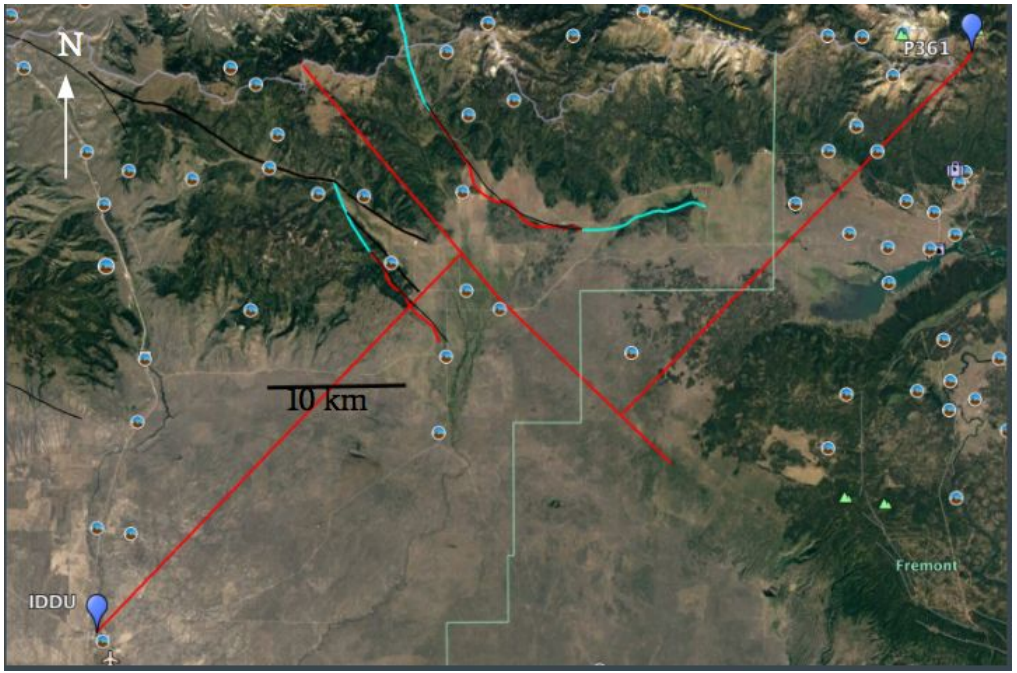
Elastic Strain Accumulation analysis via SSPX analysis and velocity profiling

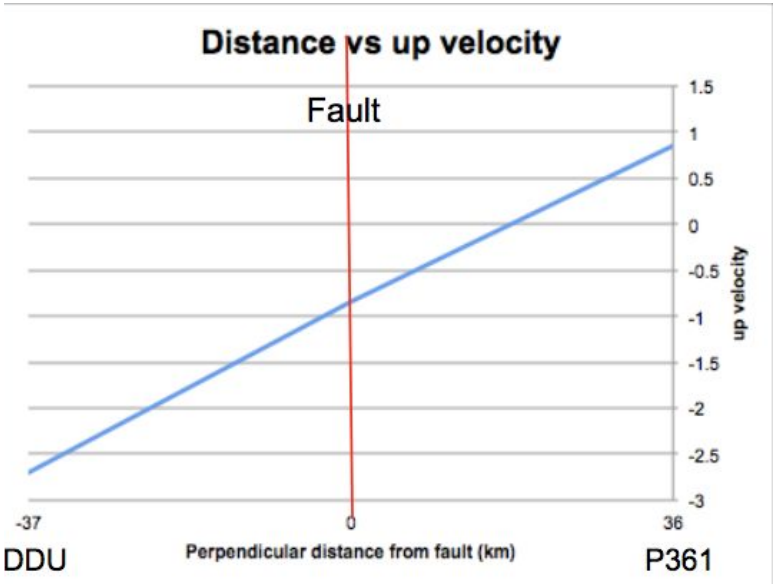




Nestor Cardozo's SSPX software

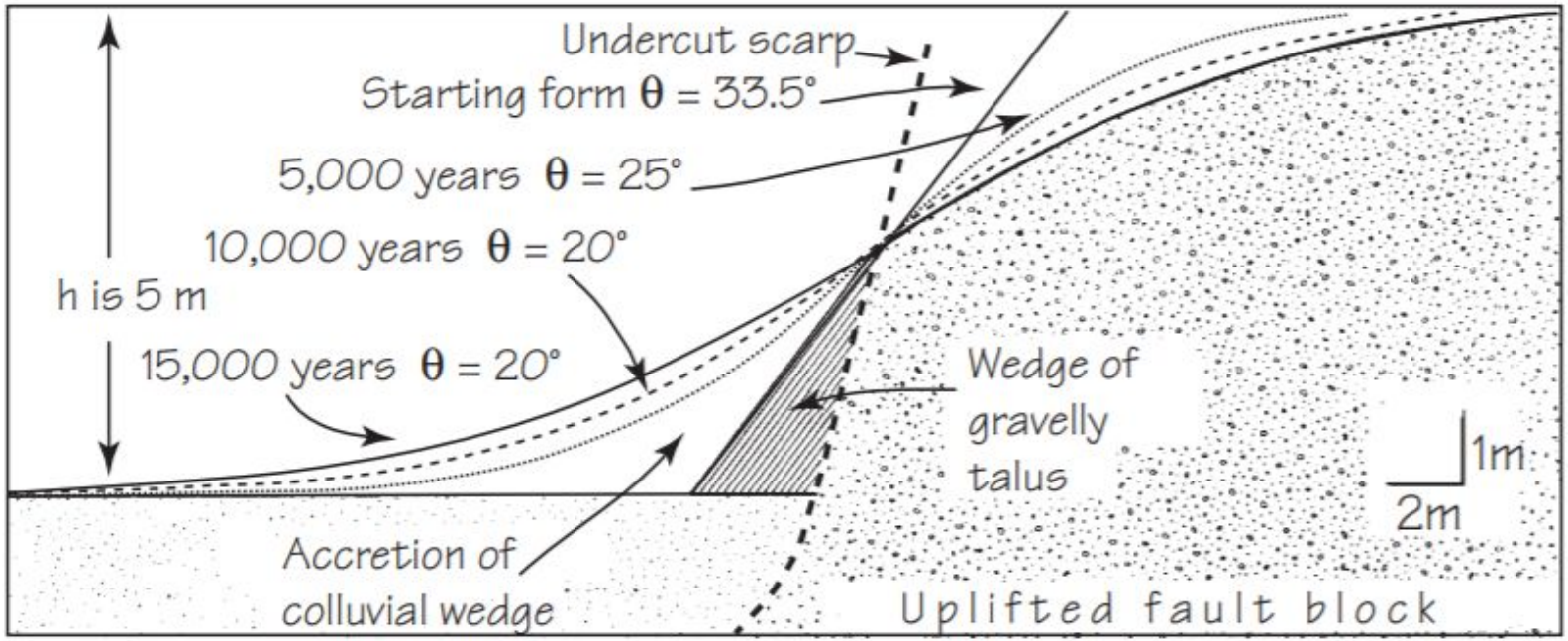
Elastic Strain Accumulation analysis via SSPX analysis and velocity profiling





Tectonic Geomorphology

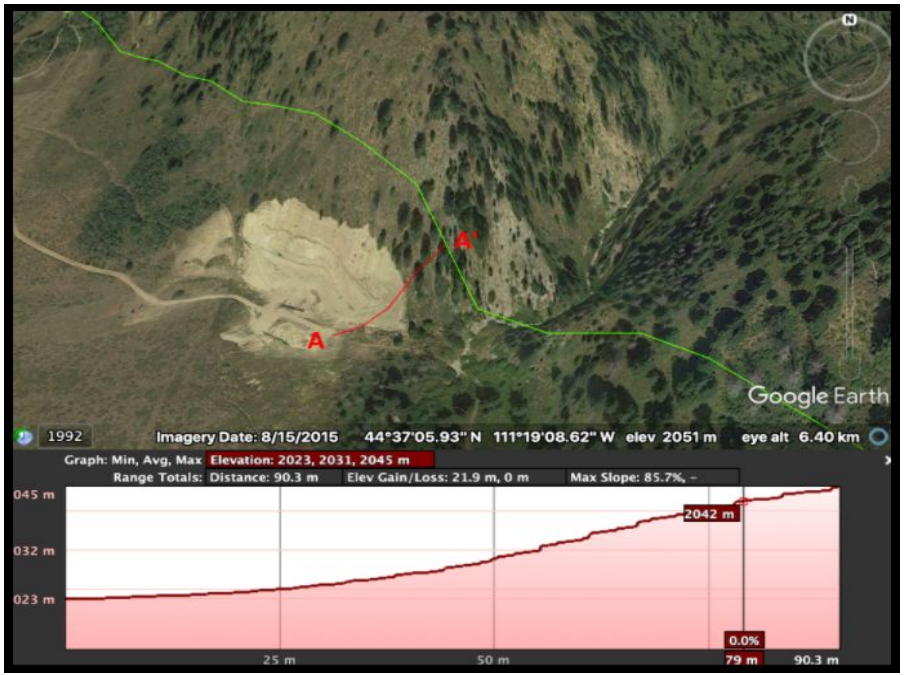
Fault scarp dating using diffusion equation modeling

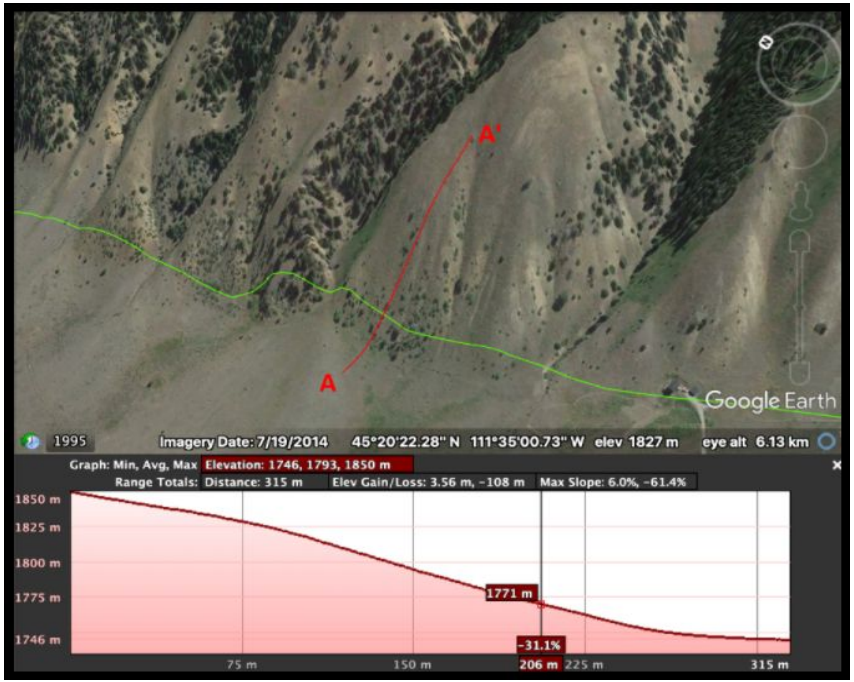


(Bull 2007)

Tectonic Geomorphology

Methods

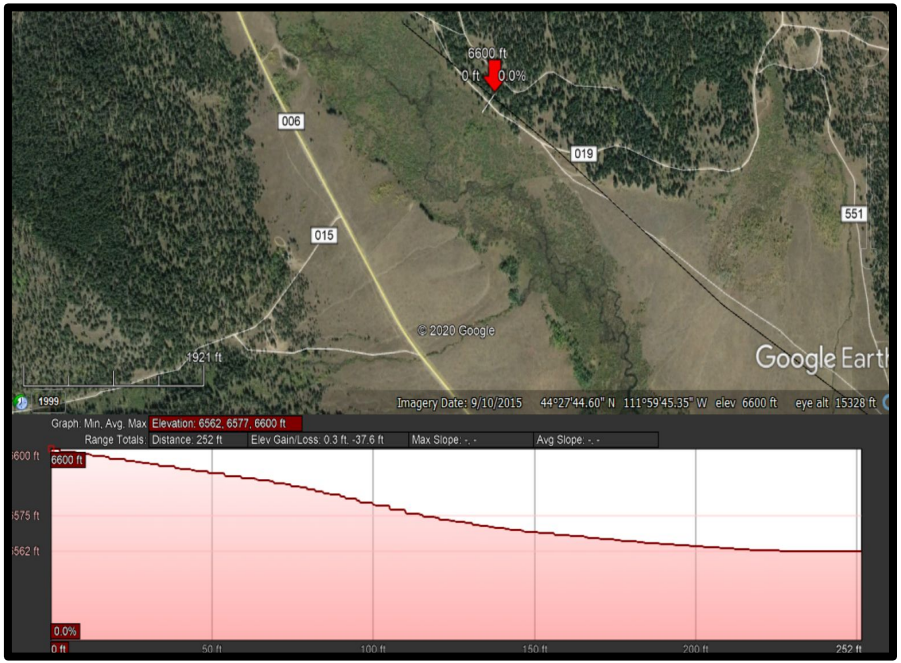




Fault scarp profiles from the Madison Fault

Tectonic Geomorphology

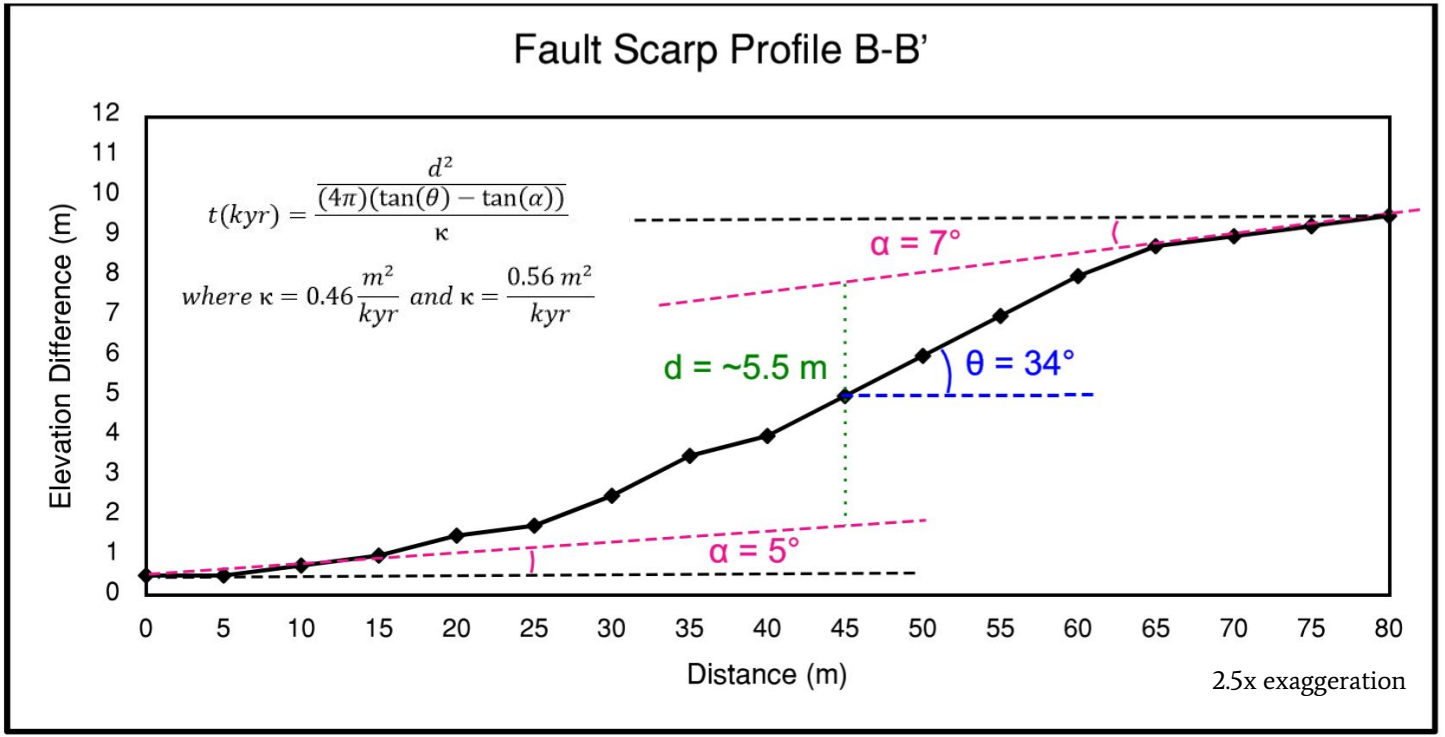
Methods



Fault scarp profiles from the unnamed faults south of the Centennial Range

Tectonic Geomorphology

Methods



Tectonic Geomorphology

Results from the unnamed faults south of the Centennial Mountains

Profile	Surface Offset (m)	Calculated age (yrs)	
		0.46 m^2/kyr	0.52 m^2/kyr
A	5.0	5,000	4,000
B	5.5	8,000	6,000
C	5.5	9,000	8,000
D	6.0	10,000	8,000
E	7.5	14,000	12,000
F	8.5	11,000	9,000
G	9.0	22,000	18,000
H	12.0	37,000	30,000
I	12.5	41,000	34,000
J	16.0	44,000	36,000
K	26.0	102,000	84,000

- Fault scarps analyzed in the unnamed faults south of the Centennial Mountains yielded Upper Pleistocene to Holocene ages

Tectonic Geomorphology

Results from the Madison faults

Profile	Surface Offset (m)	Calculated age (yrs)	
		0.46 m^2/kyr	0.56 m^2/kyr
A	46.0	928,000	762,000
B	40.0	2,137	1,891
C	8.0	257	227

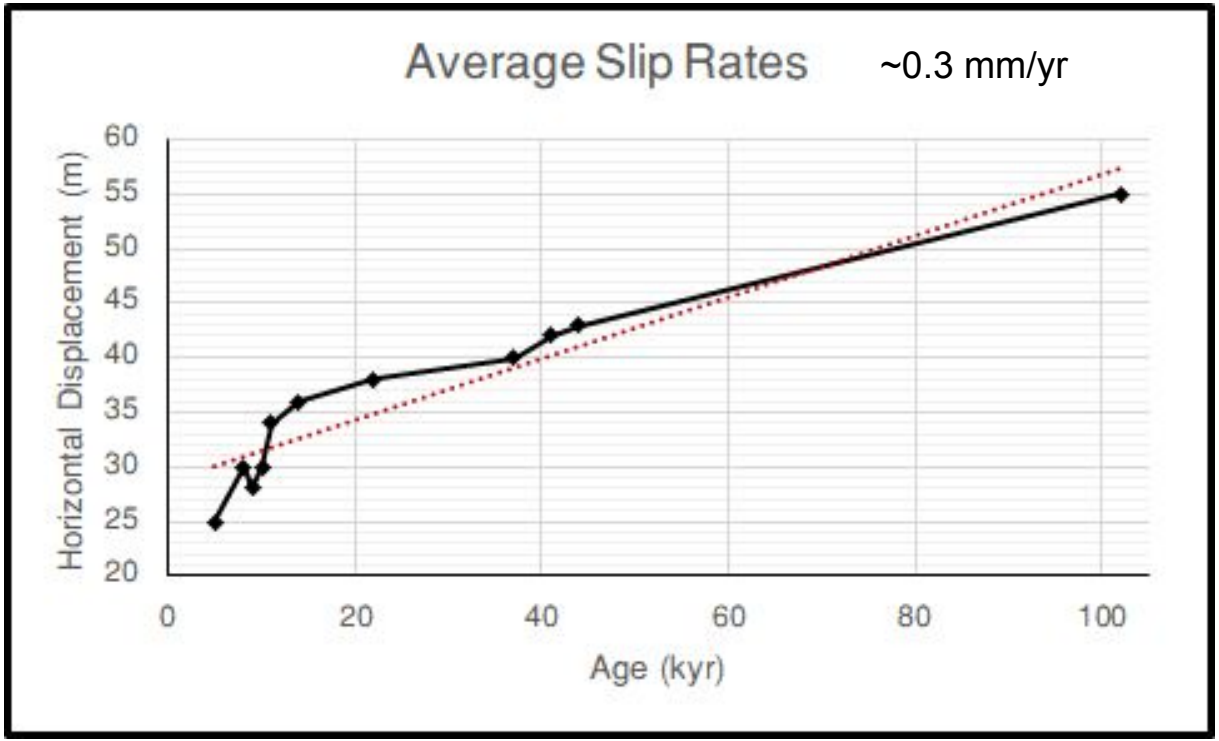
Analysis by Kaitlin Thomas

- Fault scarps analyzed in the Madison faults yielded lower Pleistocene to Holocene ages

Tectonic Geomorphology

Results

- Average slip rates on the unnamed faults south of the Centennial Moutnains calculated using a graphical method

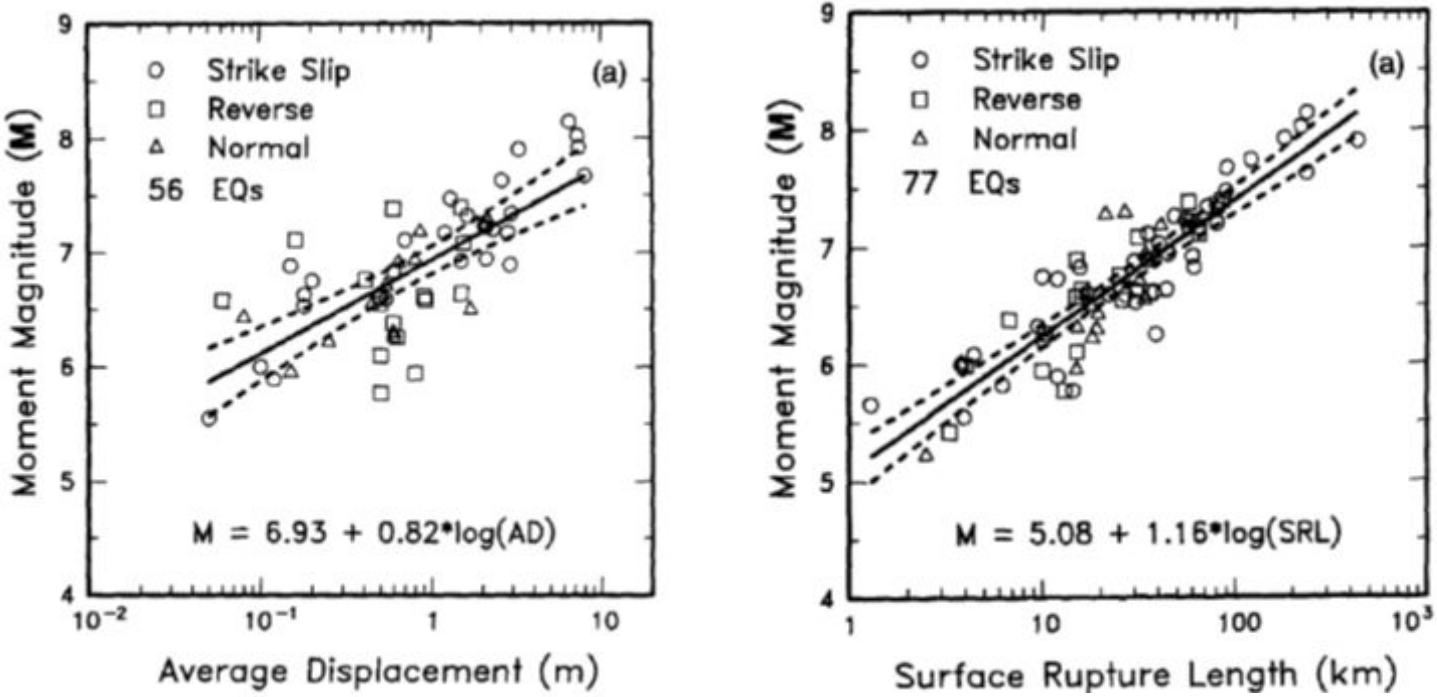


Tectonic Geomorphology

-
- There are limitations to applying fault diffusion equation modeling virtually…..
  - Low quality DEMs (digital elevation models)

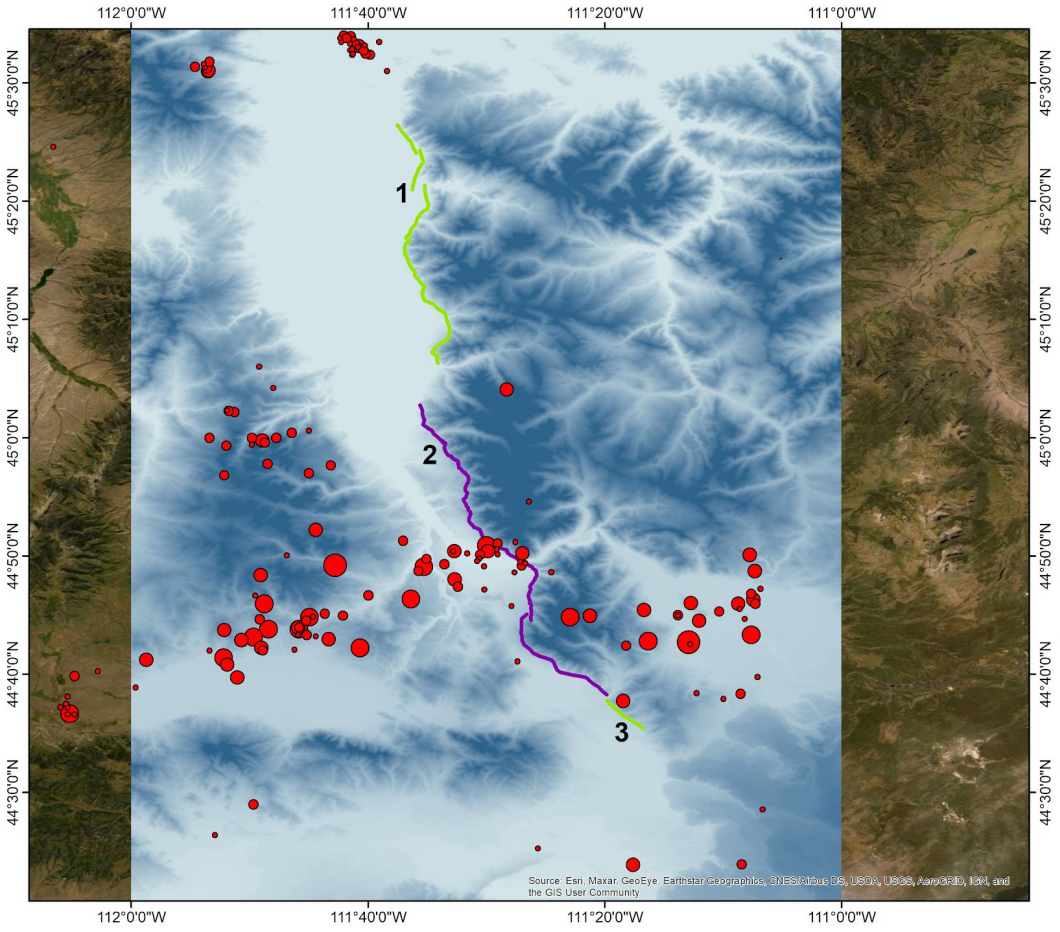
- However, there are also advantages!
  - Faster
  - Easier
  - Can be used for pre-field planning

Fault Physics



Wells and CopperSmith (1994)

Seismicity map of the Madison Fault



N

Legend

madisonfault

slip_rate

- Between 0.2 and 1.0 mm/yr
- Less than 0.2 mm/yr

World Imagery

Earthquake

mag

- 3.00 - 3.20
- 3.21 - 3.66
- 3.67 - 4.30
- 4.31 - 5.23
- 5.24 - 7.30

merge

Value

- High : 3092
- Low : 1869

University of Houston
Date saved: 10/05/2020, 9:11PM

Coordinate System: GCS WGS 1984
Datum: WGS 1984
Units: Degree

Legend

USGS Quaternary Faults

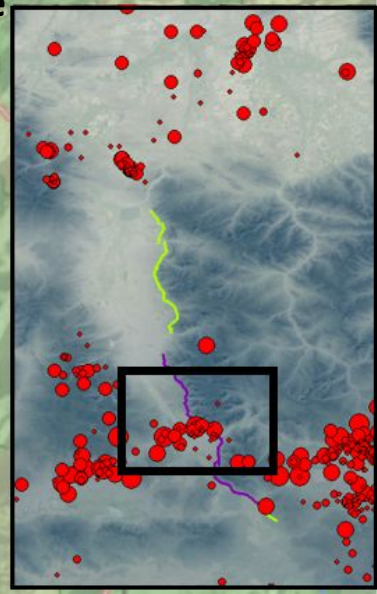
Quaternary Faults Database

- Historic (< 150 years), well constrained location
- Historic (< 150 years), moderately constrained location
- Historic (< 150 years), inferred location
- Latest Quaternary (<15,000 years), well constrained location
- Latest Quaternary (<15,000 years), moderately constrained location
- Latest Quaternary (<15,000 years), inferred location
- Late Quaternary (< 130,000 years), well constrained location
- Late Quaternary (< 130,000 years), moderately contrained location
- Late Quaternary (< 130,000 years), inferred location

Could the increase in Southern earthquake activity be due to neighboring fault systems?

Hebgen Fault System

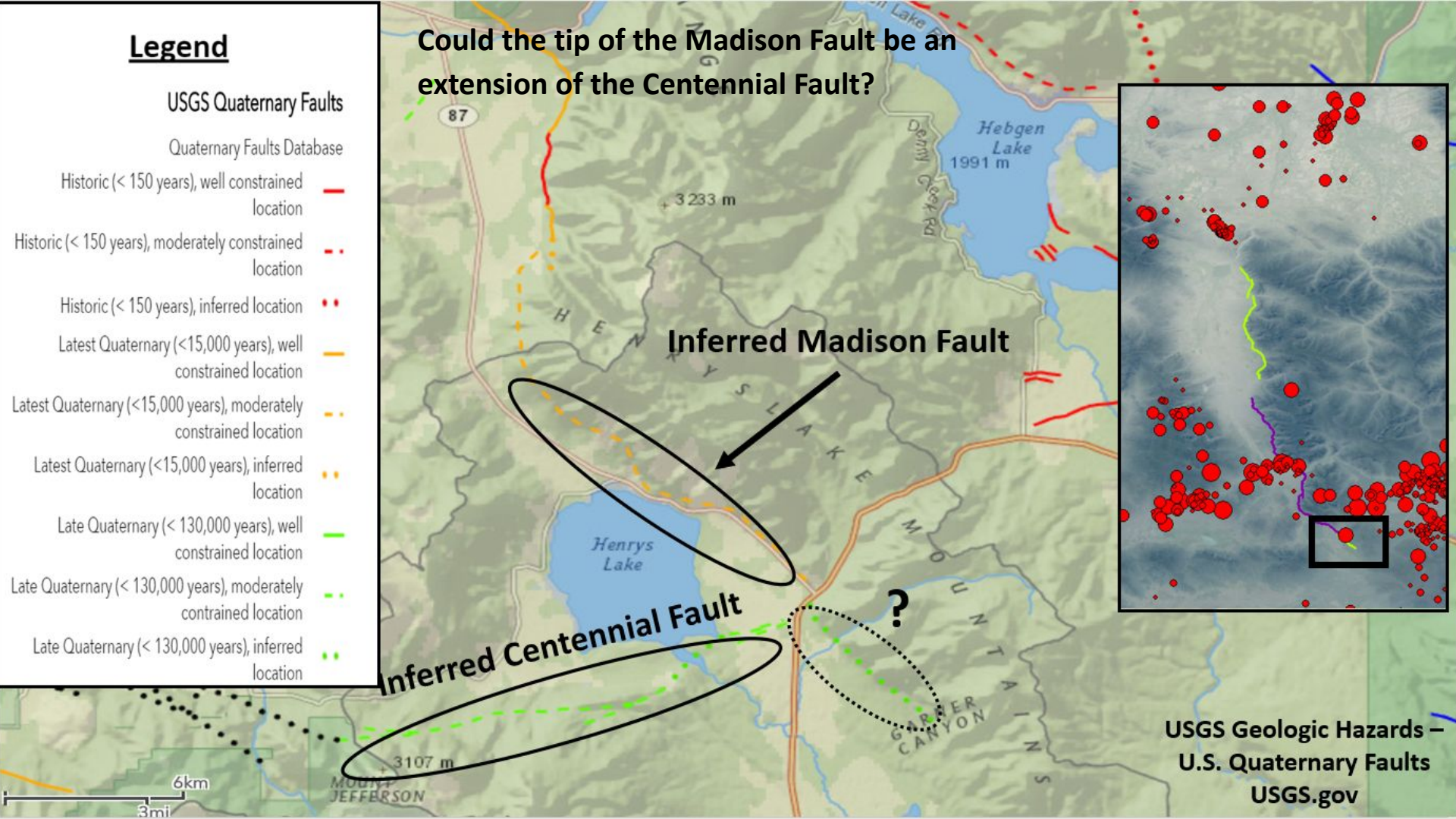
Madison Fault



10km

6mi

USGS Geologic Hazards – U.S. Quaternary Faults USGS.gov


Legend
USGS Quaternary Faults
Quaternary Faults Database
Historic (< 150 years), well constrained location
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Historic (< 150 years), inferred location
Latest Quaternary (<15,000 years), well constrained location
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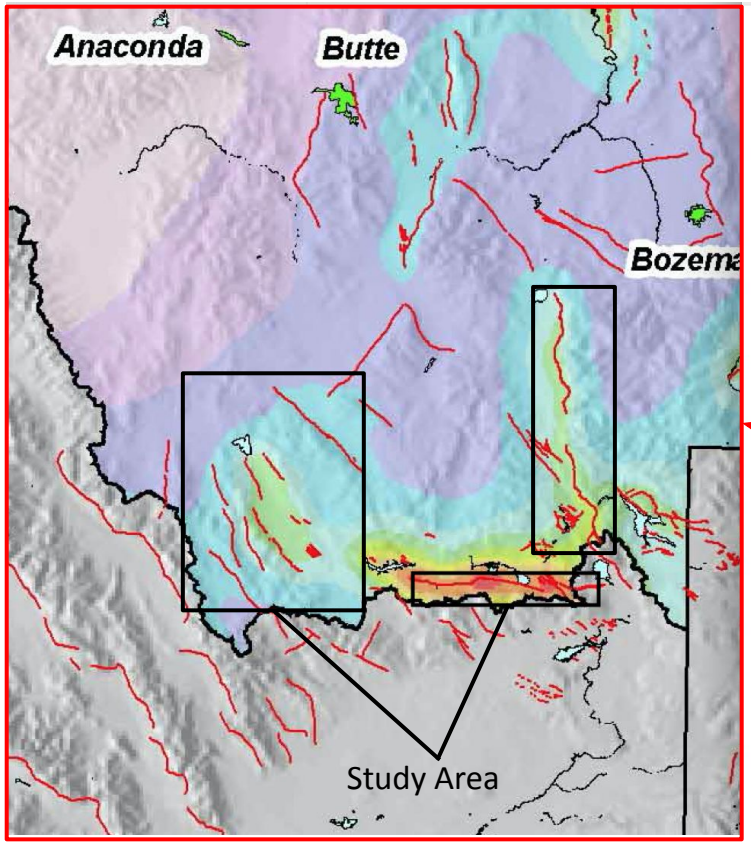
Latest Quaternary (<15,000 years), inferred location
Late Quaternary (< 130,000 years), well constrained location
Late Quaternary (< 130,000 years), moderately contrained location
Late Quaternary (< 130,000 years), inferred location
Could the tip of the Madison Fault be an extension of the Centennial Fault?
Inferred Madison Fault
Inferred Centennial Fault
?
Hebgen Lake
1991 m
3233 m
Henrys Lake
3107 m
87
Denny Creek Rd
HENRYS LAKE MOUNTAINS
BARTER CANYON
MOUNT JEFFERSON
6km
3mi
USGS Geologic Hazards – U.S. Quaternary Faults
USGS.gov

Hazard/Risk Assessment



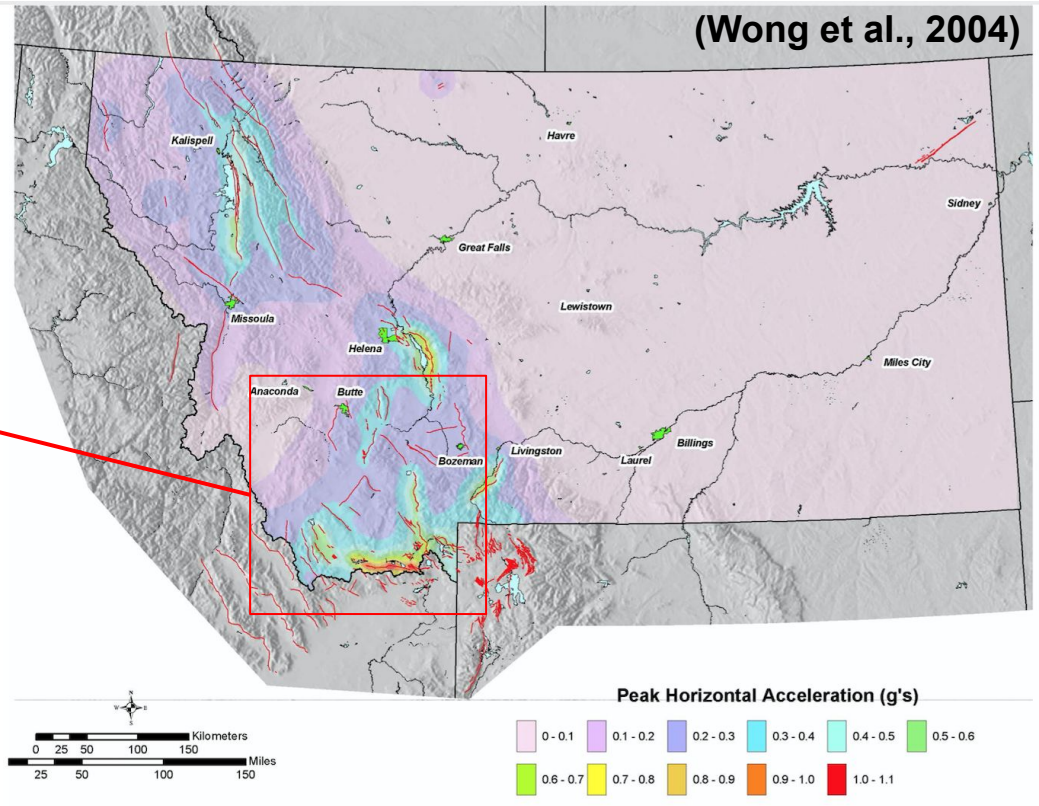
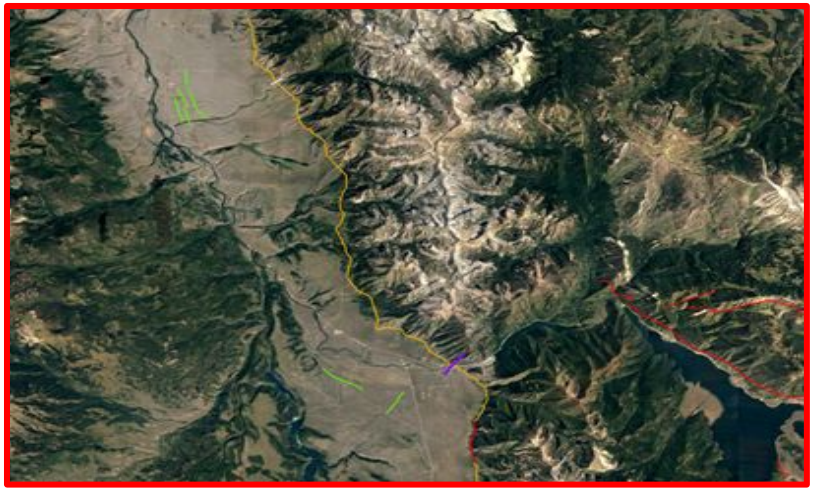


Figure 2. Peak horizontal acceleration (g) on rock for a 5000-year return period

Paleoseismology Madison fault

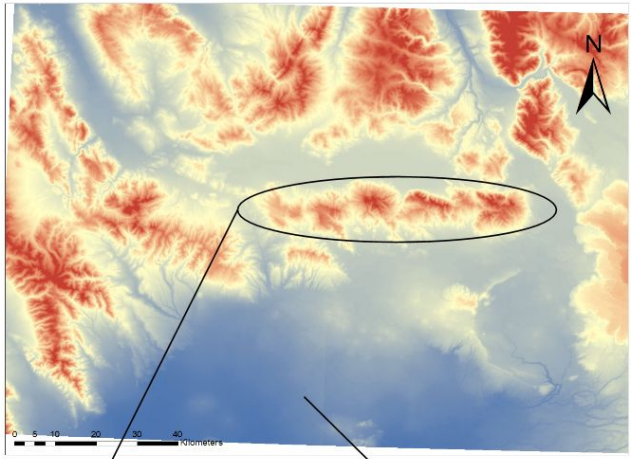
Yellow dots indicate earthquake epicenters



Key area for trench digging

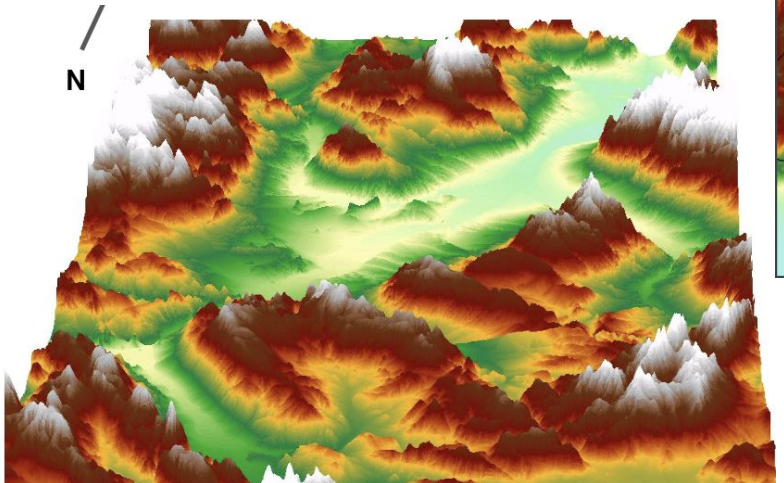
Key area showing massive Landslide

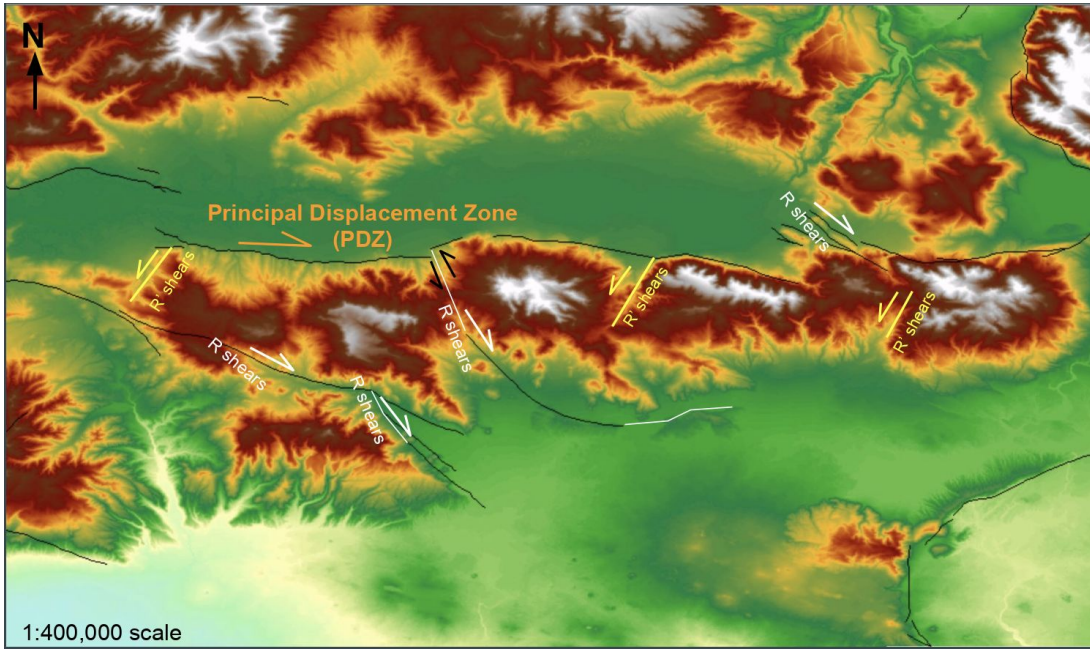
Summary

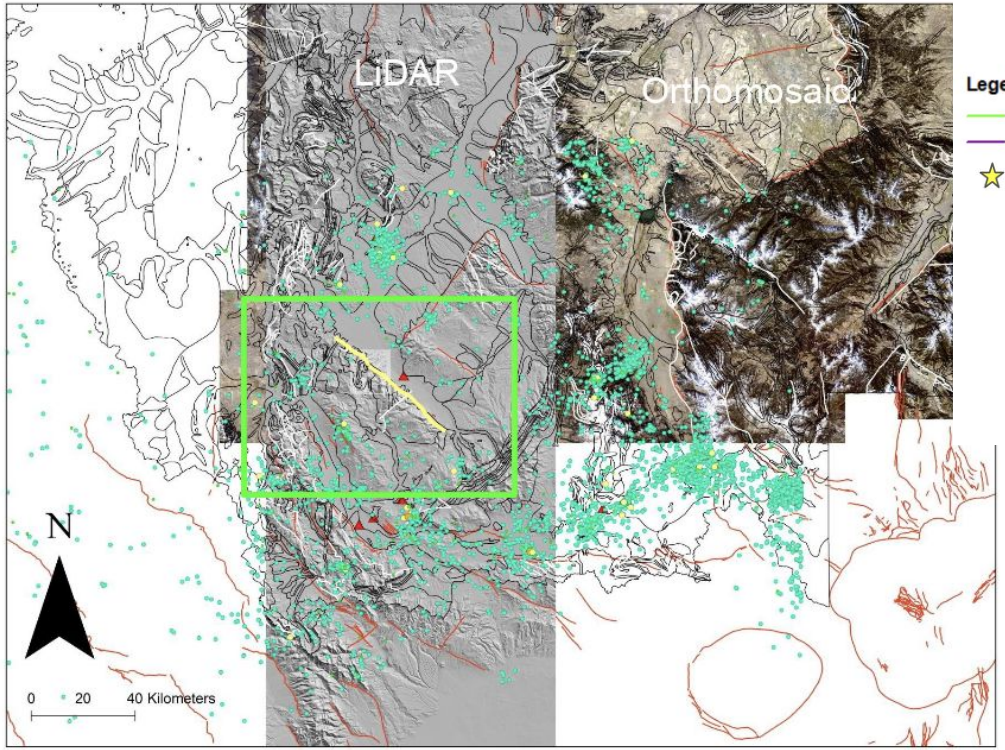


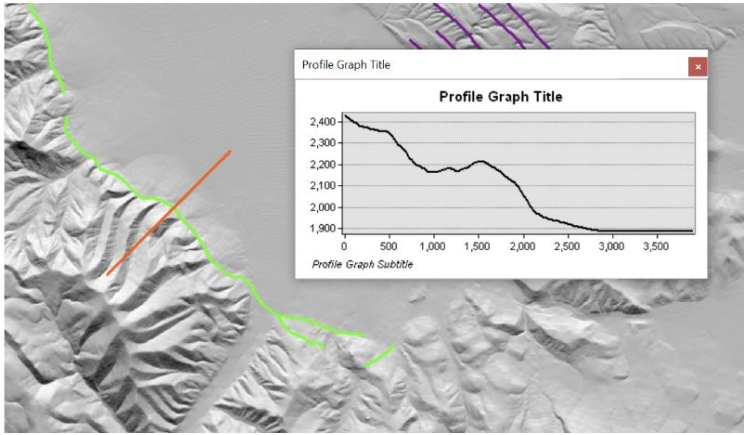
Centennial Range

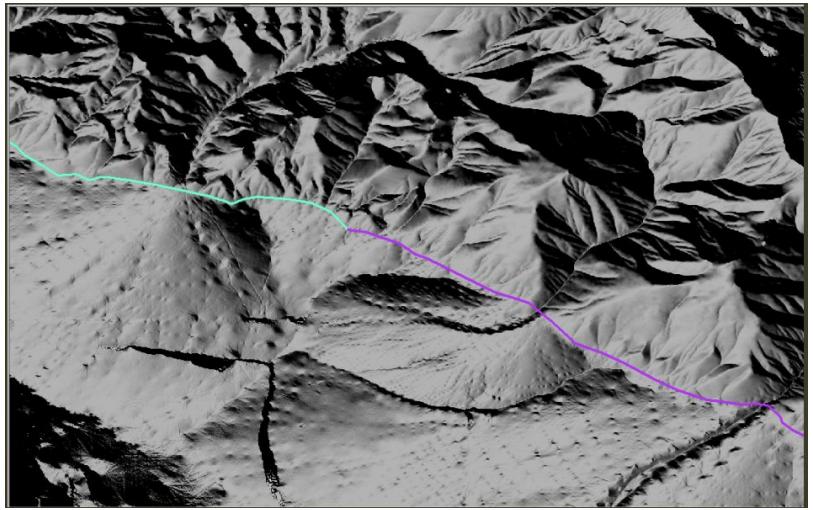
Snake River Plain












Study Area

Blacktail Fault

Geologic Contacts

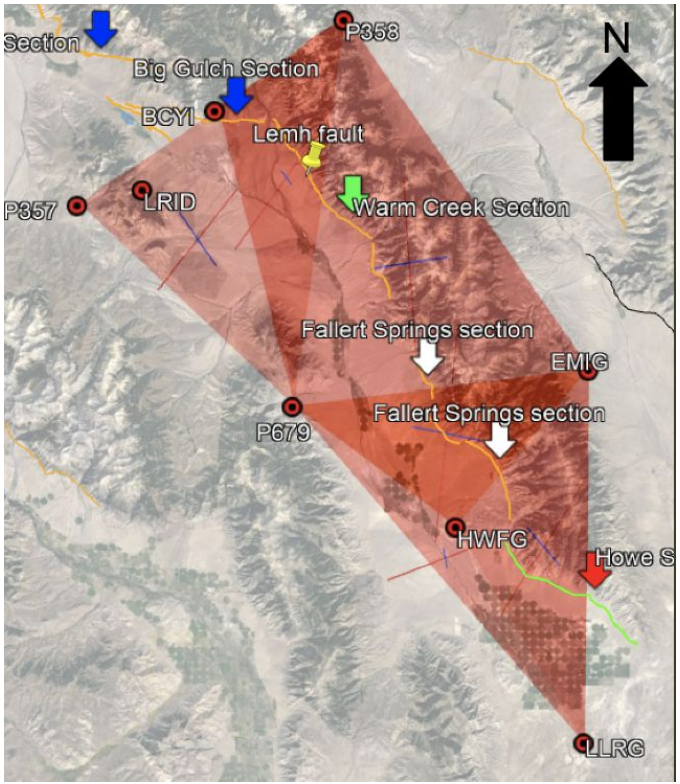
Quaternary Faults

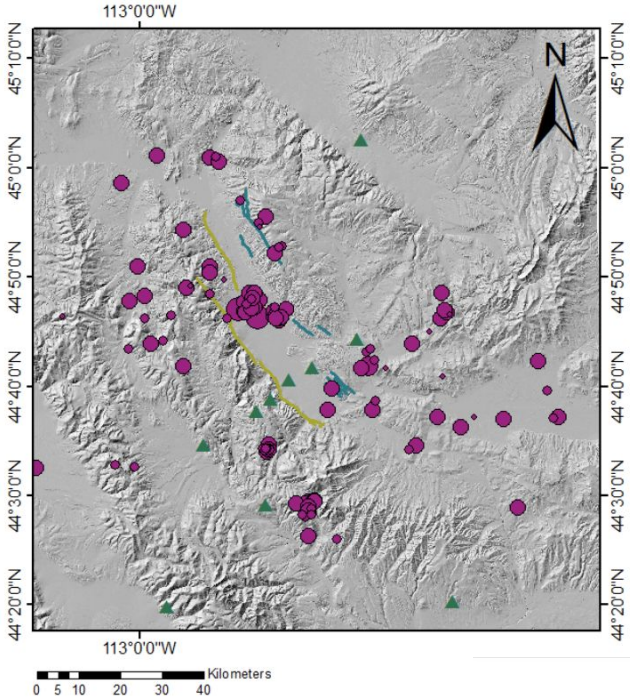

Montana Faults

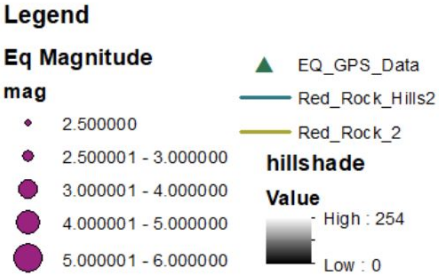

Earthquakes

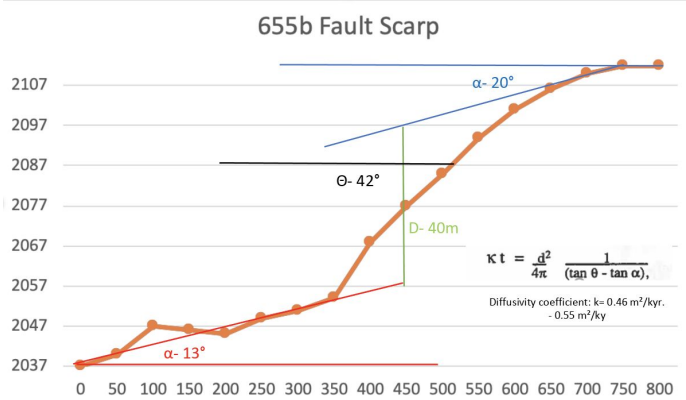

GPS Stations

Red Rock Fault and Monument Hills Fault

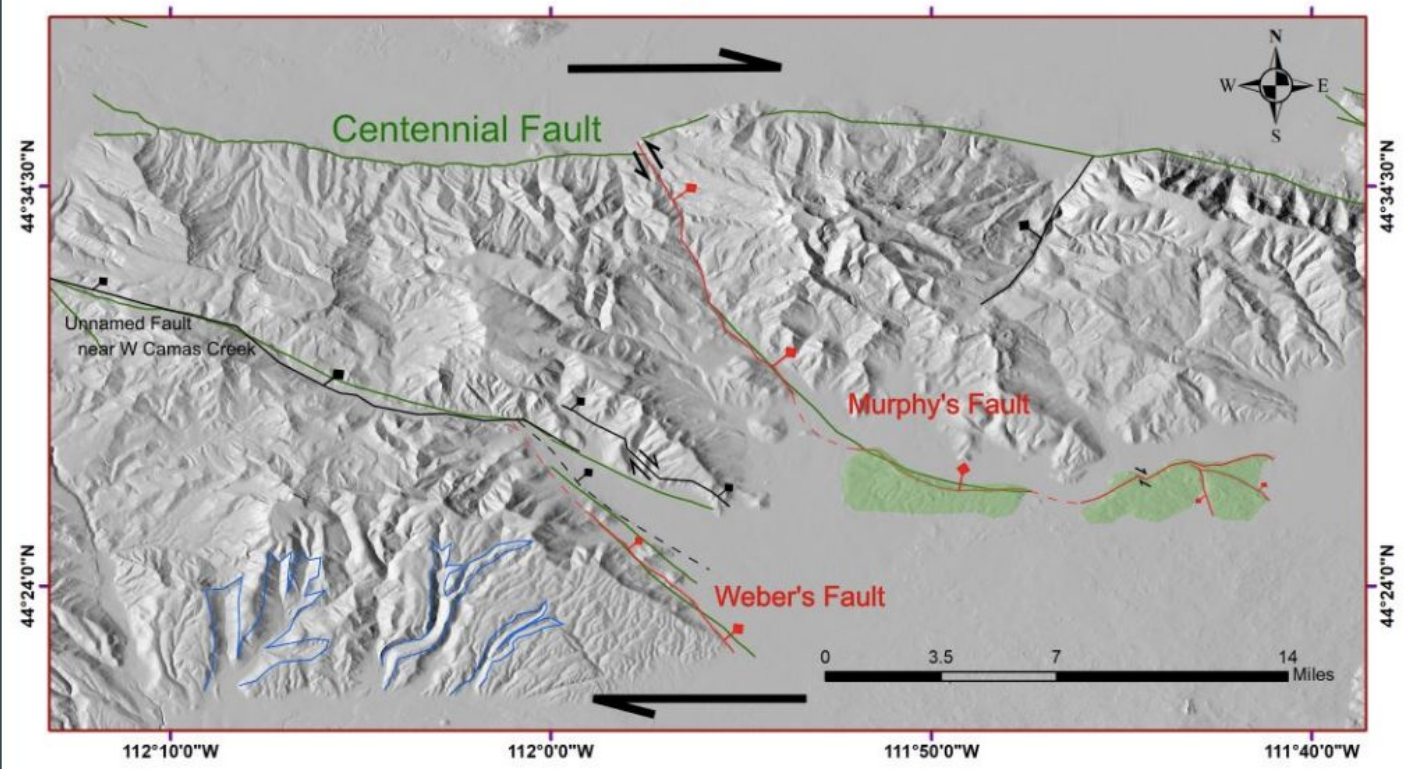


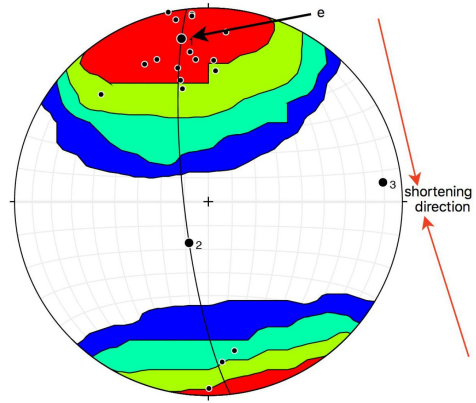


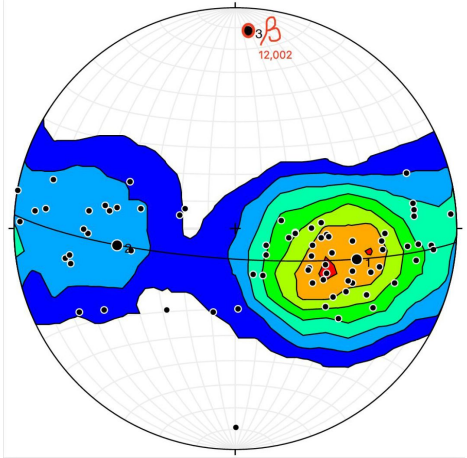




Unnamed Faults near Kilgore and Cottonwood Creek







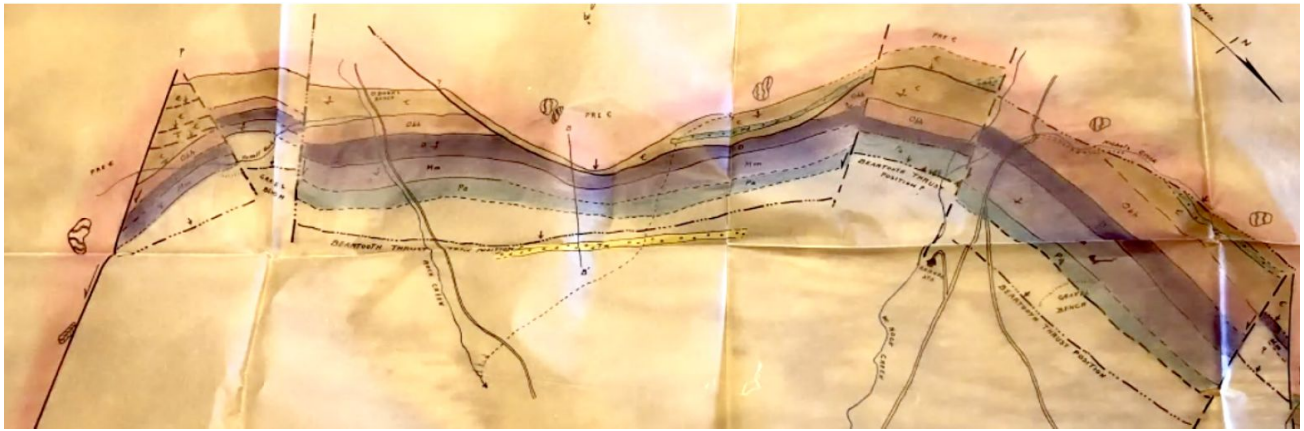
LEGEND

- normal fault trace (red or black)
- inferred fault trace (red or black)
- USGS Quarternary Faults
- River-cut valleys
- Old Alluvial Fan Deposits
- Direction of Shear Stress

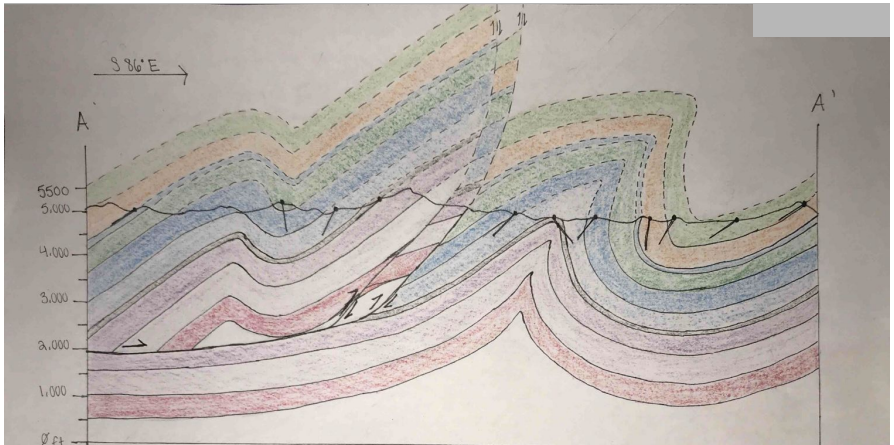
Coordinate System: GCS WGS 1984
Datum: WGS 1984
Units: Degree

1 cm = 3 km

YBRA field camp student cross section **1939**



UH virtual field camp student's cross section **2020**



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