Analysis of the Boulder Front Fault and its Rupture History

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Introduction

- The Boulder Front Fault (BFF) is located in central Idaho and is an extension of the seismogenic Sawtooth fault (**Fig. 1**)
- The Sawtooth Fault and the BFF scarp can be seen on lidar acquired by FEMA, but the scarp has not been studied or mapped in detail
- Characterizing the rupture history and accurately mapping the BFF allows for the determination of and mitigation of potential hazards near a site with many tourists during all seasons of the year
- The objectives of my research are as follows:
  - To determine the extent of the BFF by doing research interpreting lidar, published maps and fieldwork in Idaho
  - To determine when past ruptures occurred on the BFF
  - To determine the absolute age of the surficial deposits cut or overlapped by the BFF:
    - Mapping the extent of the Sawtooth-BFF in the Wood River Valley from the lidar
    - Profiling the fault scarp using differential GPS then modeling the scarp profiles into rupture ages (**Fig. 4**)

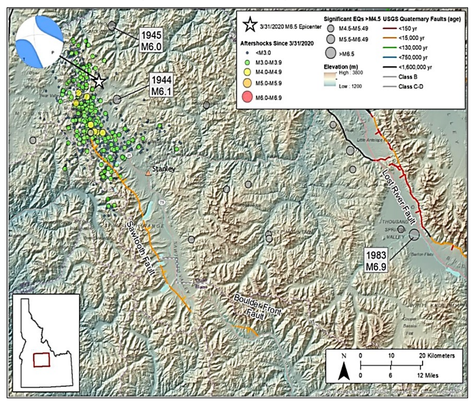


Figure 1.
Shaded relief map of central Idaho showing Quaternary faults, significant historical earthquakes > M4.5, and recent seismicity related to the March 31, 2020, M6.5 earthquake (Lifton, 2020).

Figure 3.
Trimble GPS base station (right) and mobile receiver.

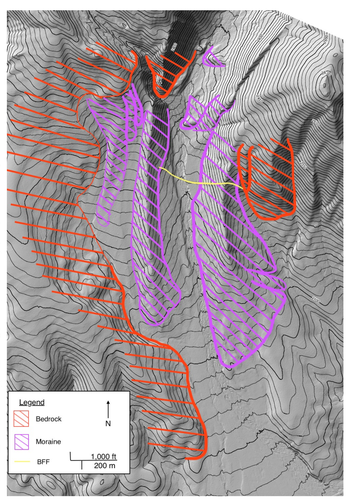


Figure 2.
Map that displays the BFF, areas of bedrock (shaded in red), and areas that are moraines (shaded in purple) on top of lidar data acquired from FEMA.

Methods

- Literature Review of active faulting and the glacial history of the Northern Rocky Mountains
- Completed the ArcGIS quick-start tutorials provided by the Lehigh site license Esri Software
- 7 days in the field mapping the fault scarp and collecting samples for absolute age
  - Reconnaissance of multiple segments of the BFF
  - I made a geologic map that displays areas of bedrock and moraines that my field assistant and I distinguished around the BFF (**Fig. 2**)
  - A Trimble GPS base station and mobile receiver were used to collect six profiles of the BFF scarp (**Fig. 3 & 6**)
    - Positions were determined every 0.05 m to 1.0 m (**Fig. 4**)
  - Absolute dating:
    - Two charcoal samples were collected and used for C_{14} dating
    - Samples from the same soil pit were collected and used for OSL dating (**Fig. 4**)
    - A terrestrial cosmogenic nuclide (TCN, Be_{10}) sample was collected from a boulder at the top of a lateral moraine from the youngest glacial deposit in the field and will be sent to a lab for TCN dates by IGS (**Fig. 4**)

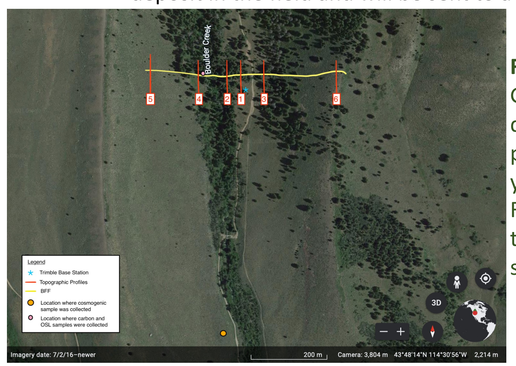


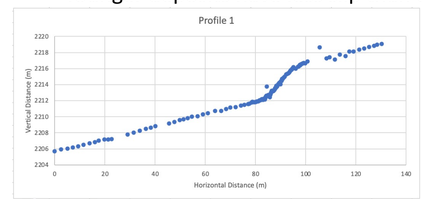
Figure 4.
Google Earth satellite image displaying locations of scarp profiles measured by GPS. The yellow line indicates the BFF. Red lines indicate profiles taken, and circles indicate samples that were collected.

Results

- The BFF does not cut older bedrock deposits but does cut the Late Quaternary Pinedale glacial deposits (**Fig. 2**)
- The Southern segment of the BFF cuts the eastern lateral moraine, but not its equivalent western moraine, which was sampled for TCN
- The BFF is west-dipping and is on the East side of the Wood River Valley
- Younger deposits have less slip recorded than older deposits determined by inset relationships (**Fig. 5**)
- The C_{14} sample was sampled from an inset deposit and is being dated by the Beta Analytics Laboratory
- OSL and TCN samples will be sent to the lab by the IGS

Conclusions to Date

- The BFF is younger than the age of the lateral moraines because it cuts the deposit
- The BFF have made steep topography in liniments on the landscape as shown by the lidar (**Figs. 2 & 4**)
- Younger deposits have less slip than older deposits (**Fig. 4**)



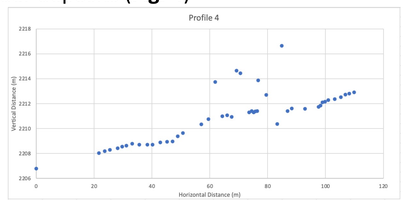


Figure 5.
These two graphs display the slope of the BFF scarp (with vertical exaggeration) at two locations that can be seen in **Fig. 4.** The background slope for both profiles is shallower than that at the fault rupture. Profile 4 cuts a younger deposit than Profile 1 and has less total offset.

Continuing Work

- Geospatial reconciliation of topographic, lidar, and GPS data sets
- Absolute dating of samples at external labs
  - carbon samples in their stratigraphic context
  - OSL samples in their stratigraphic context
  - TCN sample of a glacial boulder on the lateral moraine
- Fault scarp modeling using MATLAB scripts will determine scarp age with
  - single slip: $\frac{du}{dx} = k\frac{d^2u}{dx^2}$
  - continuous slip models: $u(x,t) = (a + At)\,\mathrm{erf}\left(\frac{x}{2\sqrt{kt}}\right) + \frac{Ax^2}{2k}\left[erf\,\frac{x}{2\sqrt{kt}} - \mathrm{sgn}(x)\right]$
- Further ArcGIS coverages including geologic map compilation

Acknowledgements

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References

- Hanks, 1984, 2000
- Harkins, 2005
- Lifton, 2020
- Majerowicz,2007, 2008, 2010
- Mattson and Bruhn, 2001
- Regalla, 2007

Figure 6.
Field assistant using the Trimble mobile receiver to collect positions on Profile 5.