Evidence For Multiple Surface Ruptures with 0.5-1.4 Meter Slip-Per-Event Along Structures Between The Salt Lake City and Provo Segments of The Wasatch Fault

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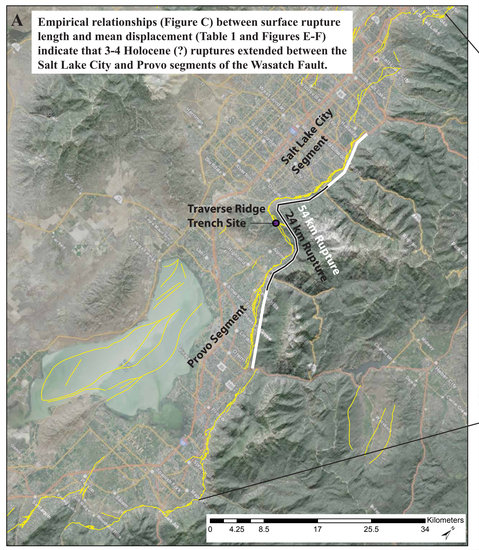
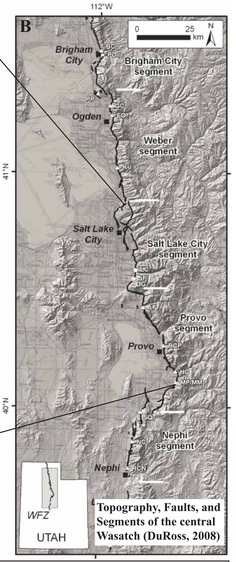
Session: 238
Booth: 131

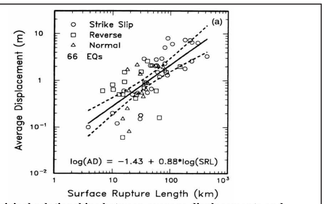
A Empirical relationships (Figure C) between surface rupture length and mean displacement (Table 1 and Figures E-F) indicate that 3-4 Holocene (?) ruptures extended between the Salt Lake City and Provo segments of the Wasatch Fault.





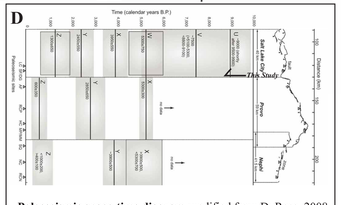
Topography, Faults, and Segments of the central Wasatch (DuRoss, 2008)

C



Empirical relationships between average displacements and surface rupture length (Wells and Coppersmith, 1994) indicate that the 0.5 - 1.4 meter displacements observed at this site may correspond to rupture lengths of 24-54 km (Figures A, E, and Table 1).

D



Paleoseismic space-time diagram modified from DuRoss, 2008. With the addition of age constraints this site should help resolve which of the Earthquakes along the Provo and Salt Lake segments (Figure B) may be temporally-related.

Table 1. Colluvial Wedge Heights, Displacement Magnitudes, and Estimated Rupture Length, Salt Lake City and Provo Segment Boundary along the Wasatch Fault - Traverse Ridge, Utah.

Location	Measurement	Apparent Height[1]	True Height[2]	Fault	Wall	*Est. Fault Slip*[3]	*Est. Rupture Length*[4]
South Exp.[7]	*South Scarp height*[6]	-	-	-	-	24 m	-
Trench-1S[7]	**Most Recent Event South Exp.**	**Min = 0.90 m Max = 1.40 m**	**0.80 m 1.25 m**	**100/70 s**	**190/73 w**	***1.4 m***	***54 km***
Central Exp.	*Central Scarp height*[6]	-	-	-	-	19 m	-
Trench-1C	**Most Recent Event Central Exp.**	**Min = 0.65 m Max = 0.75 m**	**0.50 m 0.57 m**	**095/75 s**	**035/60 e**	***0.8 m***	***32 km***
Trench-1C	**Penultimate Event Central Exp.**	**Min = 0.45 m Max = 0.55 m**	**0.34 m 0.42 m**	**095/75 s**	**035/60 e**	***0.5 m***	***24 km***
Trench-1C	**3rd Most Recent Event Central Exp.**	**Min = 0.83 m Max = 1.28 m**	**0.64 m 0.98 m**	**095/75 s**	**035/60 e**	***1.1 m***	***44 km***
North Exp.	*North Scarp Height*	Total Offset = 0 m	-	264/80 s	-	***0.0 m***	-
Trench -1N	V. Old Single Event[8]	Min = 0.60 m Max = 0.50 m	0.34 m 0.41 m	264/80 s	218/53 e	***0.5 m***	***24 km***

1 – Apparent colluvial wedge height was measured along the plane of the trench wall exposures. Trenches were sloping for safety.
2 – True colluvial wedge height was calculated by projecting the apparent wedge height (measured along the laid back trench wall exposures) into a vertical exposure.
3 – Estimated Fault slip was calculated presuming that colluvial wedge height represents ~60% of total fault slip in an earthquake due to scarp erosion.
4 – Rupture lengths were estimated using the empirical equation: **Log (average displacement) = -1.99 + 1.24 Log (Surface Rupture Length)** from Wells and Coppersmith, 1994.
5 – See Site map for each trench exposure location.
6 – Scarp Heights were extracted from 2m LiDAR data (http://gis.utah.gov/data/elevation-terrain-data/2-meter-lidar/)
7 – Trench logging is shown in the middle panel of the poster.
8 – Because there is no surface scarp this event is likely Pleistocene (pre Bonneville) age or older.

Acknowledgements:

We thank Draper City for their assistance with gaining permission to access the site and the city geologist (David Simon) for helpful discussion. Members of the Utah Geological Survey Hazards program (especially Chris DuRoss) provided a helpful trench review. The 2013 GEO 3200 class, Danny Horns, and Mike Bunds also aided in field discussions that have helped to better this work in progress. The motivation for this research came from discussions with Jim McCalpin and operational expenses were furnished from a grant from the UVU College of Science and Health Scholarly Activities Committee as well as resources related to the 2013 summer field geology camp. We also must thank the decision to leave seven consulting trenches open that were dug in 2006. They have proven to be great educational and research tools.

References:

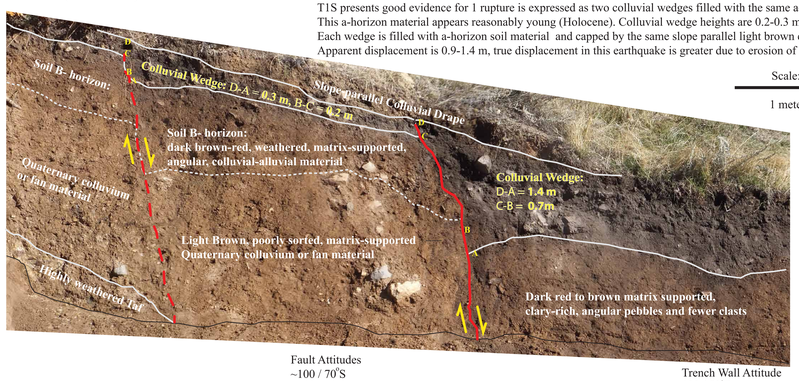
Biek, R. F., 2005, Geologic Map of the Lehi Quadrangle and Part of the Timpanogos Cave Quadrangle, Salt Lake and Utah Counties, Utah, M-210 - Utah Geological Survey 7.5' Geological Maps.

DuRoss, C., 2008, Holocene Vertical Displacement on the Central Segments of the Wasatch Fault Zone, Utah, Bulletin of the Seismological Society of America, Vol. 98, No. 6, pp. 2918-2933.

Utah Automated Geographic Reference Center, 2006, 2 Meter LiDAR Elevation Data, http://gis.utah.gov/data/elevation-terrain-data/2-meter-lidar/.

Wells, D. L. and K.J. Coppersmith, 1994, New empirical relationships among magnitude, rupture length, rupture width, and surface displacement, Bulletin of the Seismological Society of America, Vol. 84, No. 4, pp. 974-1002.

E - Trench 1 South (east wall)



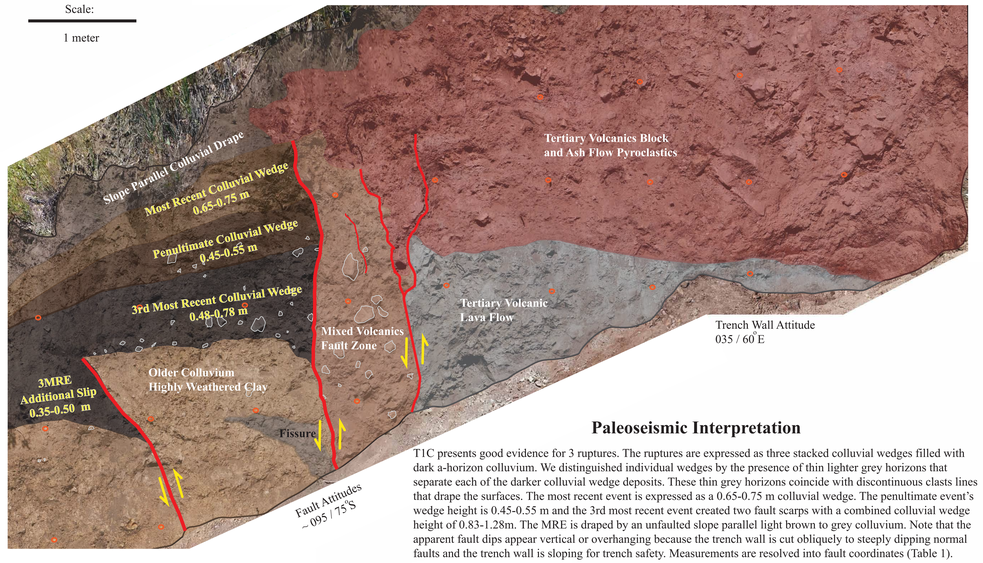
Fault Attitudes
~100 / 70˚S

Trench Wall Attitude
190 / 73˚E

Paleoseismic Interpretation

T1S presents good evidence for 1 rupture is expressed as two colluvial wedges filled with the same a-horizon colluvium. This a-horizon material appears reasonably young (Holocene). Colluvial wedge heights are 0.2-0.3 m and 0.7-1.1 m. Each wedge is filled with a-horizon soil material and capped by the same slope parallel light brown colluvial debris. Apparent displacement is 0.9-1.4 m, true displacement in this earthquake is greater due to erosion of the upthrown block.

F - Trench 1 Center (west wall)



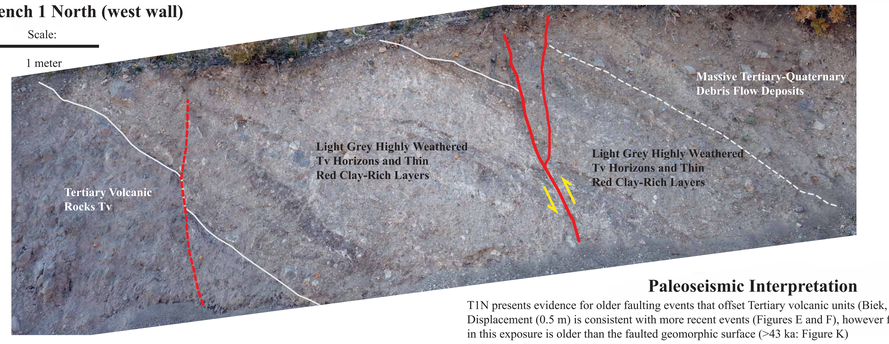
Fault Attitudes
~095 / 75˚S

Trench Wall Attitude
035 / 60˚E

Paleoseismic Interpretation

T1C presents good evidence for 3 ruptures. The ruptures are expressed as three stacked colluvial wedges filled with dark a-horizon colluvium. We distinguished individual wedges by the presence of thin lighter grey horizons that separate each of the darker colluvial wedge deposits. These thin grey horizons coincide with discontinuous clasts lines that drape the surfaces. The most recent event is expressed as a 0.65-0.75 m colluvial wedge. The penultimate event's wedge height is 0.45-0.55 m and the 3rd most recent event created two fault scarps with a combined colluvial wedge height of 0.83-1.28m. The MRE is draped by an unfaulted slope parallel light brown to grey colluvium. Note that the apparent fault dips appear vertical or overhanging because the trench wall is cut obliquely to steeply dipping normal faults and the trench wall is sloping for trench safety. Measurements are resolved into fault coordinates (Table 1).

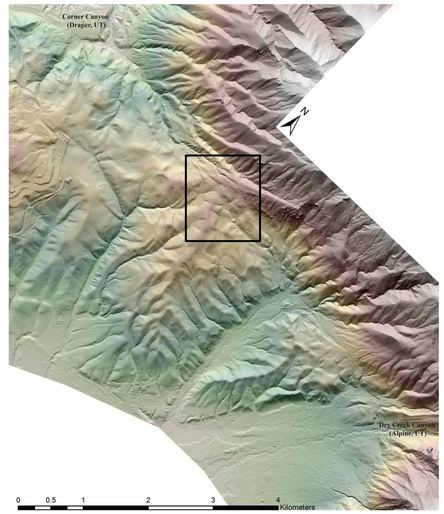
G - Trench 1 North (west wall)



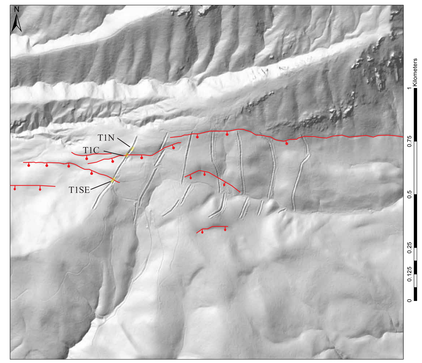
Paleoseismic Interpretation

T1N presents evidence for older faulting events that offset Tertiary volcanic units (Biek, 2005). Displacement (0.5 m) is consistent with more recent events (Figures E and F), however faulting in this exposure is older than the faulted geomorphic surface (>43 ka: Figure K)

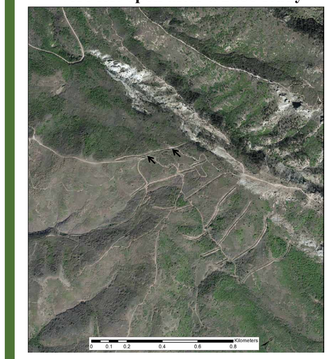
H - LiDAR derived hillshade map of the segment boundary reveals numerous well defined fault scarps trending E-W across Traverse Ridge



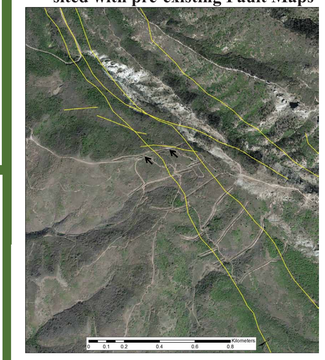
I - Fault mapping through the vegetated landscape was aided immensely by LiDAR data. In fact, remote mapping proved to be orders of magnitude more accurate for our 2013 Field Camp Students. An example of one of their maps is provided below. Note the location of the trench exposures (Figures E-G).



J₁ - Seven ~0.5 m consultant trenches were left open after a 2006 study



J₂ - 2006 consultant trenches were sited with pre-existing Fault Maps



J₃ - LiDAR Data improves fault trace location immensely

K - Trench site profiling (Figure J₃) - 43 m of displacement across a Pleistocene geomorphic surface