

PEER
Surface Fault Displacement Hazard
Workshop
Real Faults in the Real World

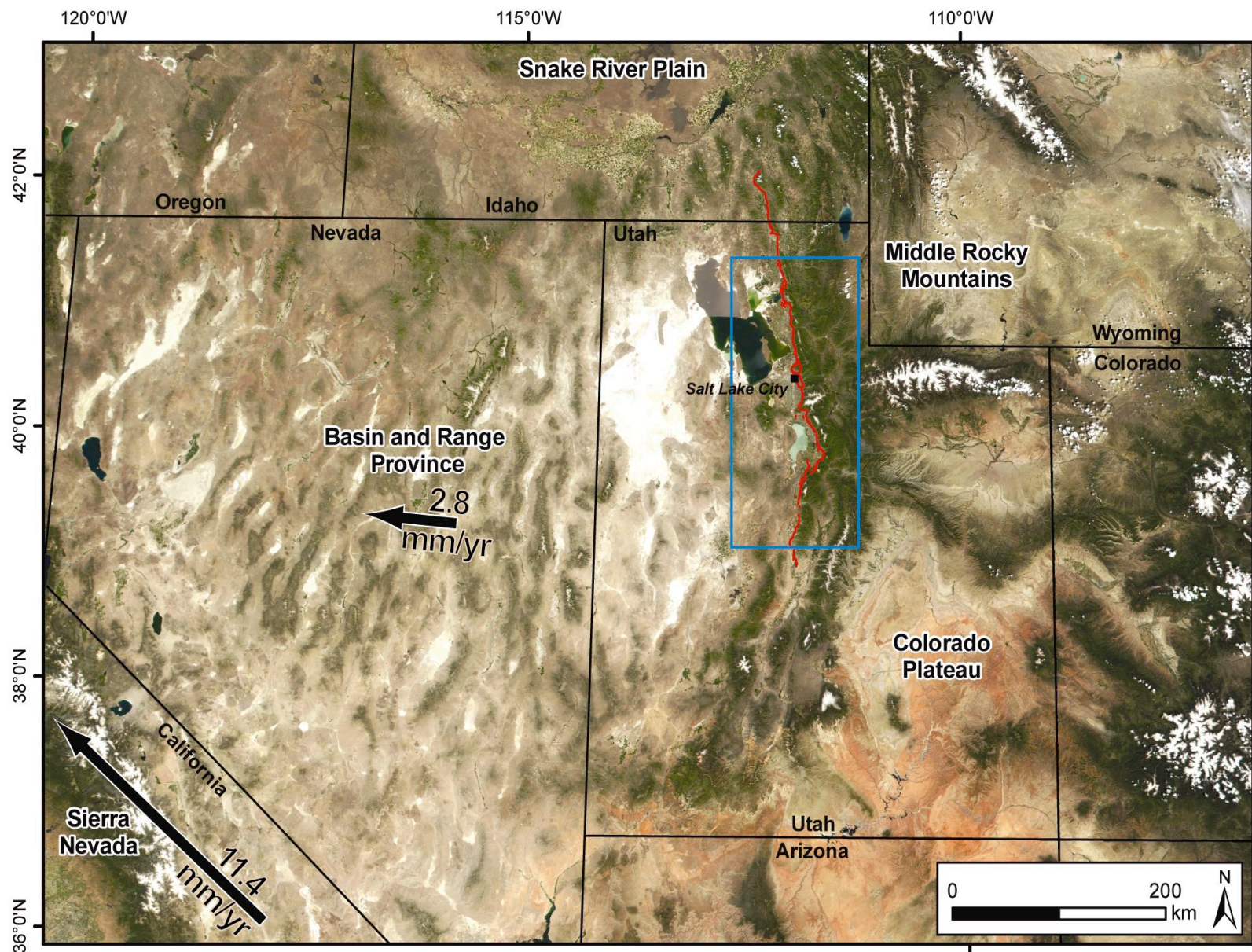
Rupture Characteristics
of the
Wasatch and Lost River
Normal Faults

UC Berkley
May 20-21, 2009

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Utah Geological Survey

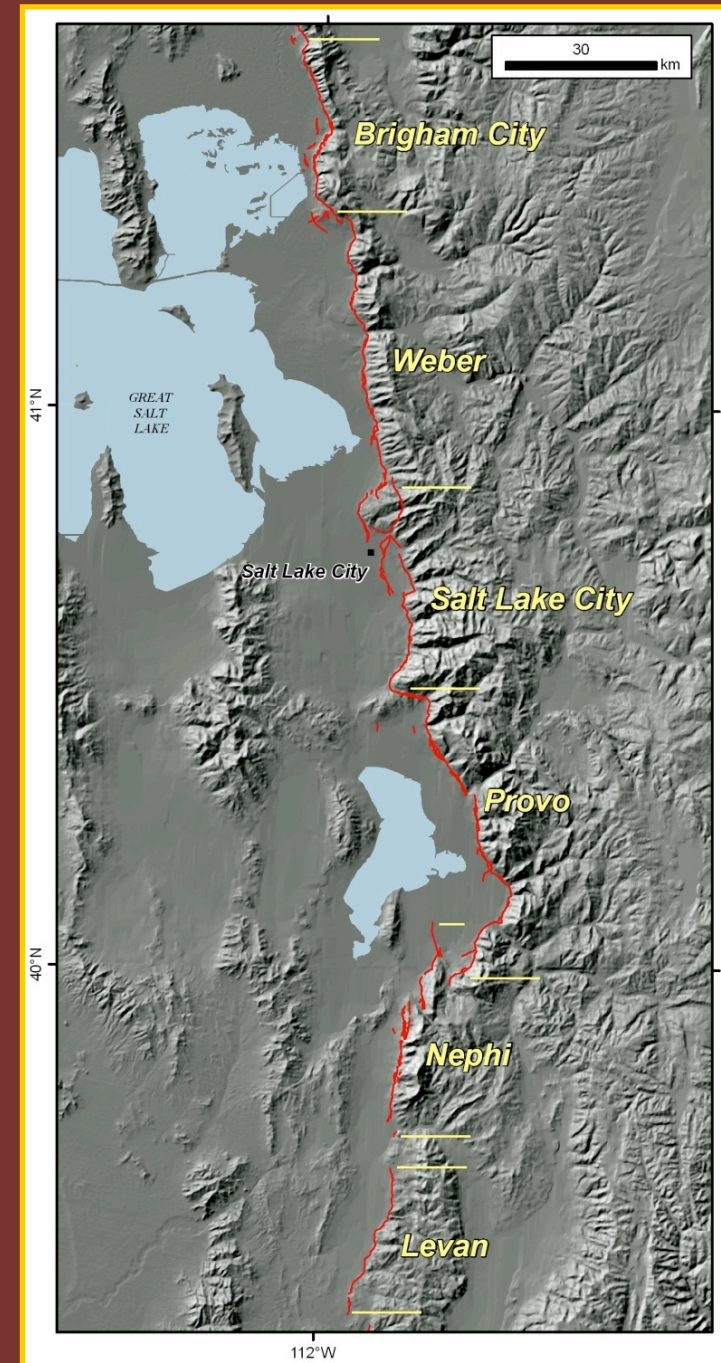


Wasatch Fault Zone



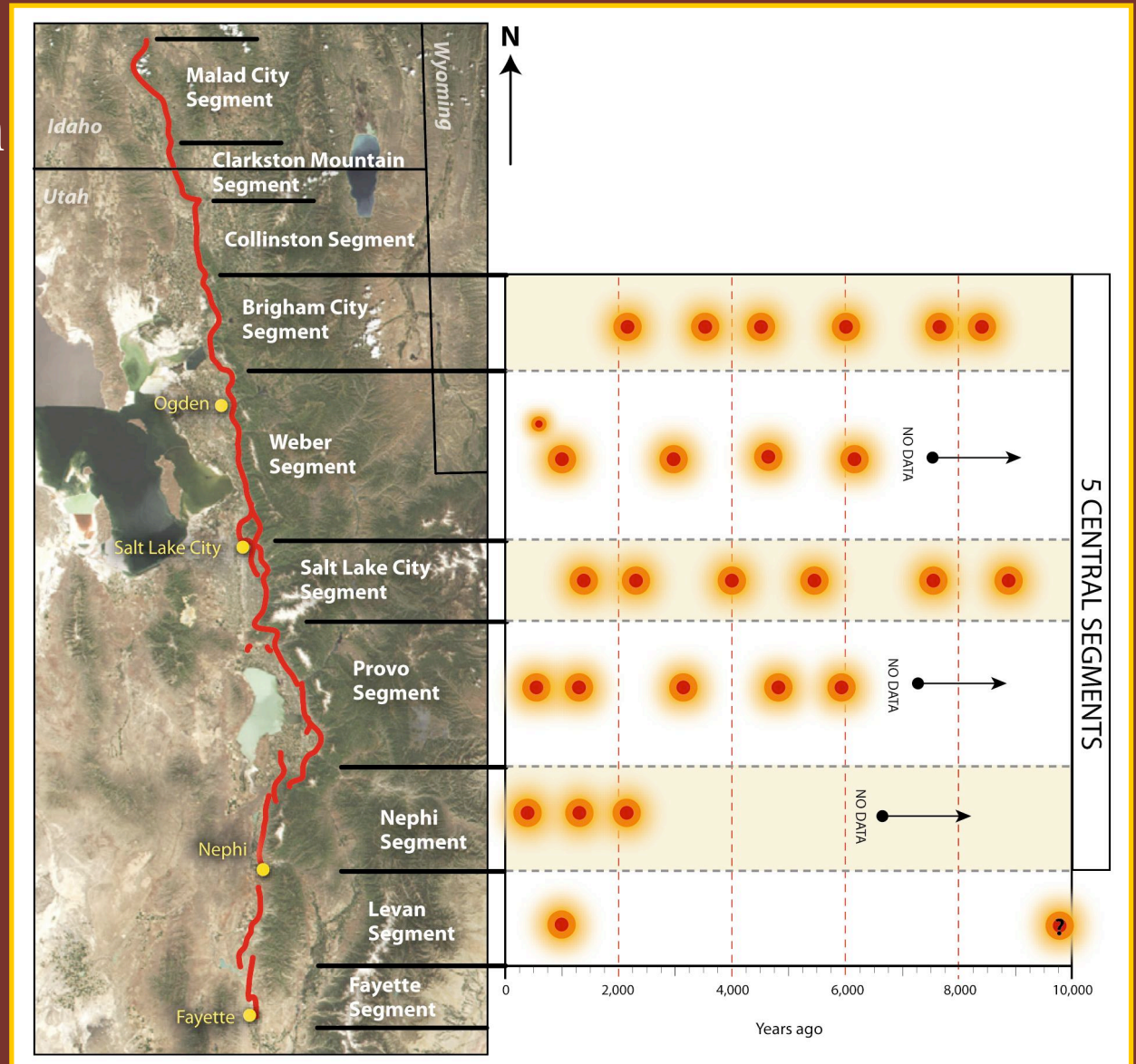
Wasatch Fault Zone

- Ten Segments Total
- Six Central Segments
 - Holocene surface faulting
 - 25-59 km long
 - Magnitude (M_W): 6.8-7.2
 - Displacement per earthquake: 2.2 ± 1.0 m (DuRoss, 2008)



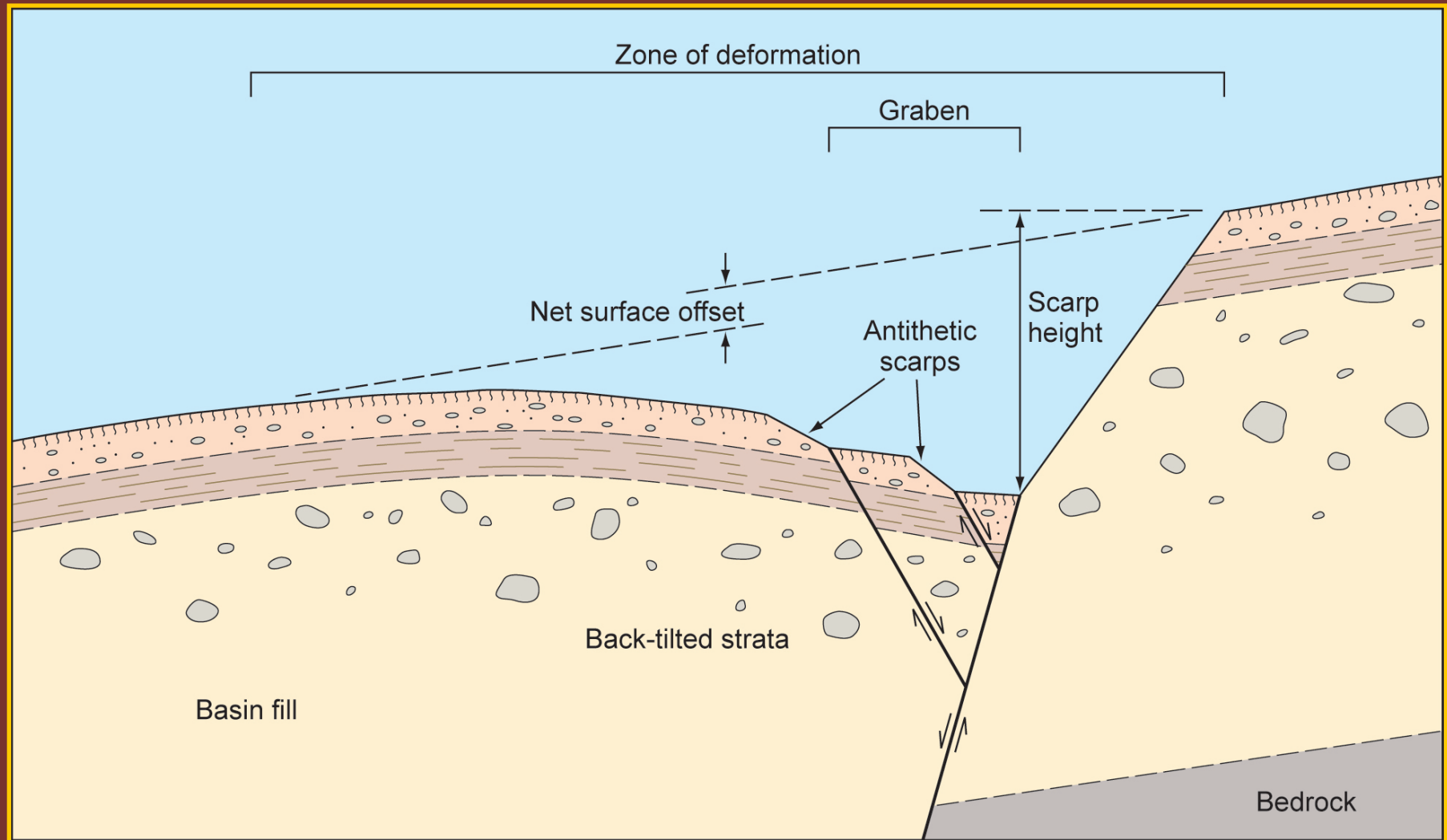
Wasatch Fault Zone

- Minimum 26 earthquakes on six central segments during Holocene
- Average of one event every ~380 yr
- Average of one event every ~300 yr for ≤ 6500 yr



Typical Normal Fault Zone of Deformation

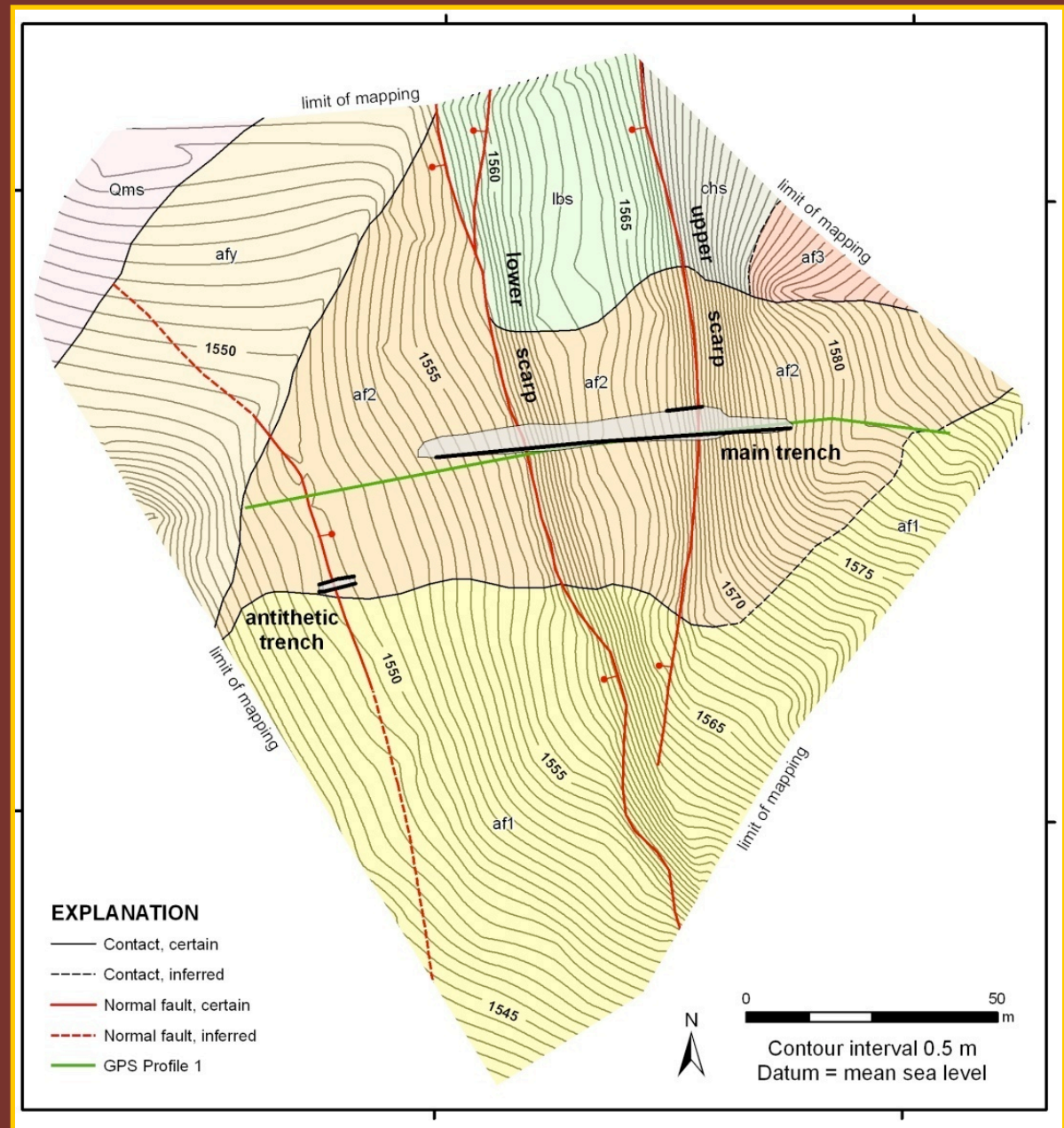
(May be present on scales of meters to kilometers)



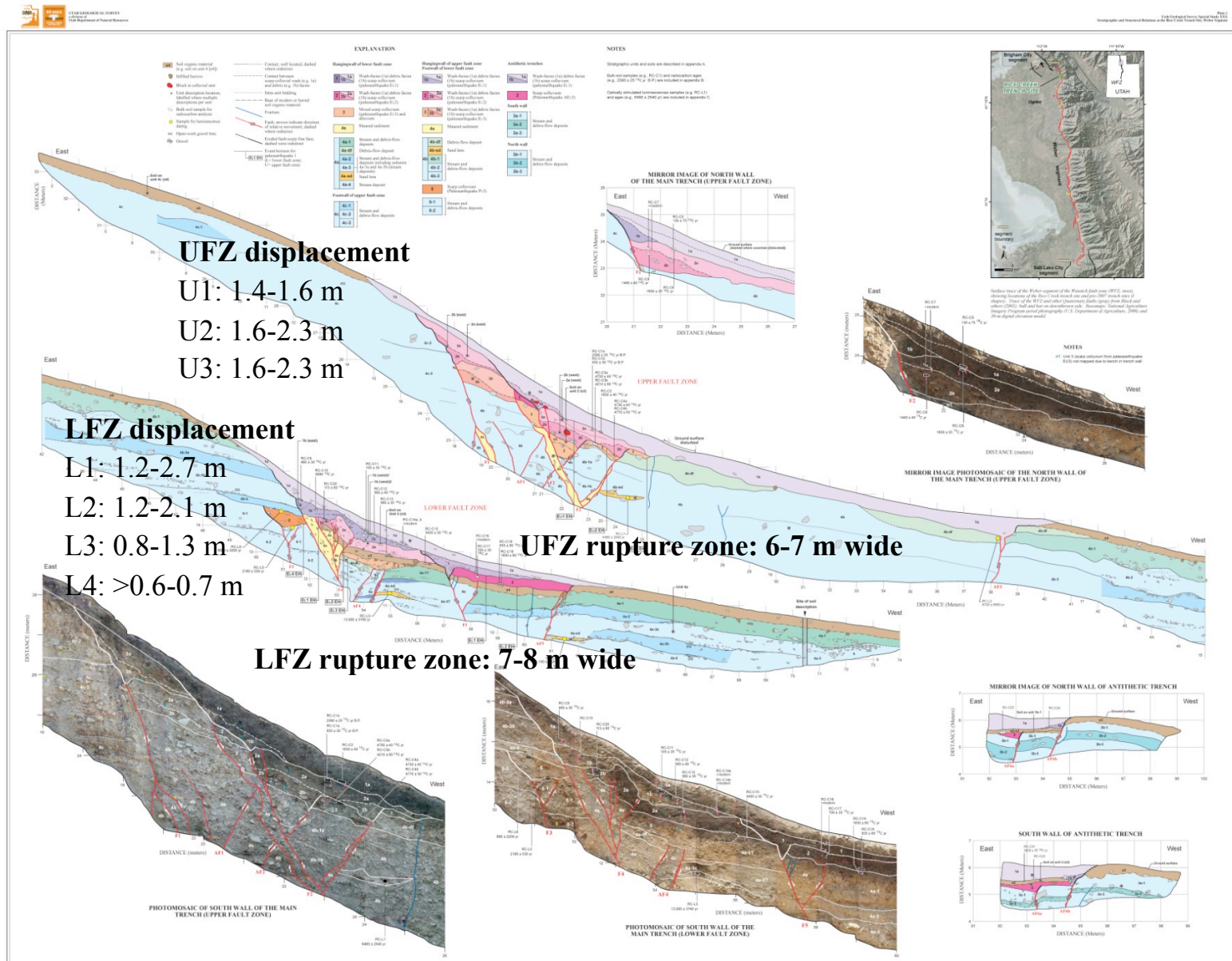
Zone of deformation may be up to 300 m wide in places along the Wasatch fault

Rice Creek Weber Segment

- Three scarps:
 - 10-m high upper scarp
 - 5-m high lower scarp
 - ~1-m high antithetic scarp
 - Width of zone ~ 85 m

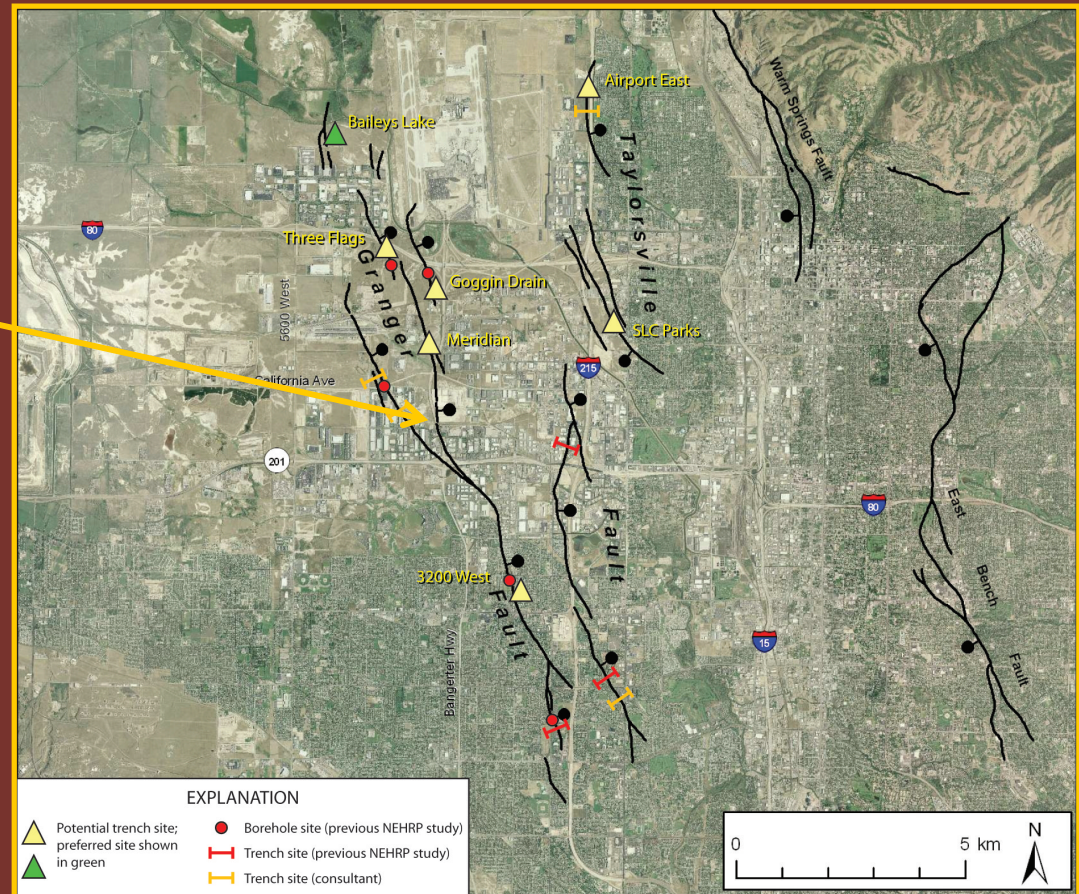
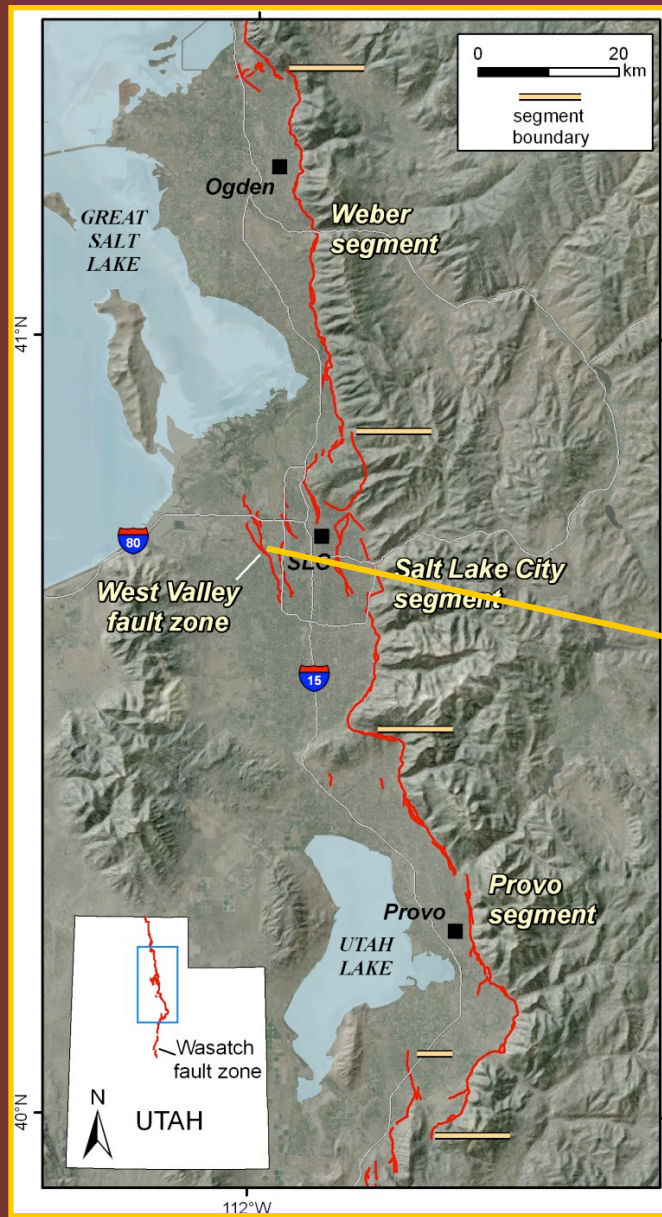


Rice Creek Trench Logs



Wasatch and West Valley Fault Zones

Antithetic Faulting and Graben Formation on a Kilometer Scale



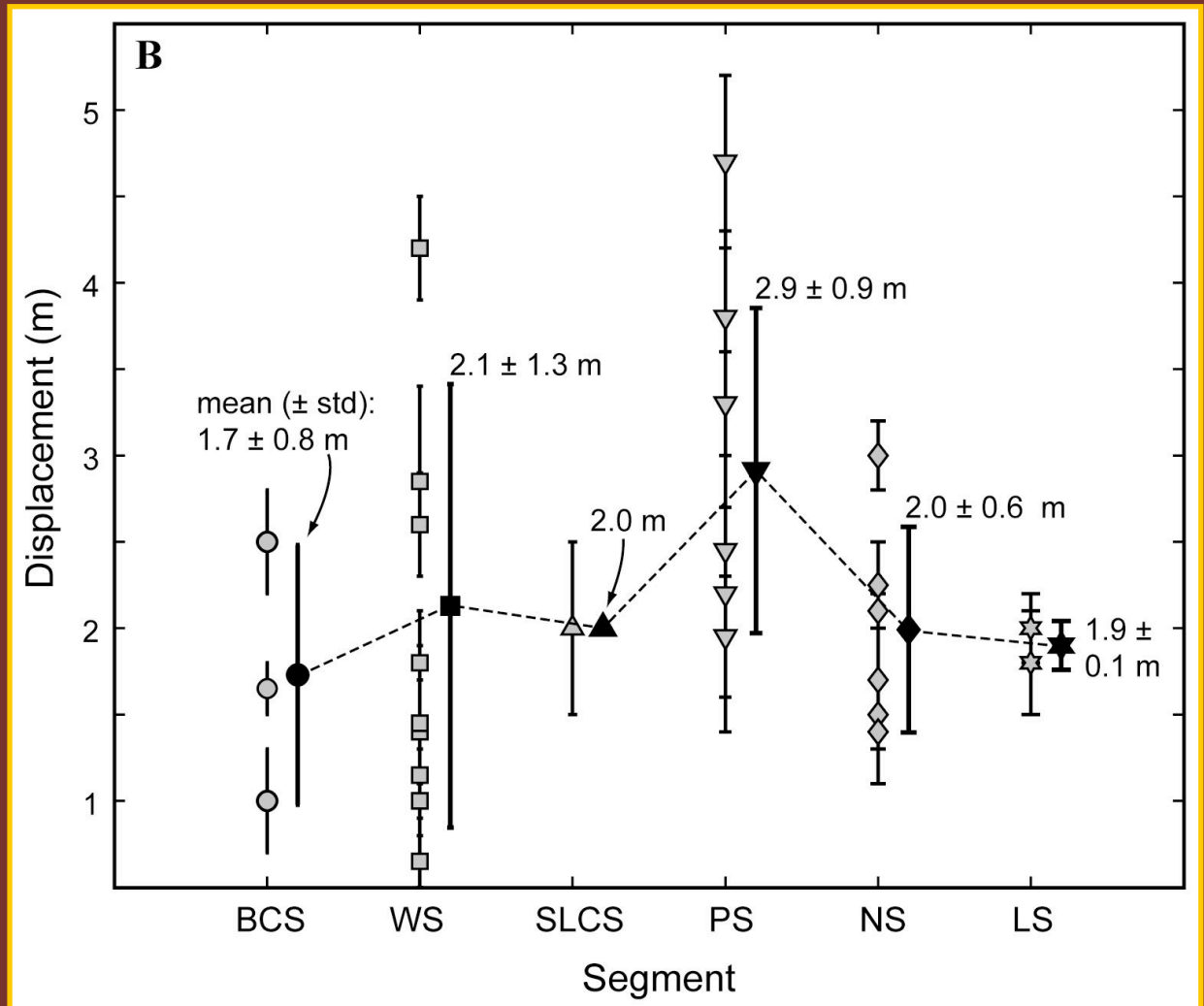
Wasatch Fault Displacement Data

- Quality varies along the WFZ:
 - 2 (Levan, Salt Lake City) to 10 (Weber) observations per segment
- Measurement types:
 - 11% – stratigraphic displacement
 - 89% – some combination of colluvial-wedge thickness, relative/average displacement, retrodeformation

WFZ Displacement Data

Mean WFZ
displacement: 2.2 ± 1.0 m

Schwartz and
Coppersmith
(1984): 2.0 ± 0.4 m



(DuRoss, 2008)

Utah Quaternary Fault Parameters Working Group

Wasatch Fault Zone

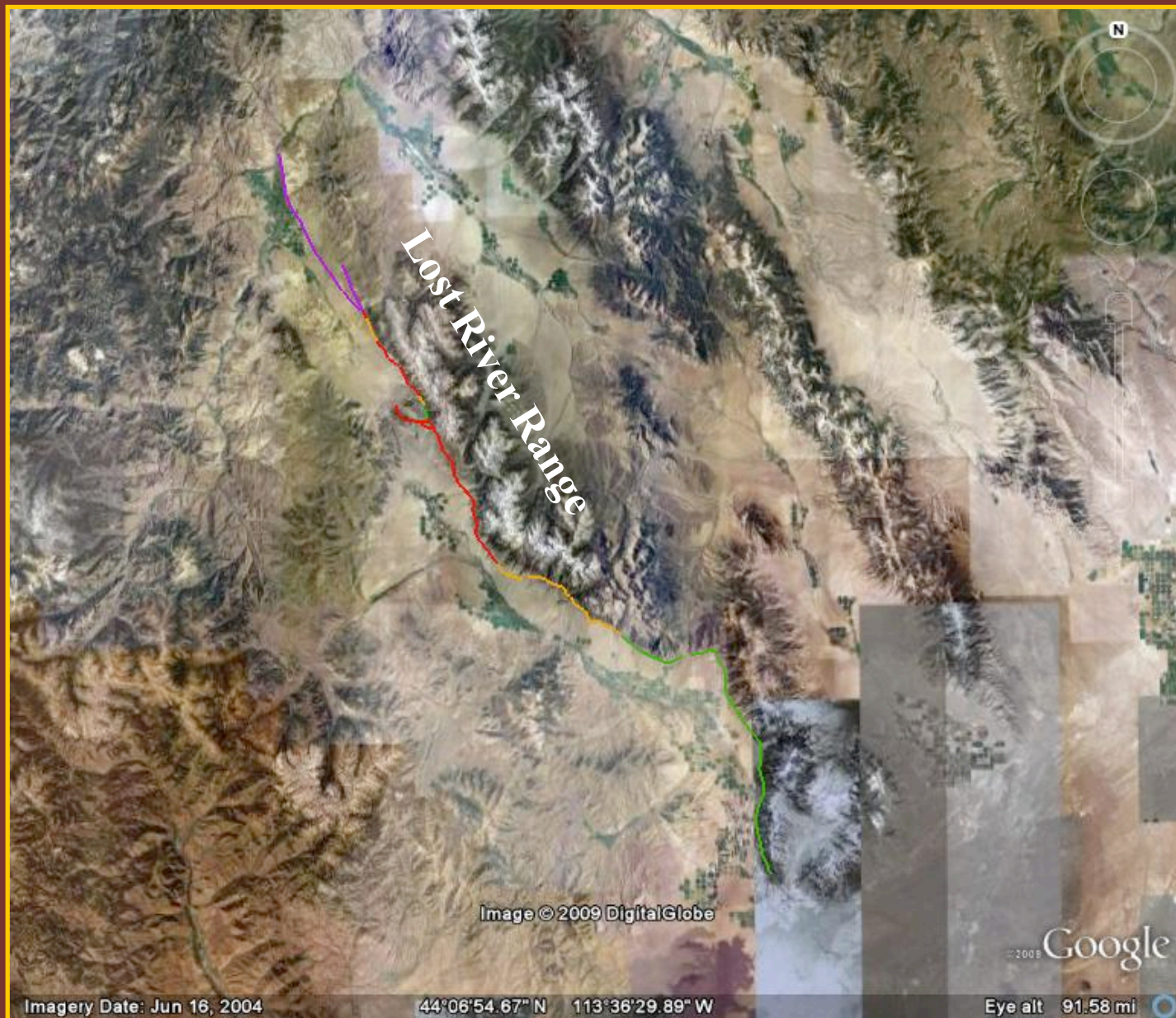
Consensus

Vertical-Slip-Rate & Recurrence-Interval Estimates

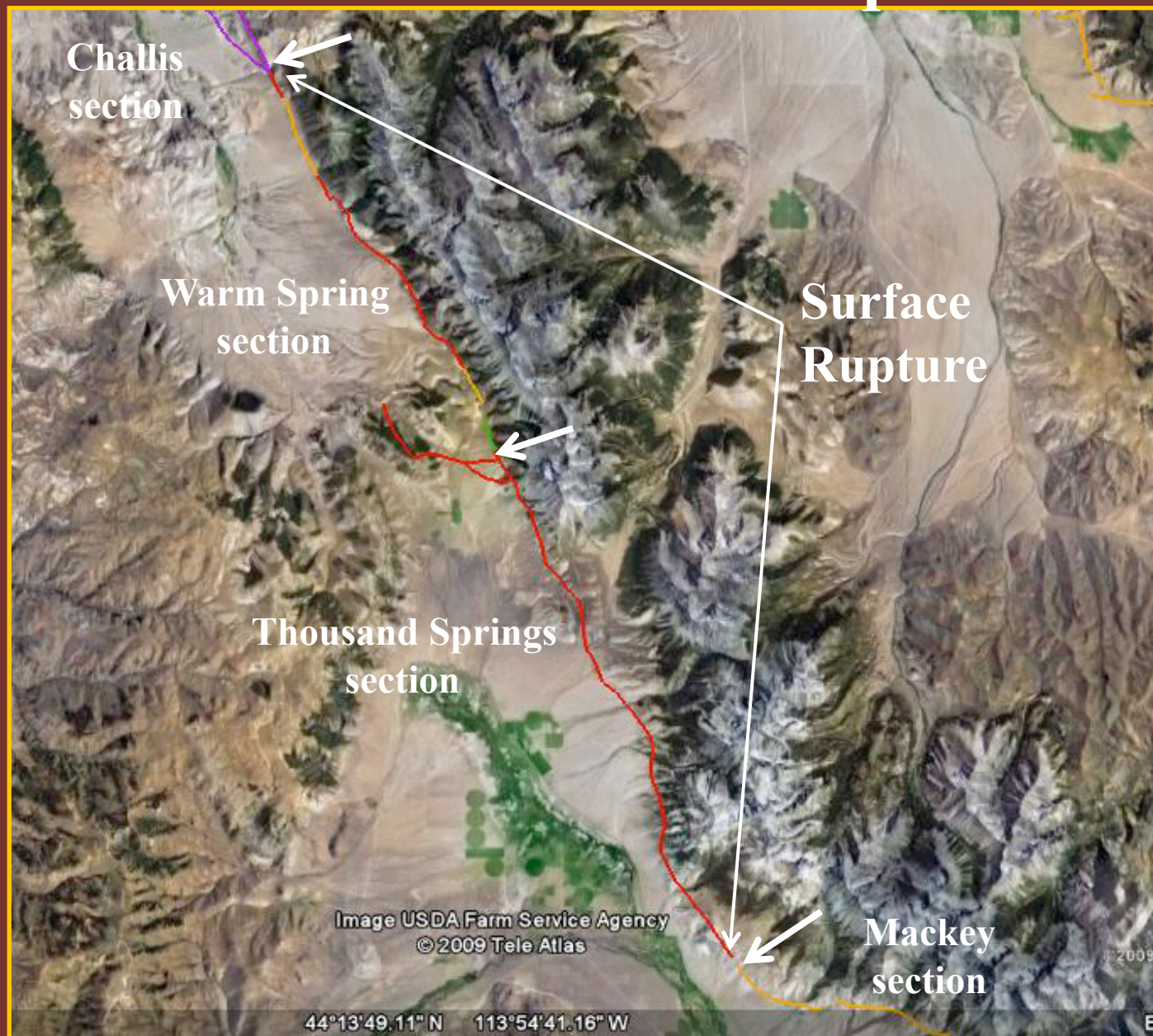
WFZ Segment	Length Straight Line (km)	Consensus Preferred Recurrence Interval	Consensus Preferred Vertical Slip Rate
Brigham City	35.5	500-1300-2800 yr	0.6-1.4-4.5 mm/yr
Weber	56	500-1400-2400 yr	0.6-1.2-4.3 mm/yr
Salt Lake City	39	500-1300-2400 yr	0.6-1.2-4.0 mm/yr
Provo	59	1200-2400-3200 yr	0.6-1.2-3.0 mm/yr
Nephi	37	1200-2500-4800 yr	0.5-1.1-3.0 mm/yr
Levan	25.5	>3 and <12 kyr	0.1-0.6 mm/yr

(Lund, 2005)

Lost River Fault



1983 Borah Peak Earthquake

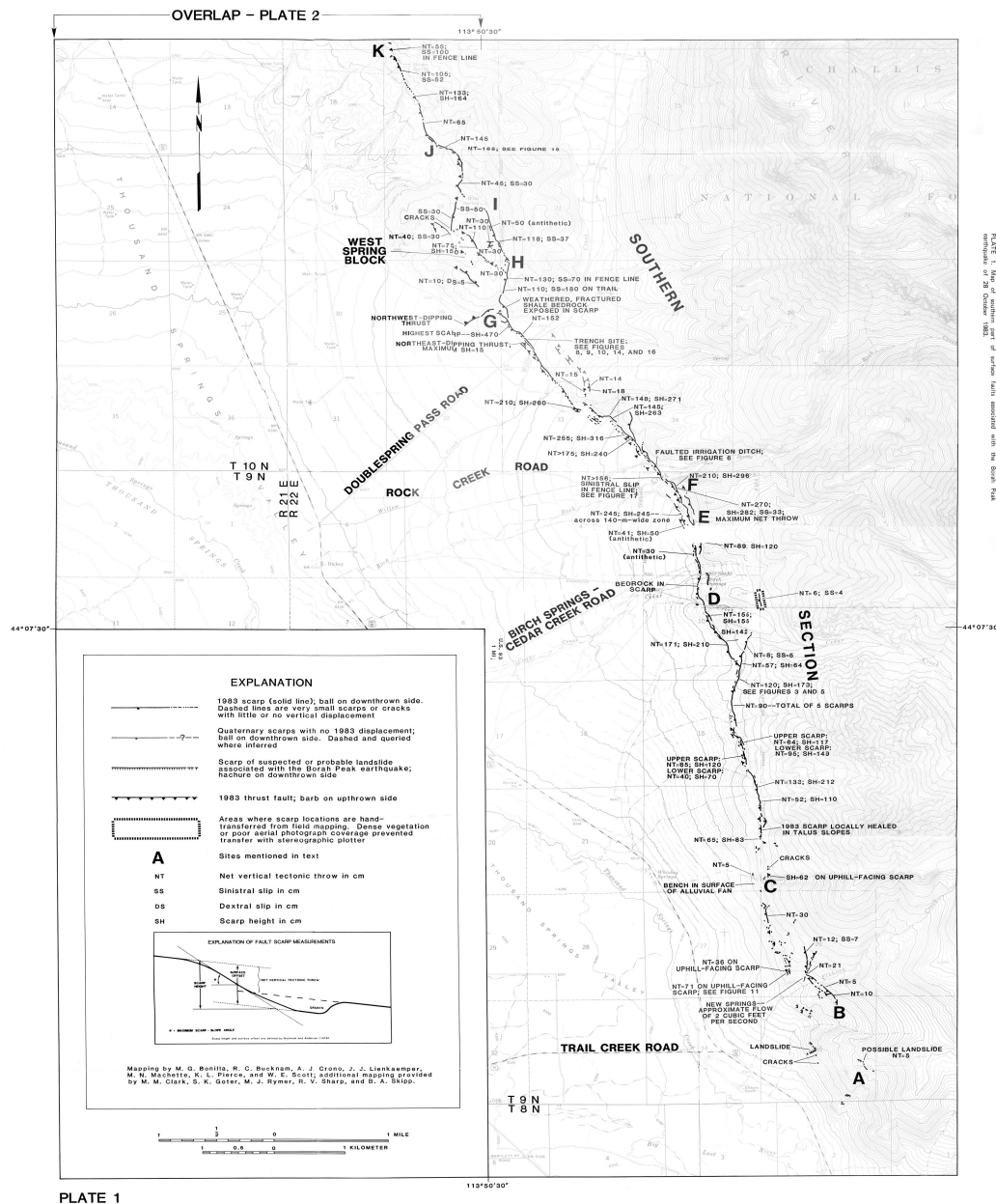


Borah Peak Earthquake

- October 28, 1983
- Various reported M 6.9 - 7.3
- Surface rupture 36.4 ± 3.1 km
- Maximum net throw 2.5 – 2.7 m
- Averaged 0.17 m of sinistral slip for 1.00 m of dip slip
- Zone of ground breaking as much as 140 m wide
- Individual scarps nearly 5 m high
- *En echelon* scarps up to meters high with synthetic and antithetic displacements
- Surface rupture divided into Southern, Western, and Northern sections

Southern Section

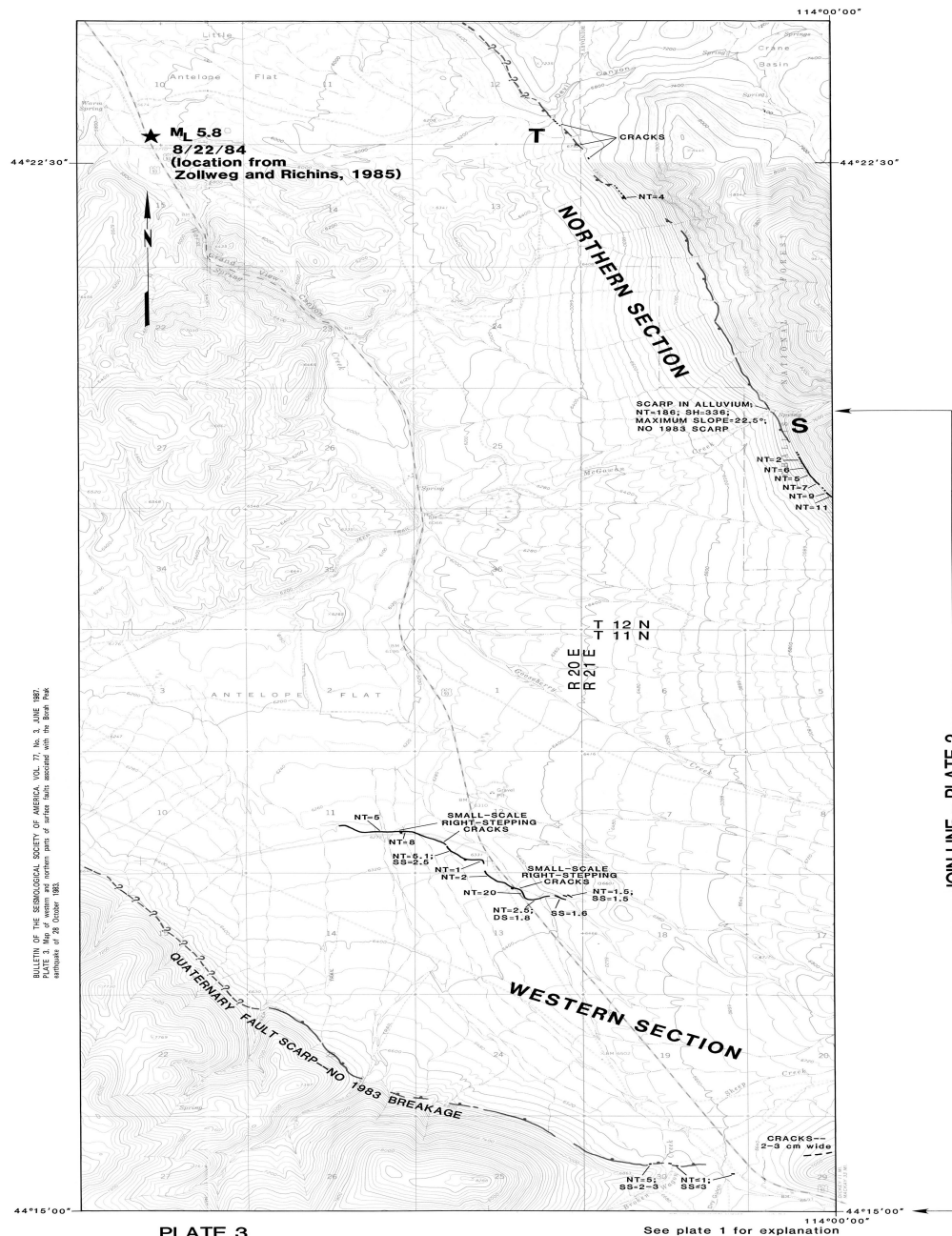
- Coincides with the Thousand Springs Segment
- 20.8 km long
- Main zone of surface faulting
- Most complex rupture patterns (up to 140 m wide) and largest net throw (2.7 m)



(Crone and others, 1987)

Western Section

- Diverges from LRF near north end of Southern section
- 14.2 km long
- Net throw generally < 0.5 m, but as much as 1.6 m
- Scarps poorly developed, many may have been incipient landslides



(Crone and others, 1987)



(Crone and others, 1987)



(Crone and others, 1987)

Ground breakage at Doublespring Pass Road

Southern Section

Complex zone of surface fault
ruptures 25 to 50 m wide near
Doublespring Pass Road



(Crone and others, 1987)

Southern Section

**Faulted concrete irrigation ditch,
vertical displacement 2.9 m,
sinistral slip 0.43 m**



(Crone and others, 1987)

**Large fault scarp; vertical
displacement 1.2 m, scarp
height 1.73 m**



(Crone and others, 1987)



(Crone and others, 1987)

Western Section

**Large fault scarp; net throw 1.4 m,
0.6 m sinistral slip**



(Crone and others, 1987)

Northern Section

**Largest scarp on Northern Section;
net throw 1.0 m, scarp height 1.2 m**

Lost River Fault

Segment Slip-Rate Data

Segment Name	Length (km)	Time of Most Recent Deformation	Slip-Rate Category
Arco	15	Late Quaternary (< 130 ka)	< 0.2 mm/yr
Challis	26	Quaternary (< 1.6 Ma)	< 0.2 mm/yr
Mackay	23	Latest Quaternary (< 15 ka)	< 0.2 mm/yr
Pass Creek	26	Late Quaternary (< 130 ka)	< 0.2 mm/yr
Thousand Springs	24	Historical	Between 0.2 and 1.0 mm/yr
Warm Springs	16	Historical	< 0.2 mm/yr