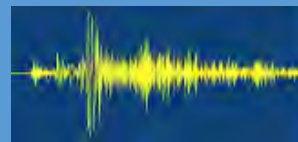


The 2019 Mw 6.4 and Mw 7.1 Ridgecrest, California earthquakes and implications for the Walker Lane

Rich D. Koehler
Nevada Bureau of Mines and Geology

Presented at the Nevada-Utah Earthquake Summit
Eldorado Resort Casino
October, 16, 2019





The Nevada Seismological Laboratory

Collaborators

Ian Pierce, Colin Chupik, UNR

Alana Williams, Arizona State University

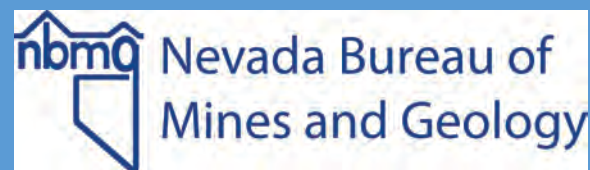
Sinan Akciz, CSU Fullerton

PG&E

Geotechnical Extreme Events Reconnaissance

California Geological Survey

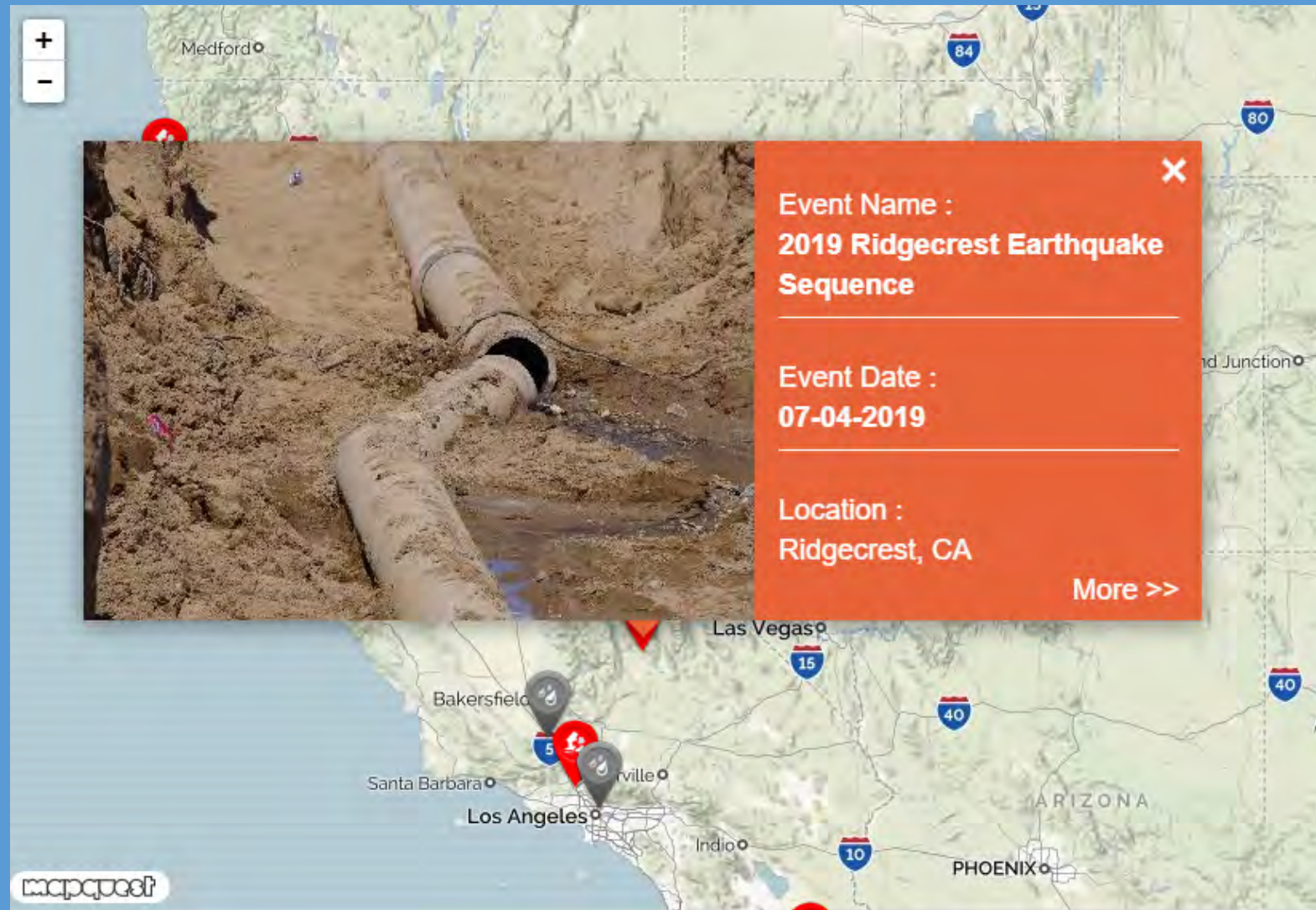
U.S. Geological Survey



California
Department of Conservation

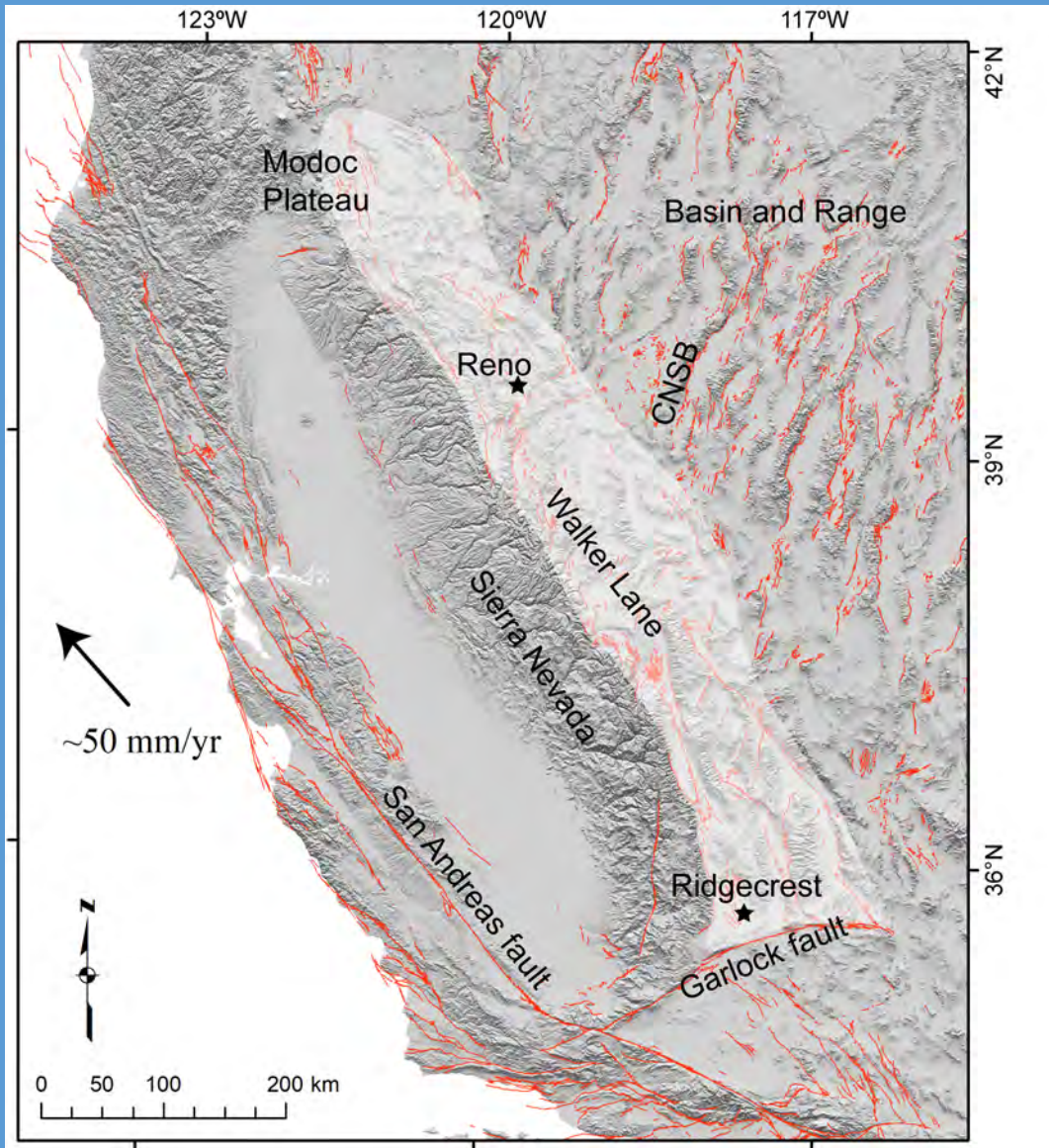


Preliminary Report on Engineering and Geological Effects of the July 2019 Ridgecrest Earthquake Sequence

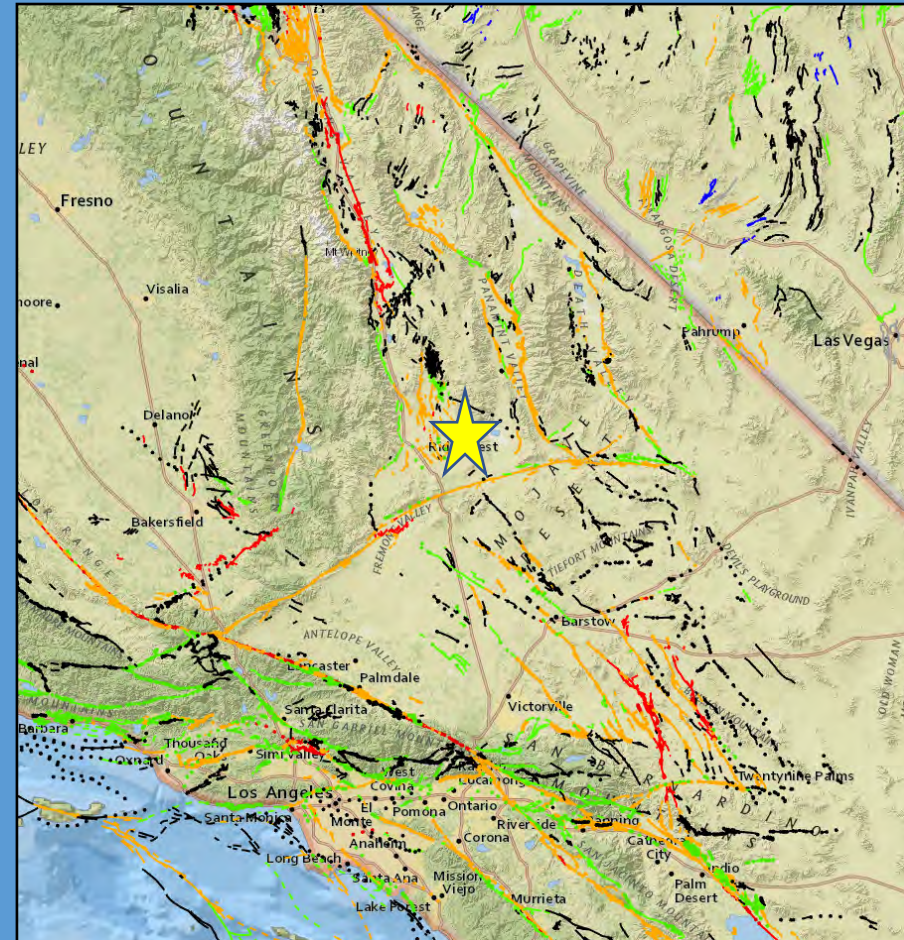


<http://www.geerassociation.org/>

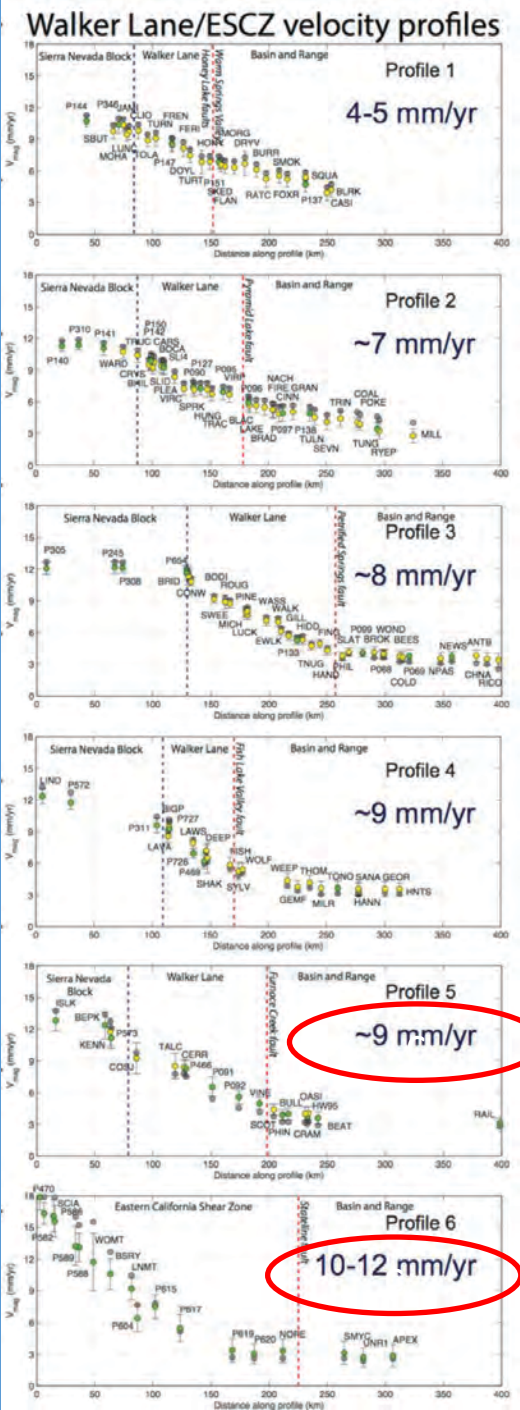
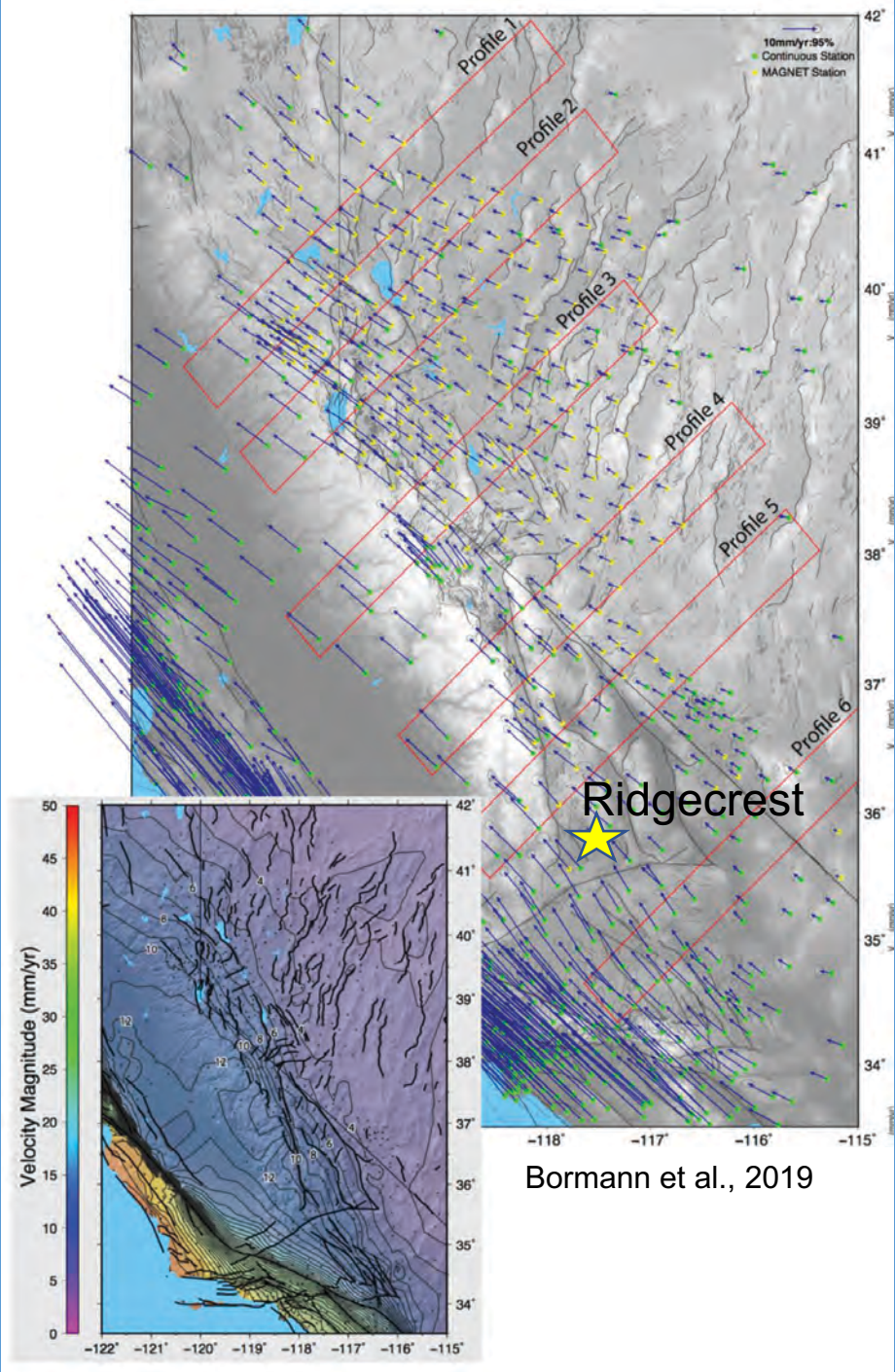
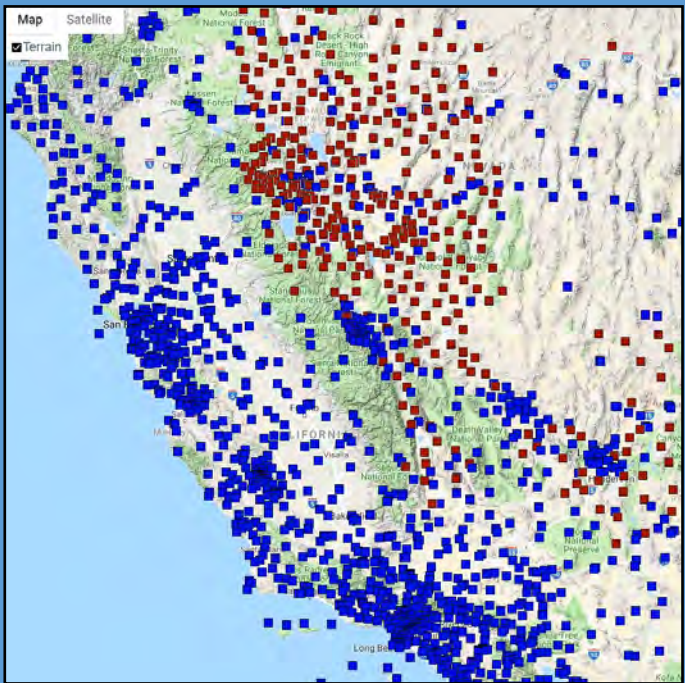
Tectonic setting



- Southern Walker Lane/Eastern CA shear zone accommodates 20-25% of the plate motion.
- Individual fault slip rates <5 mm/yr on major faults.

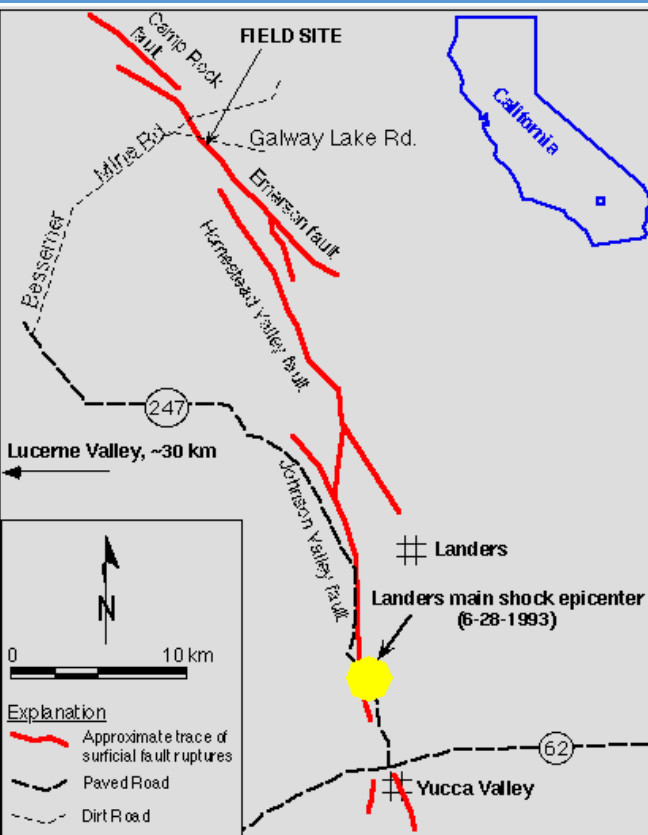
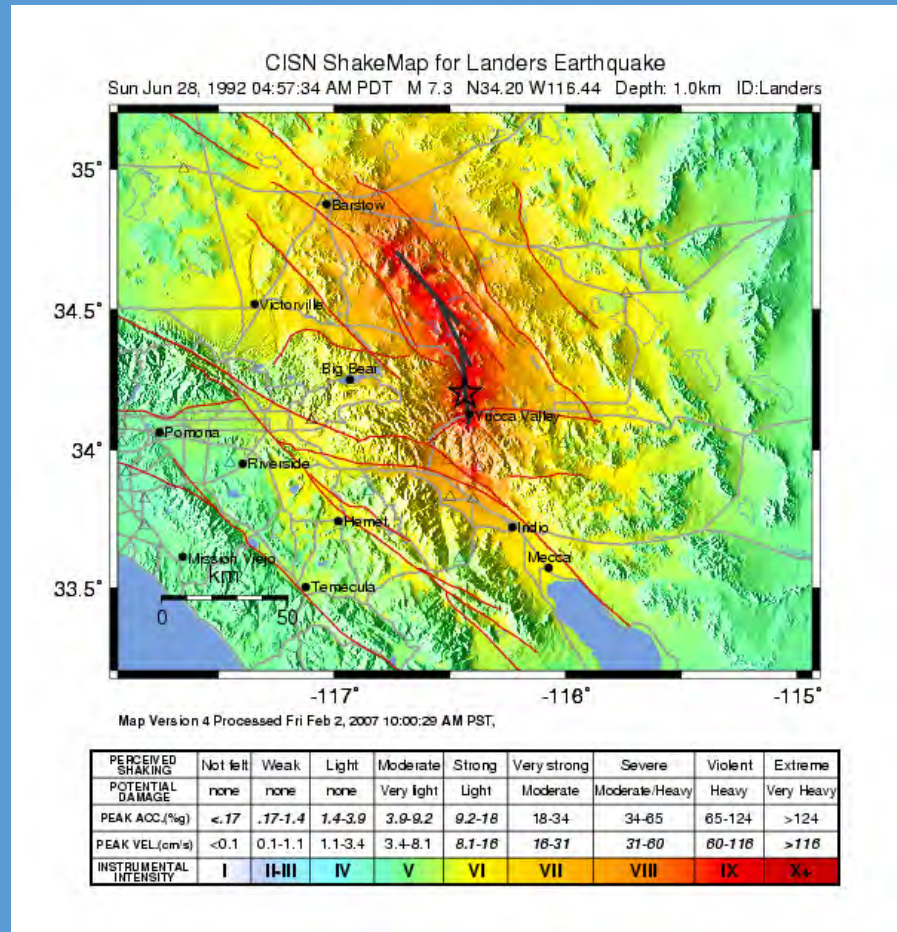


Nevada Geodetic Laboratory
MAGNET network





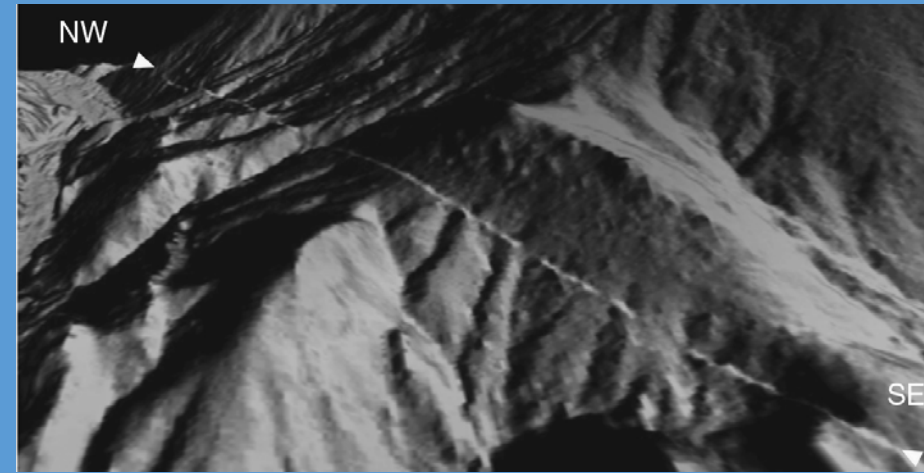
1992 M7.3 Landers earthquake



- Rupture of multiple faults
- Johnson V., Homestead V., Emerson, and Camp Rock faults
- Extensive surface rupture
- Pattern similar to Ridgecrest earthquakes



1999 M7.1 Hector Mine earthquake

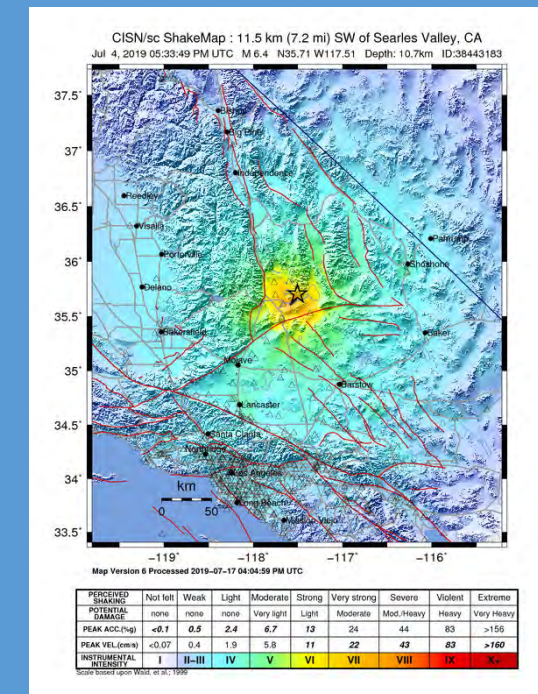


The 2019 Mw 6.4 and Mw 7.1 Ridgecrest, California earthquakes



M6.4 event

- July 4, 2019
- NE oriented left-lateral strike-slip fault.
- Hypocentral depth of ~11 km
- Rupture length or ~15 km.
- Unilaterally ruptured to the southwest.
- Max lateral displacements >1 m.



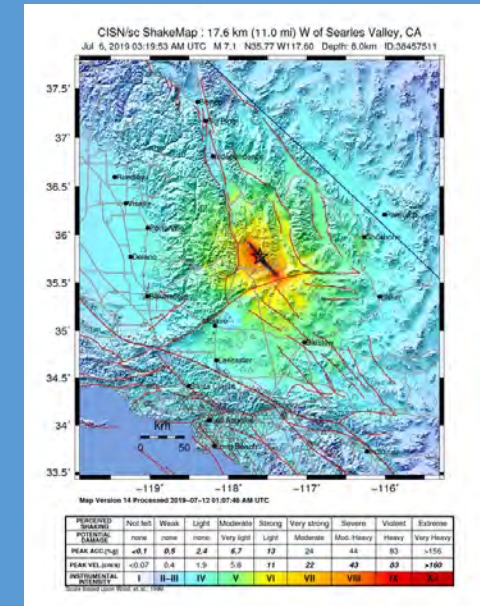
The 2019 Mw 6.4 and Mw 7.1 Ridgecrest, California earthquakes



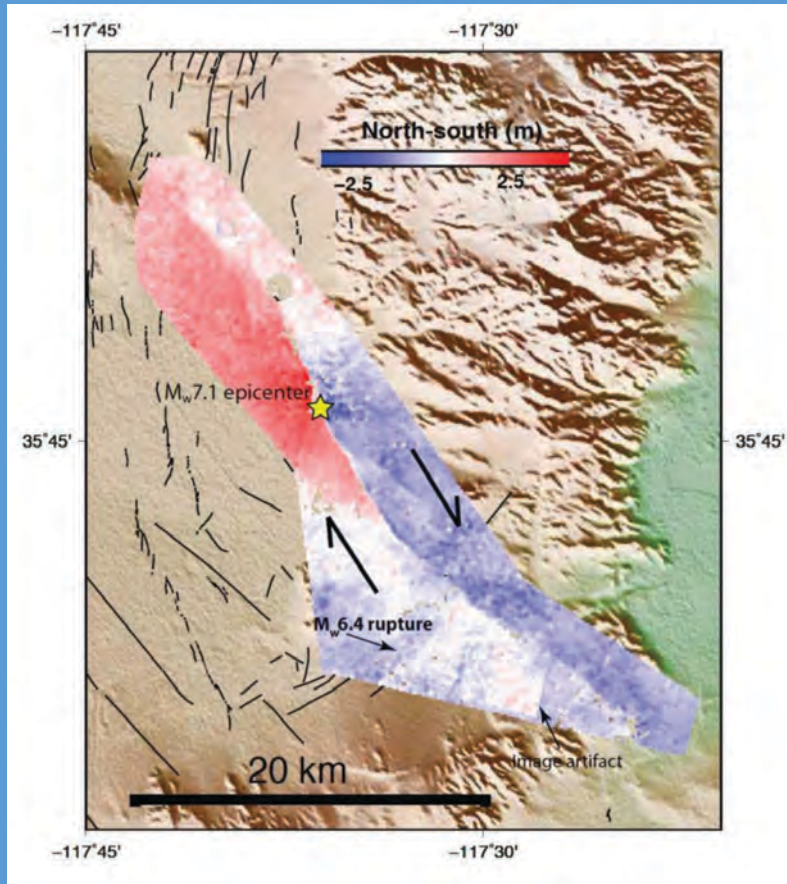
M7.1 event

- July 5, 2019, 8:19 PM
- NW oriented right-lateral strike-slip fault.
- Hypocentral depth of ~8 km
- Rupture length of >50 km.
- Bilaterally ruptured to the NW and SE.
- Max lateral displacements >4.5 m.
- Rupture distributed over 2.5 km

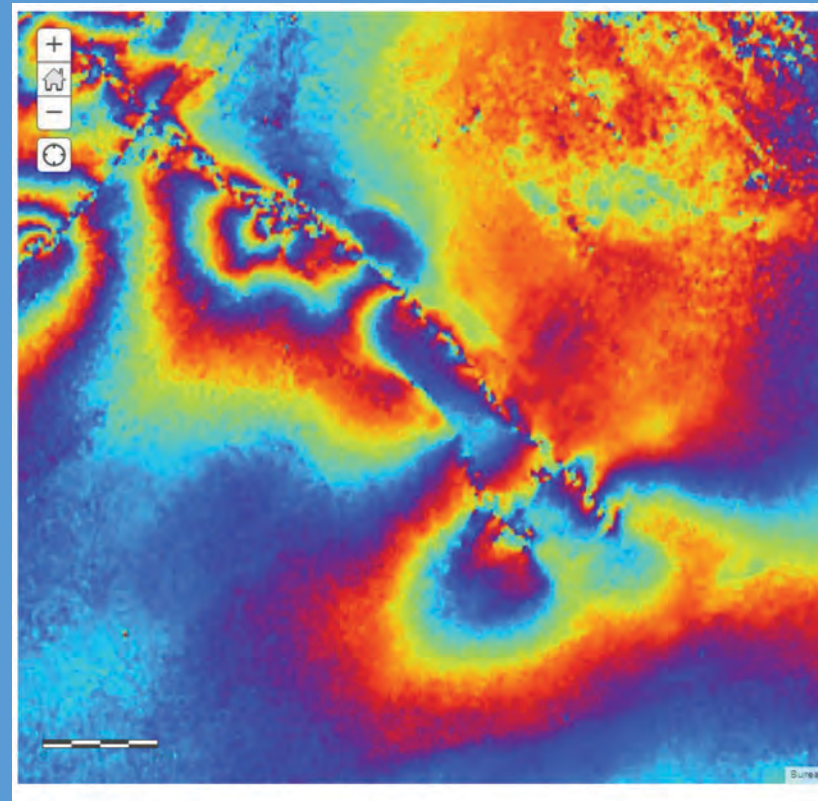
~\$100 M



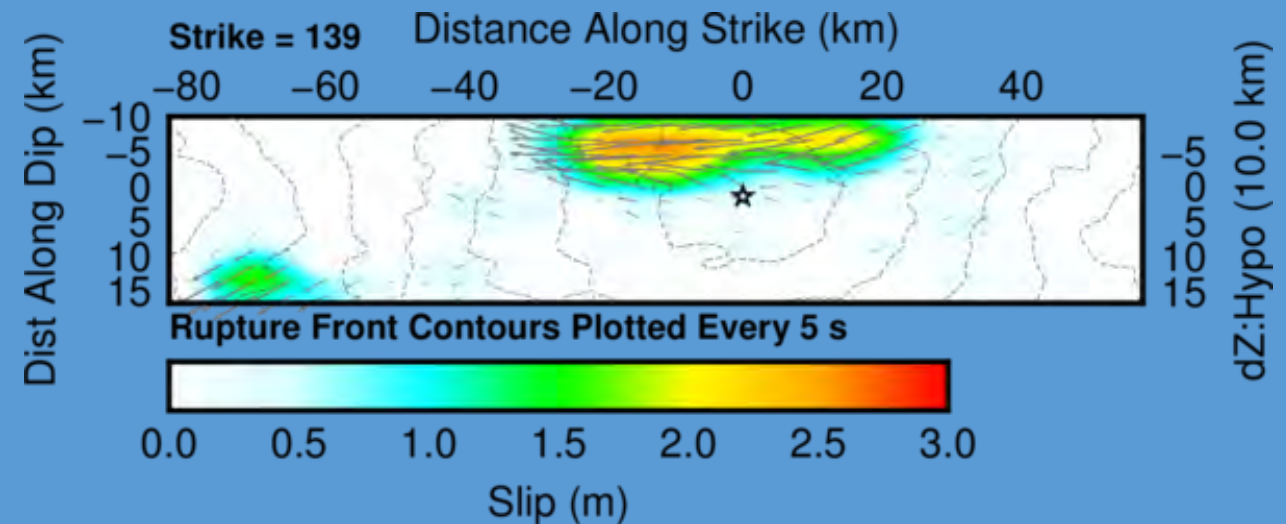
Patton, 2019

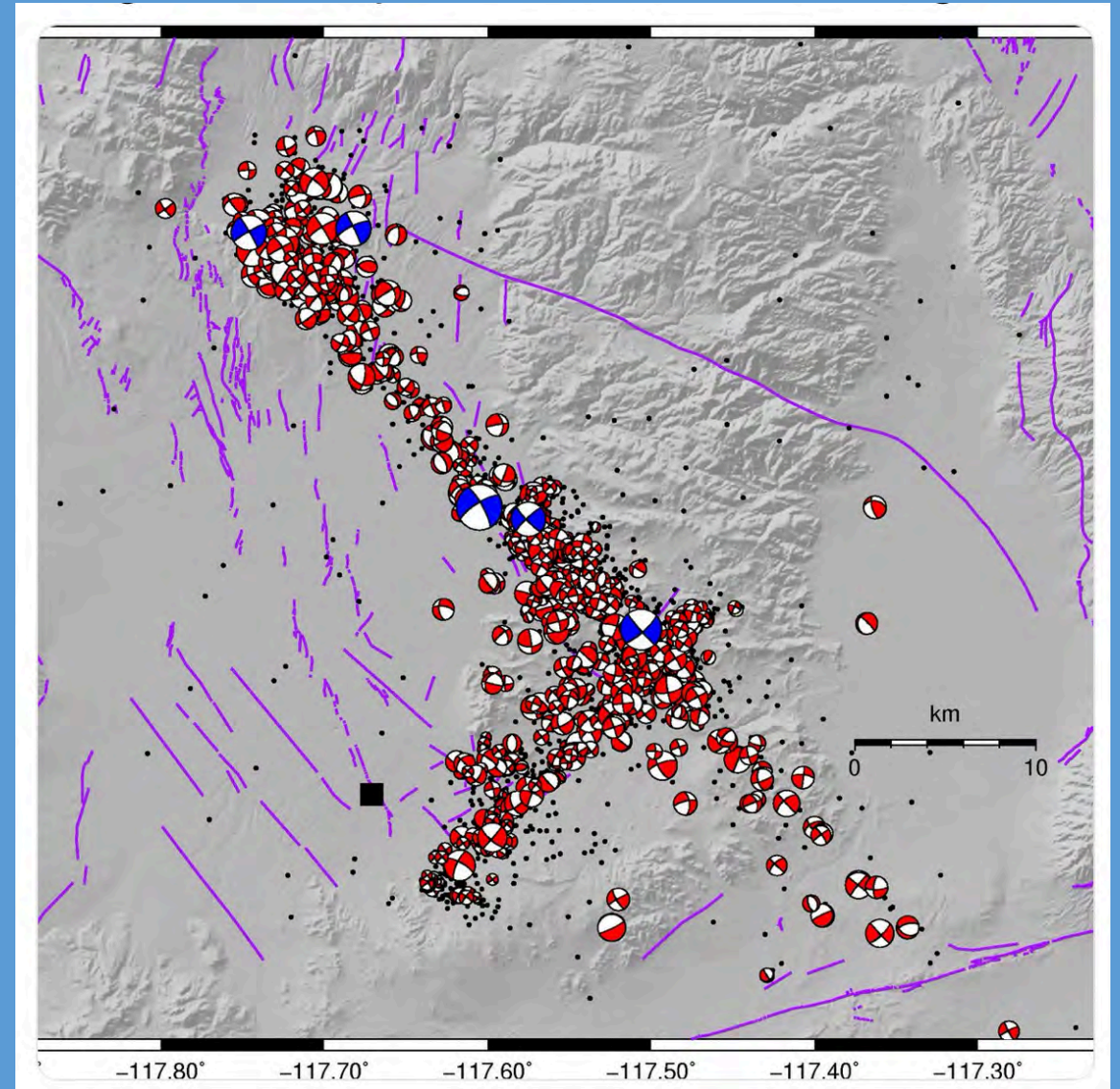
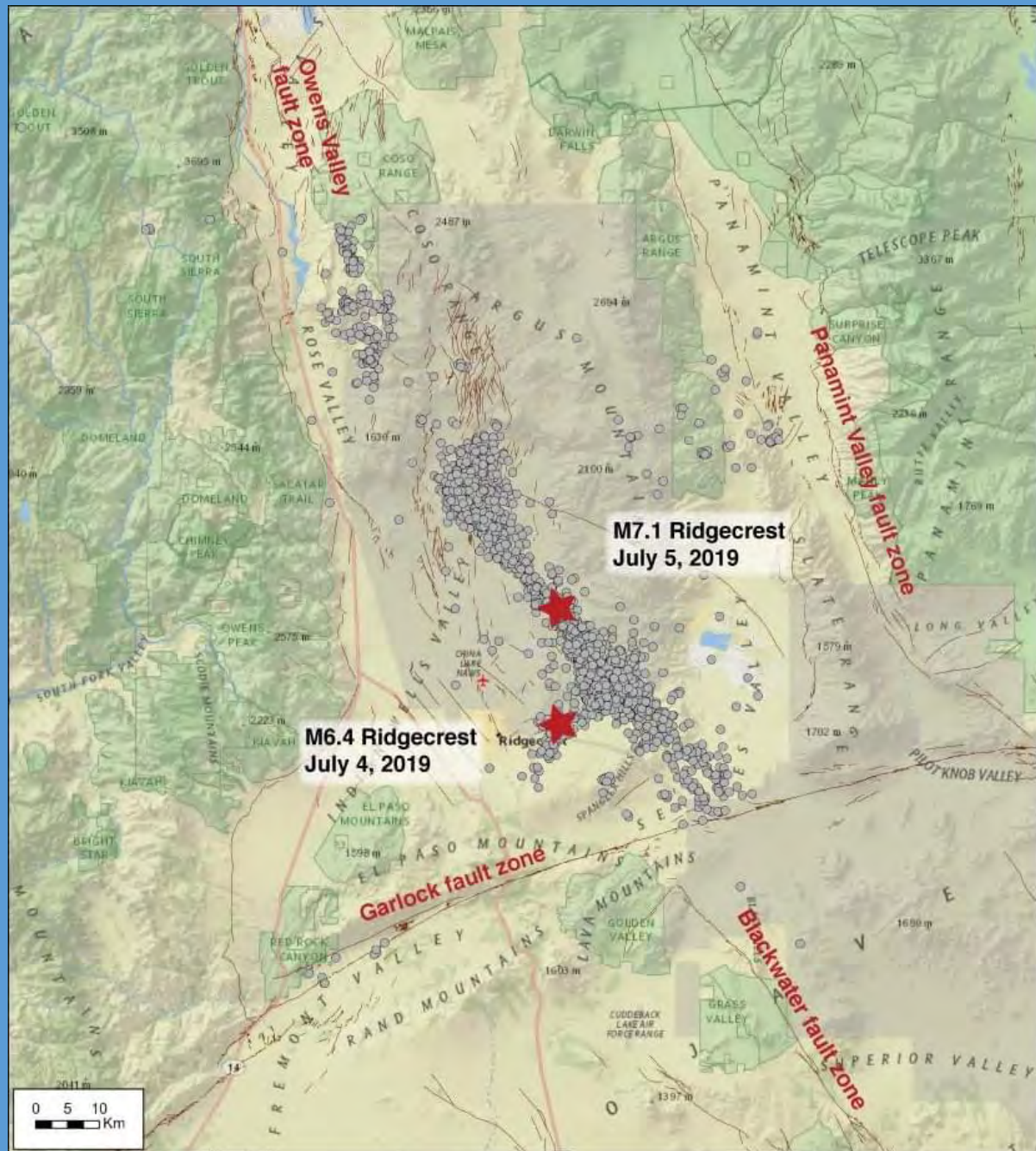


Pixel tracking and image cross-correlation of Planetlabs satellite imagery shows more distributed deformation towards rupture tips (Milliner, 2019)



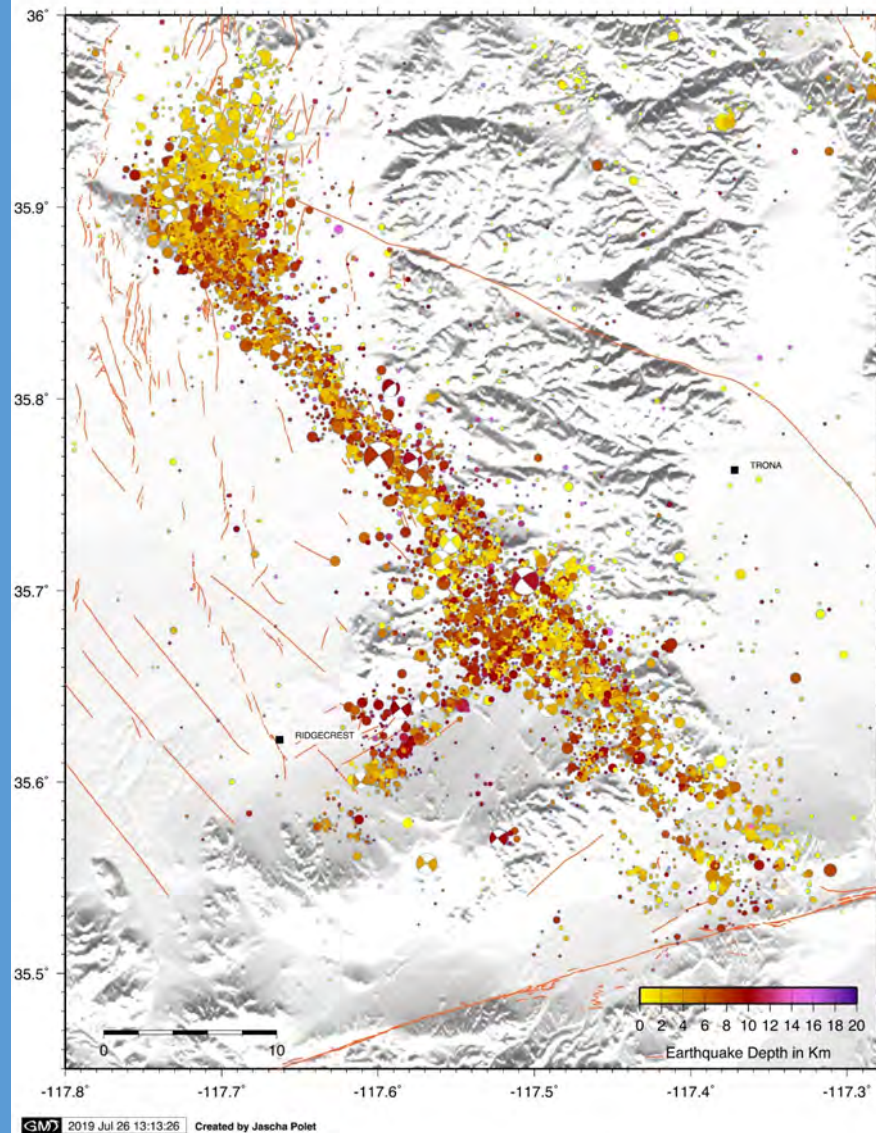
InSAR data from JAXA ALOS2 satellite images showing multiple fault strands and distributed deformation. Color bands = 4.5 in. (NASA/JPL/CalTech, 2019)



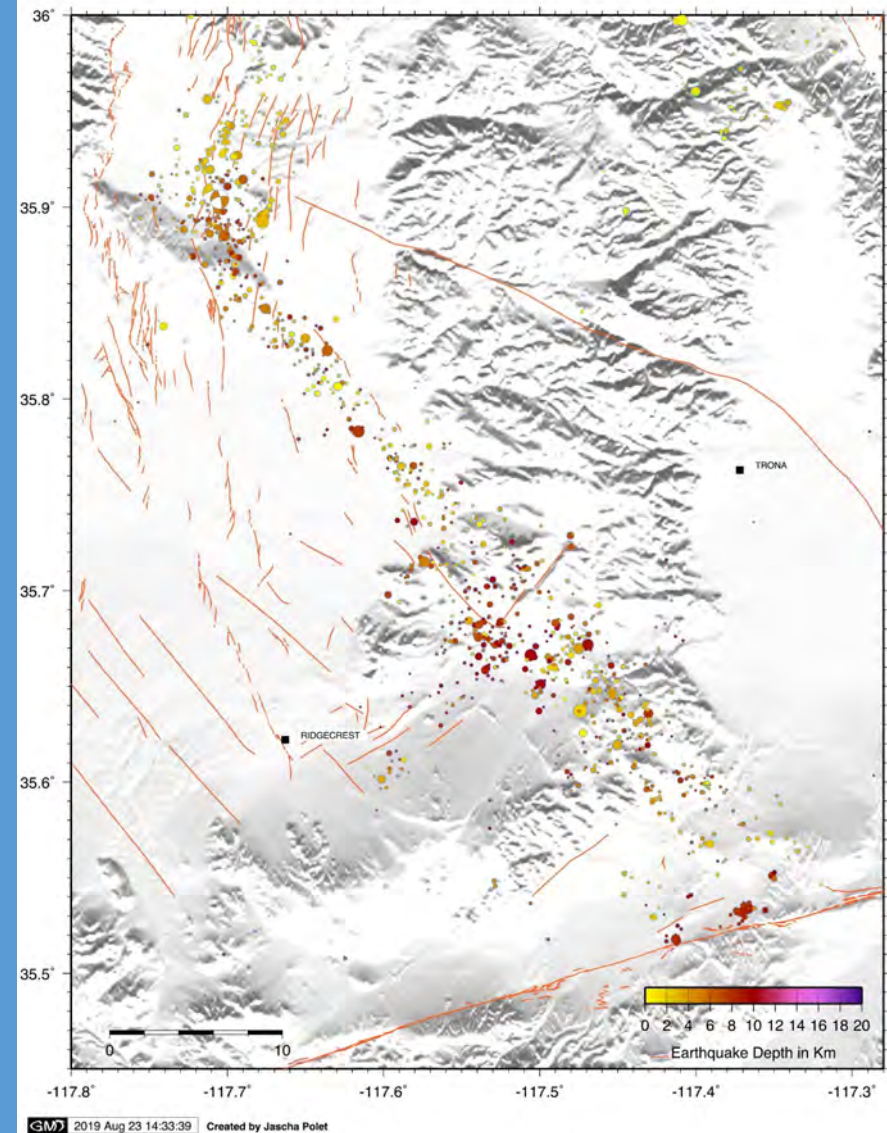


Jascha Polet, CalPoly

Seismicity before 07/26

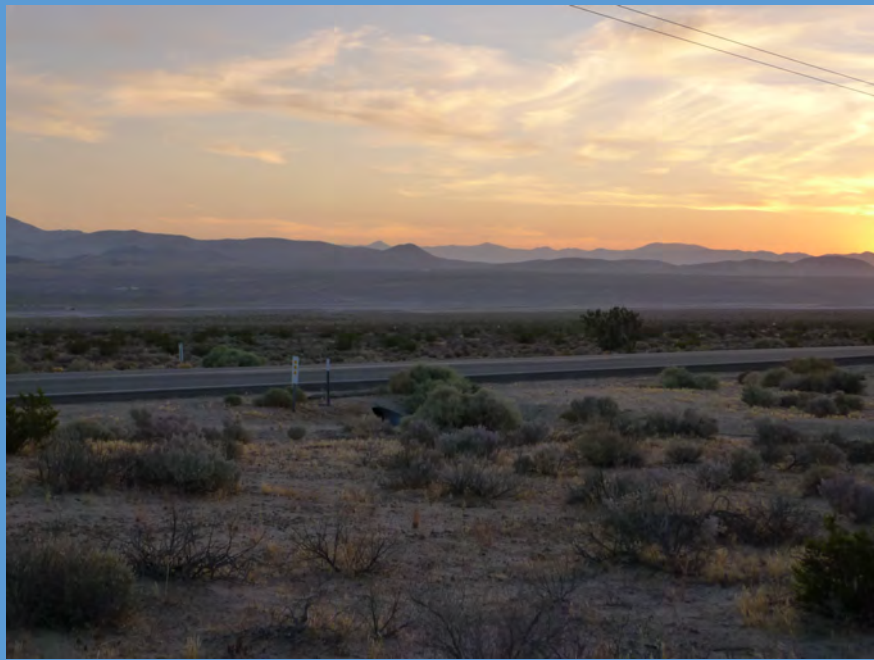


Seismicity 07/24-08/23



Why do rapid reconnaissance?



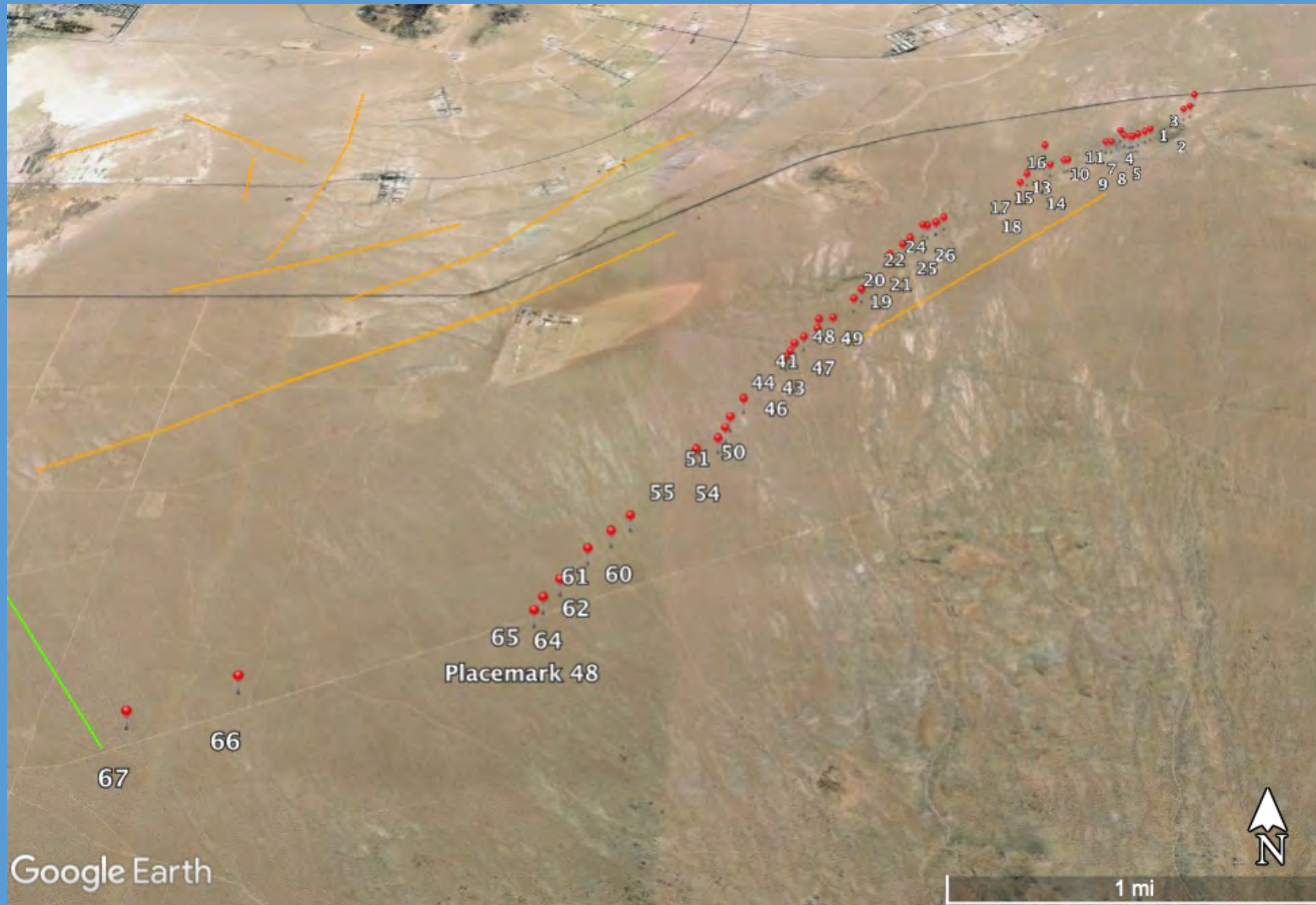


M6.4 around 5 AM,
July 5th

No sleep,
M5+ aftershock



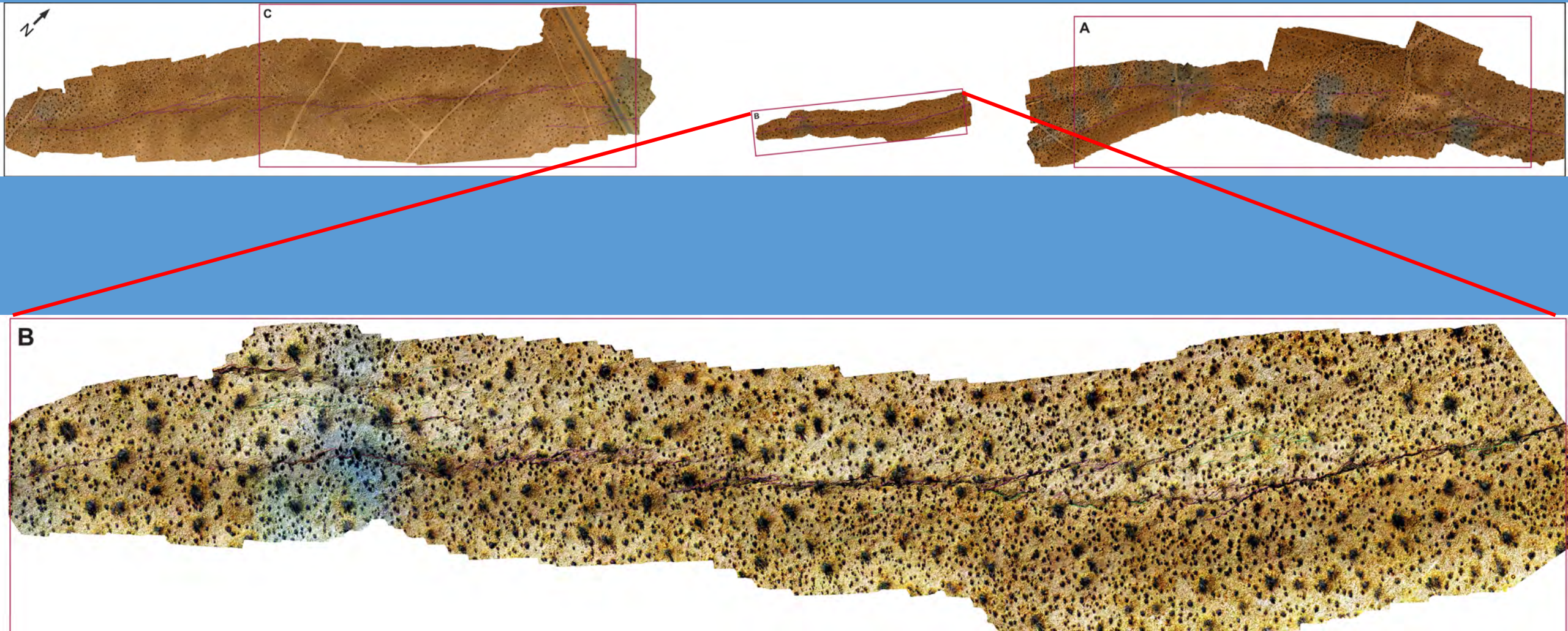
M6.4 rupture observations points (8 miles)



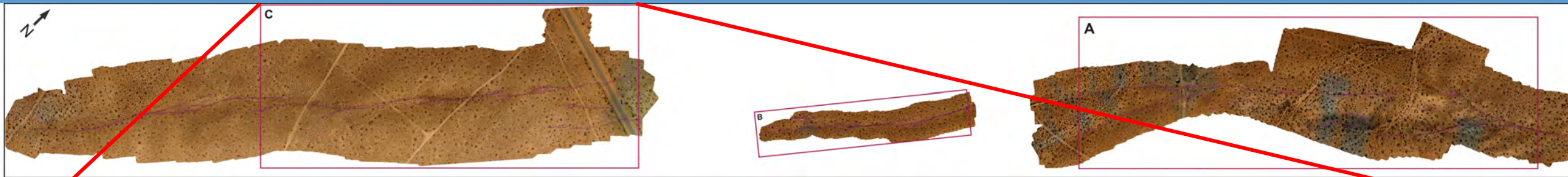




Mw6.4 surface rupture



Mw6.4 surface rupture



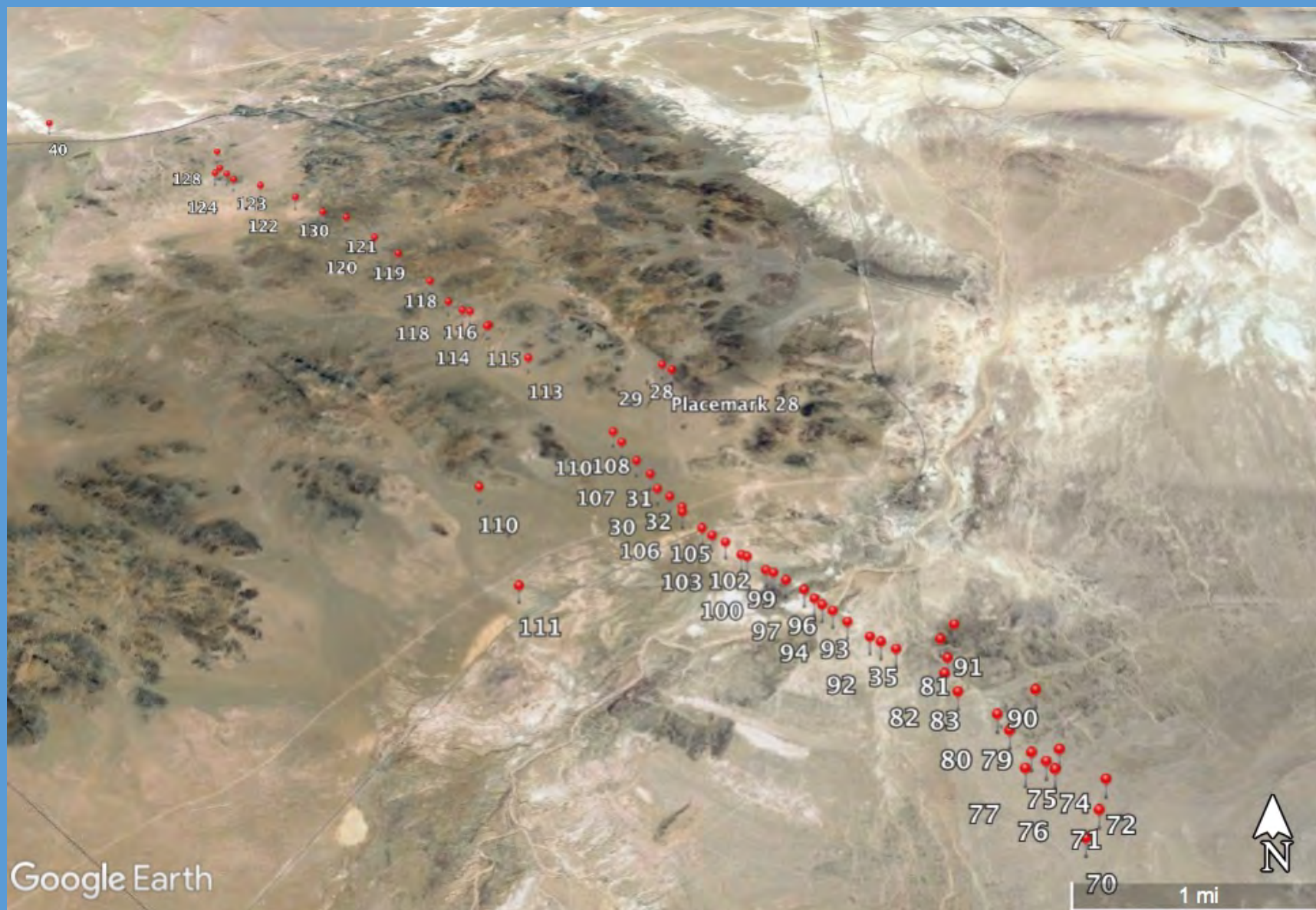
M7.1 Earthquake, 8:19 PM



Highway 178



M7.1 rupture observations points (12 miles)











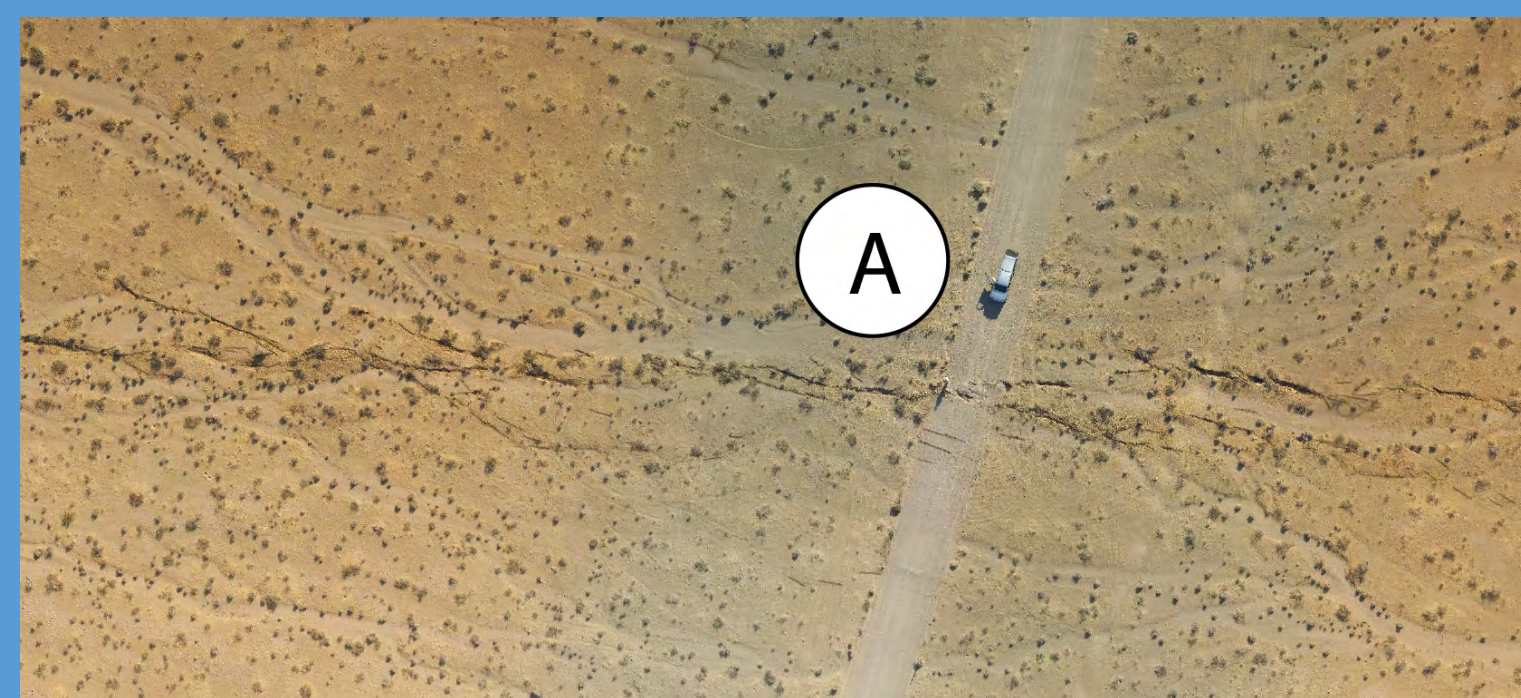
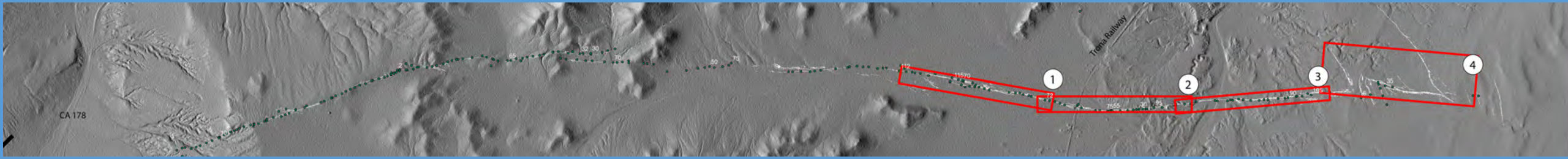






Mw7.1 surface rupture

High resolution drone imagery and orthophotographs



Mw7.1 surface rupture

CA 178

Trenk Railway

1172

11570

72

255

41

189

30

1

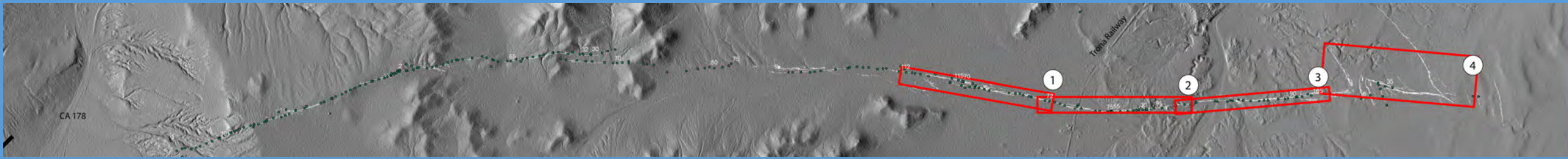
2

3

4



Mw7.1 surface rupture



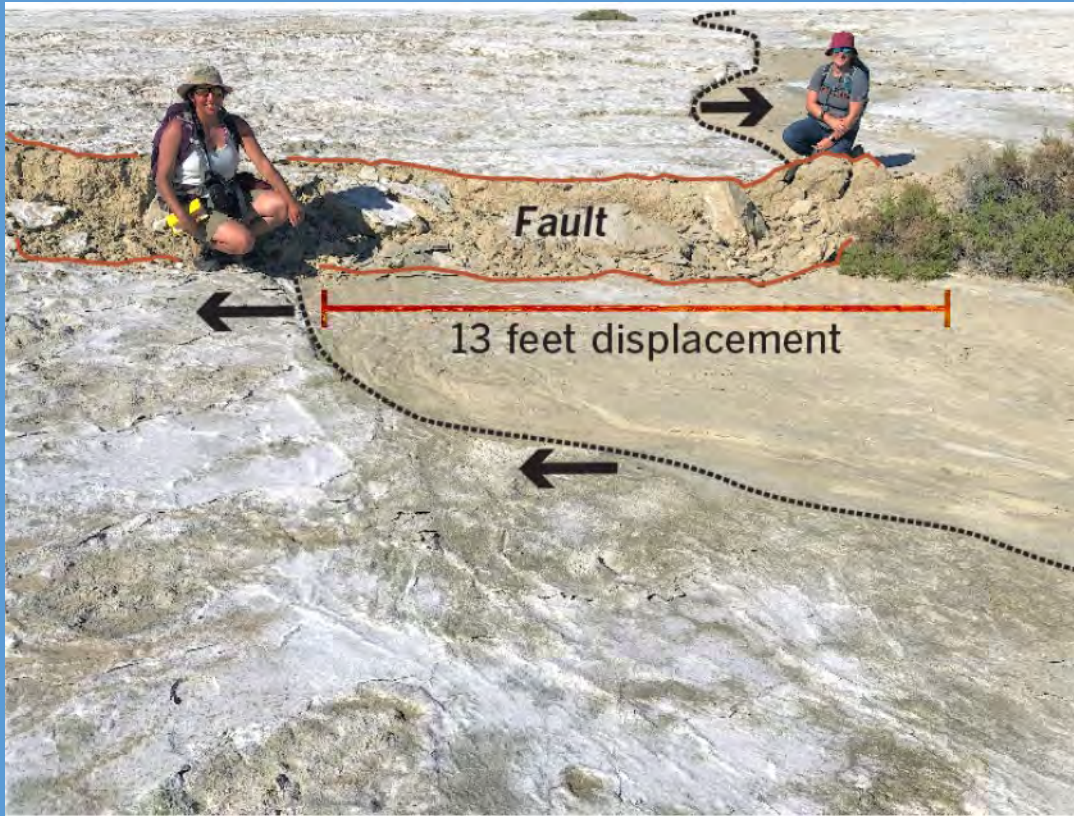
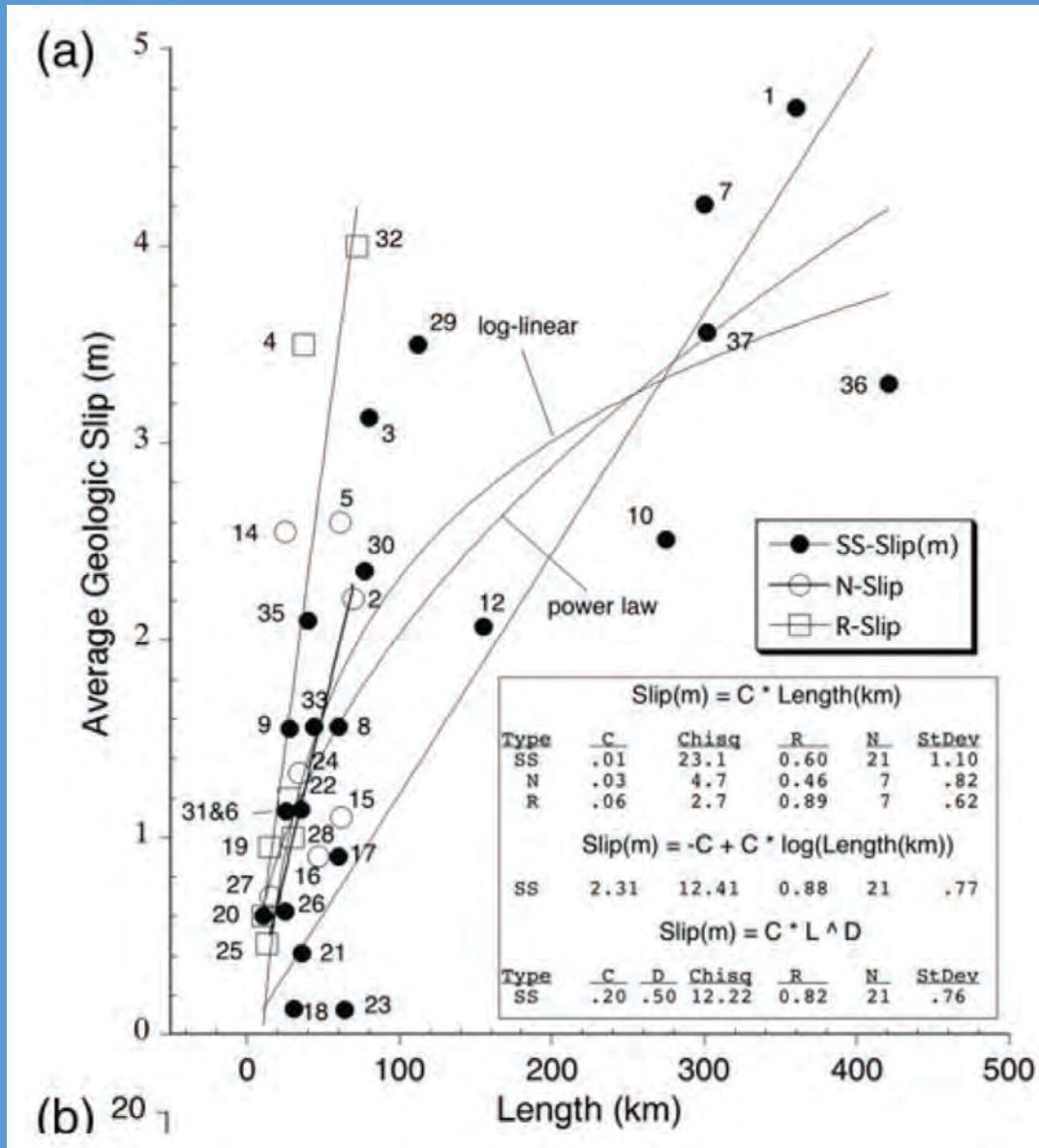


Photo credits USGS and CGS

Large displacements on the NAWS



Average slip vs. rupture length

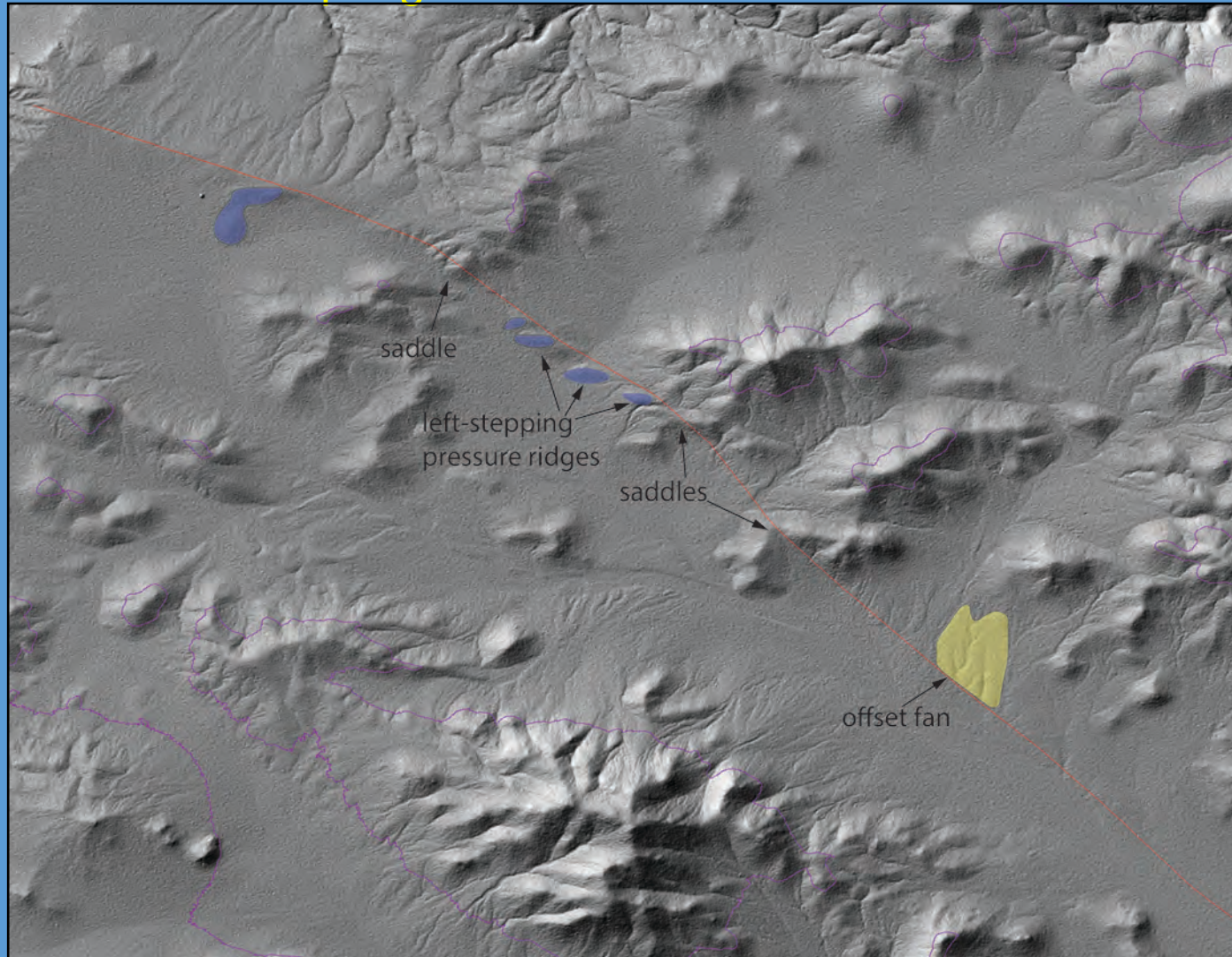


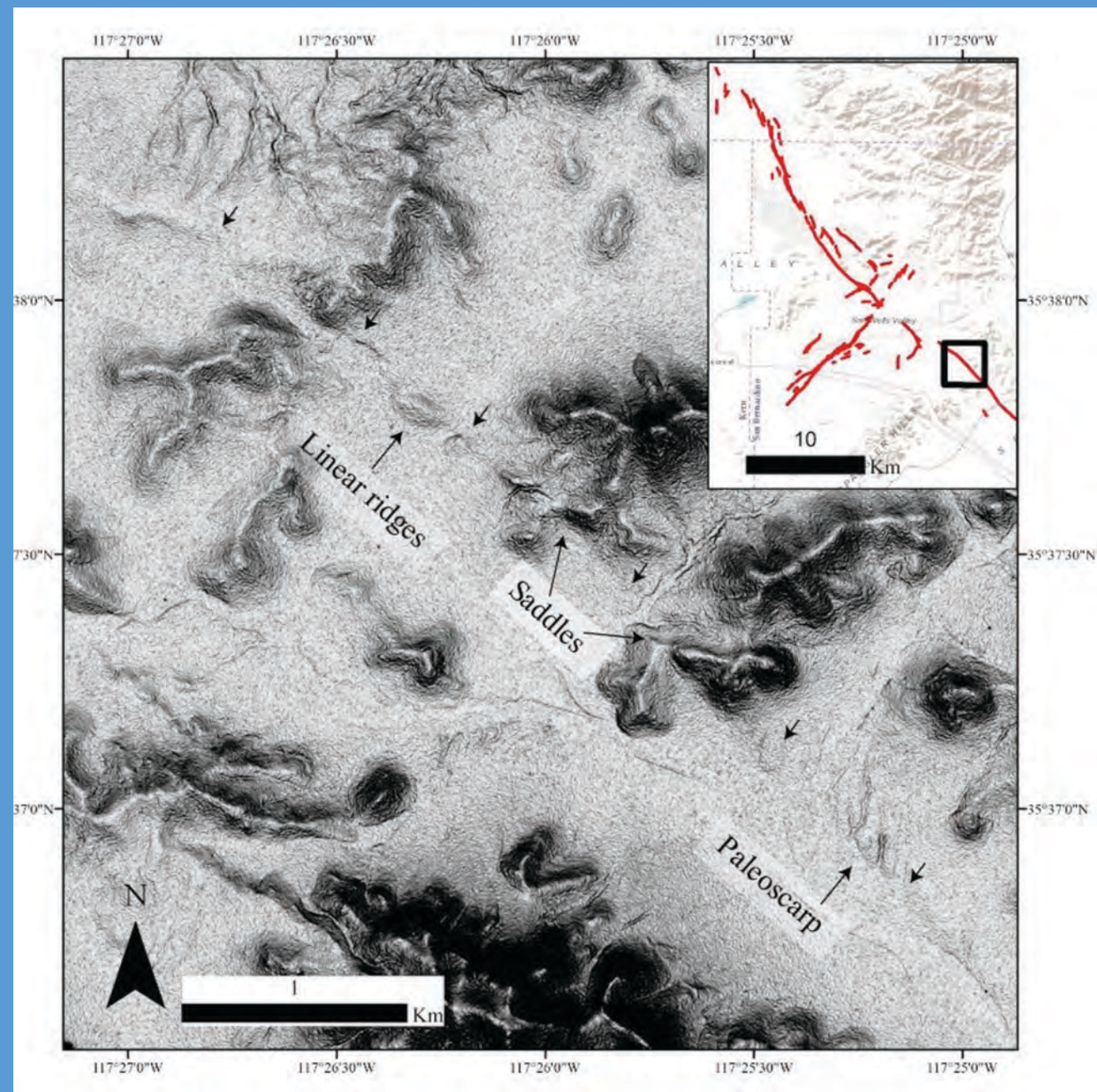
Average slip in the Ridgecrest earthquakes generally fits with the global dataset For strike-slip faults

Wesnousky, 2008

Future work and ongoing research

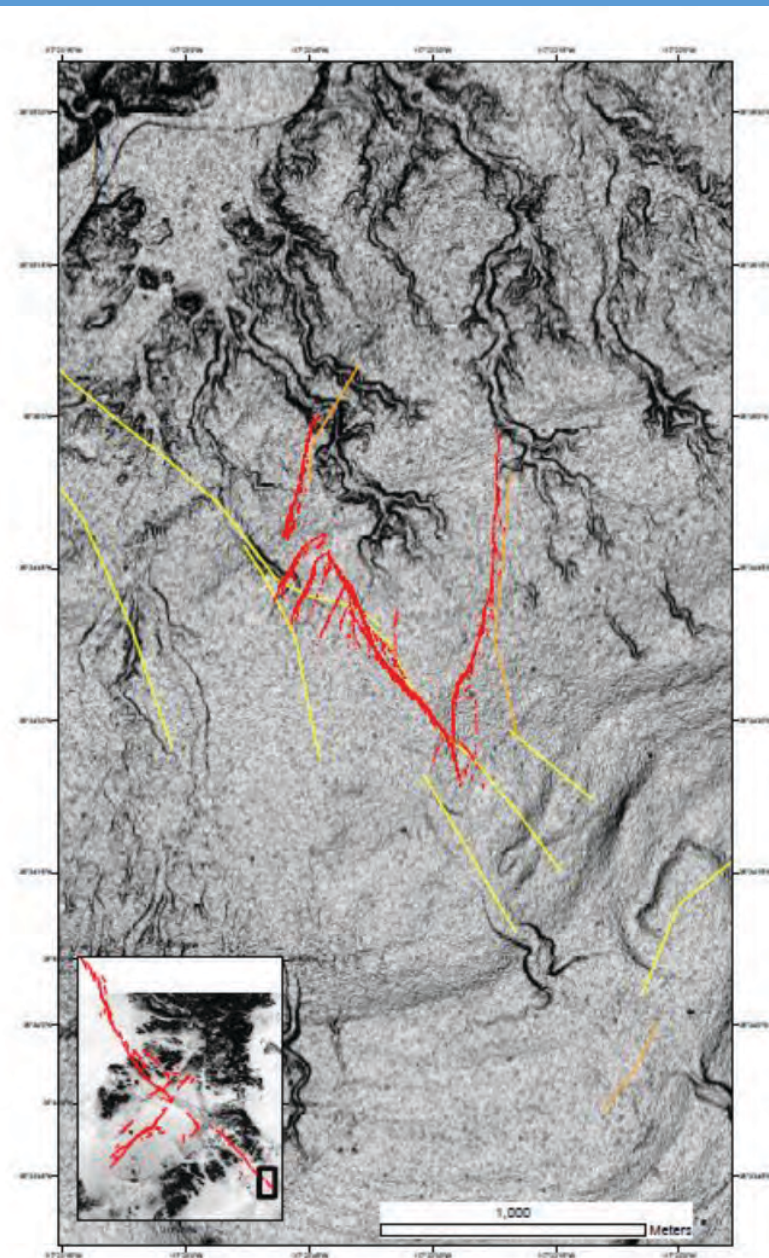
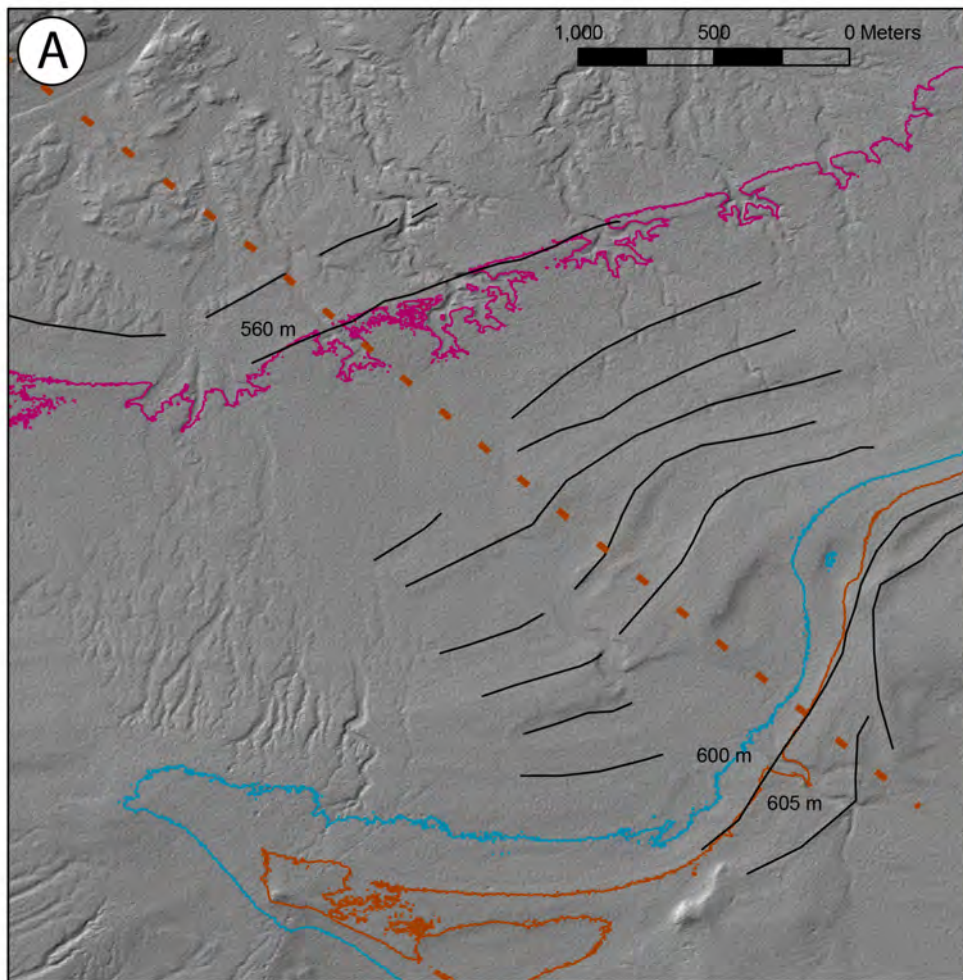
Soils and OSL analyses of faulted alluvial fans within the Spangler Hills





Future work and ongoing research

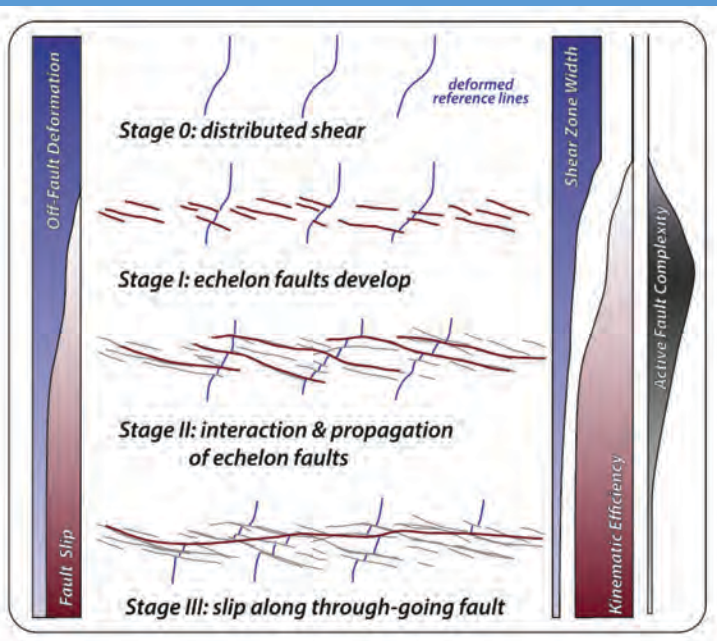
Geochronology of pluvial Lake Searles
Shorelines, Recurrence, timing



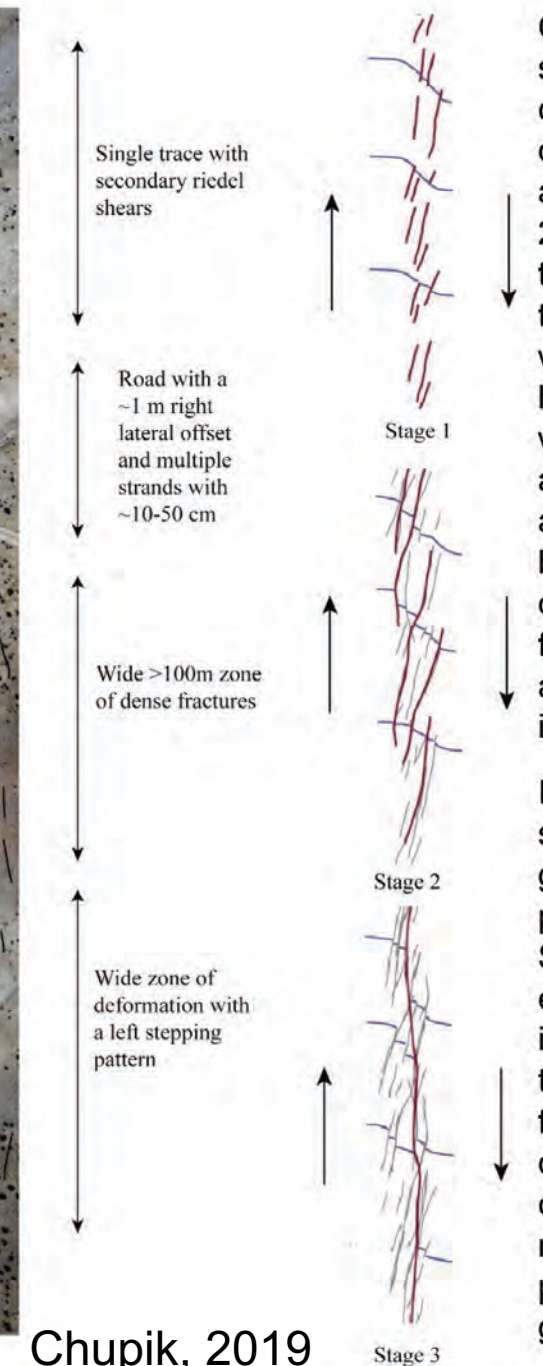
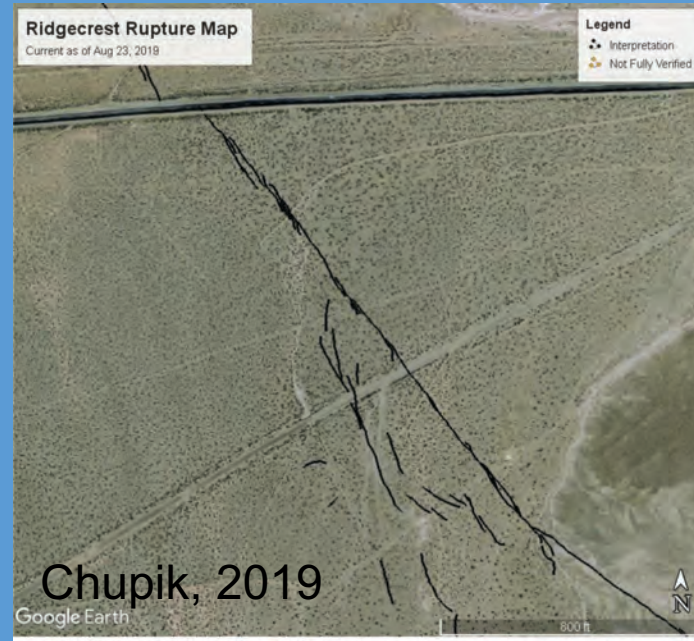
Future work and ongoing research

Width of rupture and off fault deformation

- Critical component to fault displacement hazard analyses
- Immature faults have up to 40% of deformation off-fault

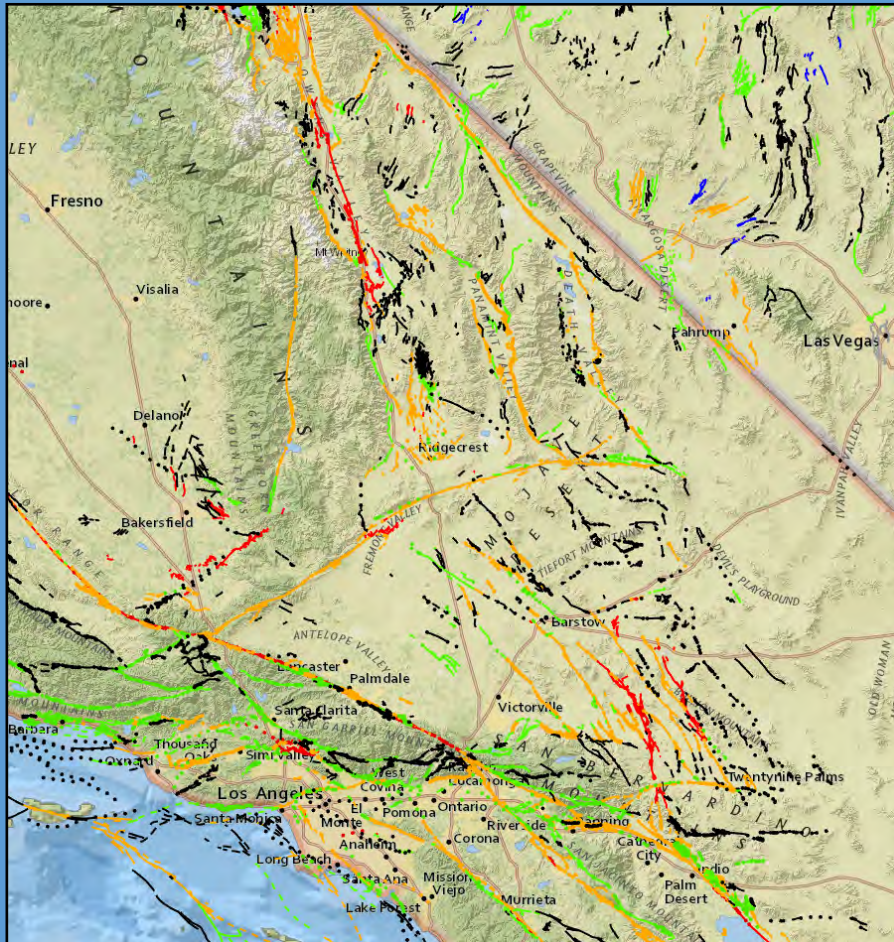


Stages of strike-slip fault growth from experiments in wet clay.
Hattem et al. (2017)

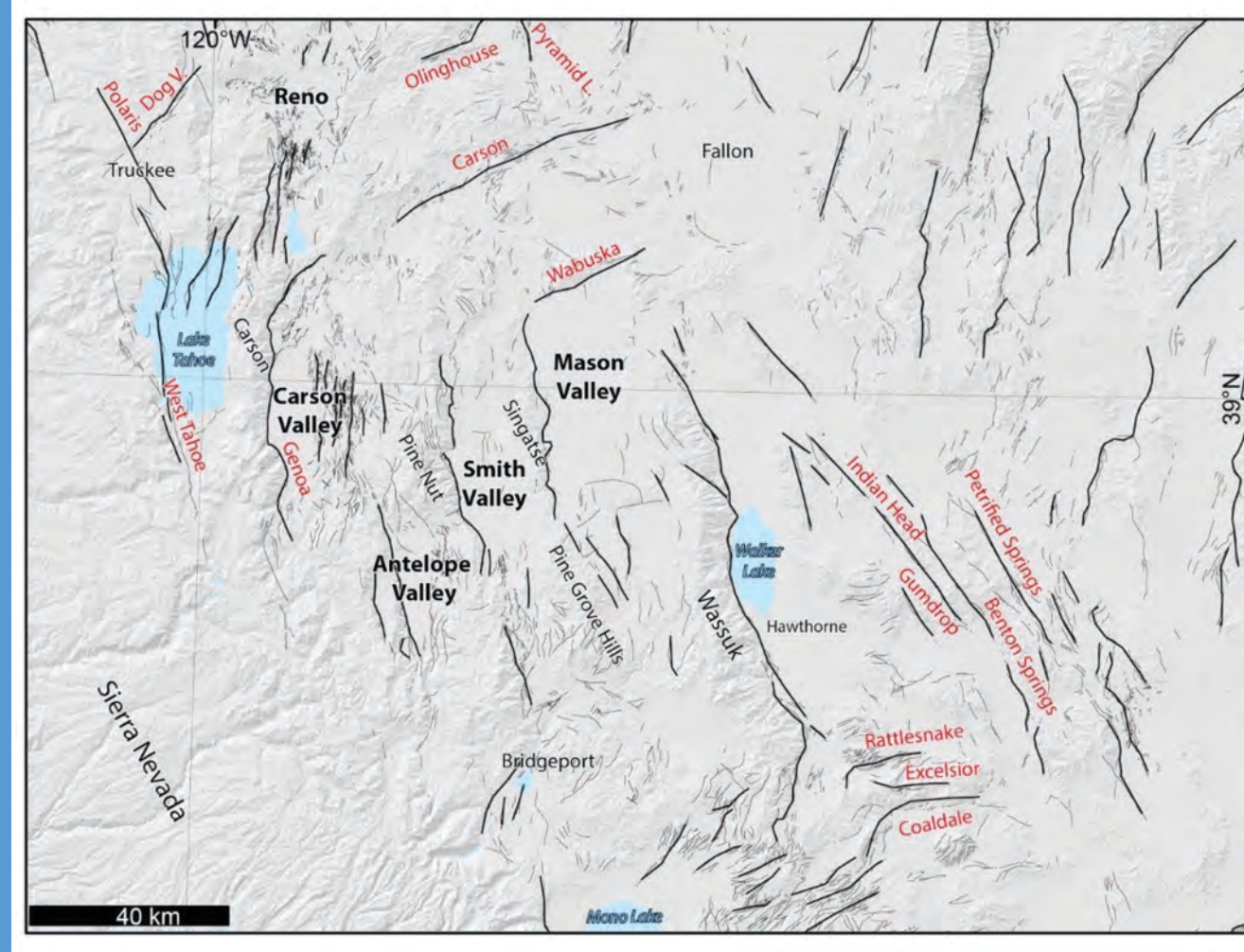


Chupik, 2019

Implications for the Walker Lane

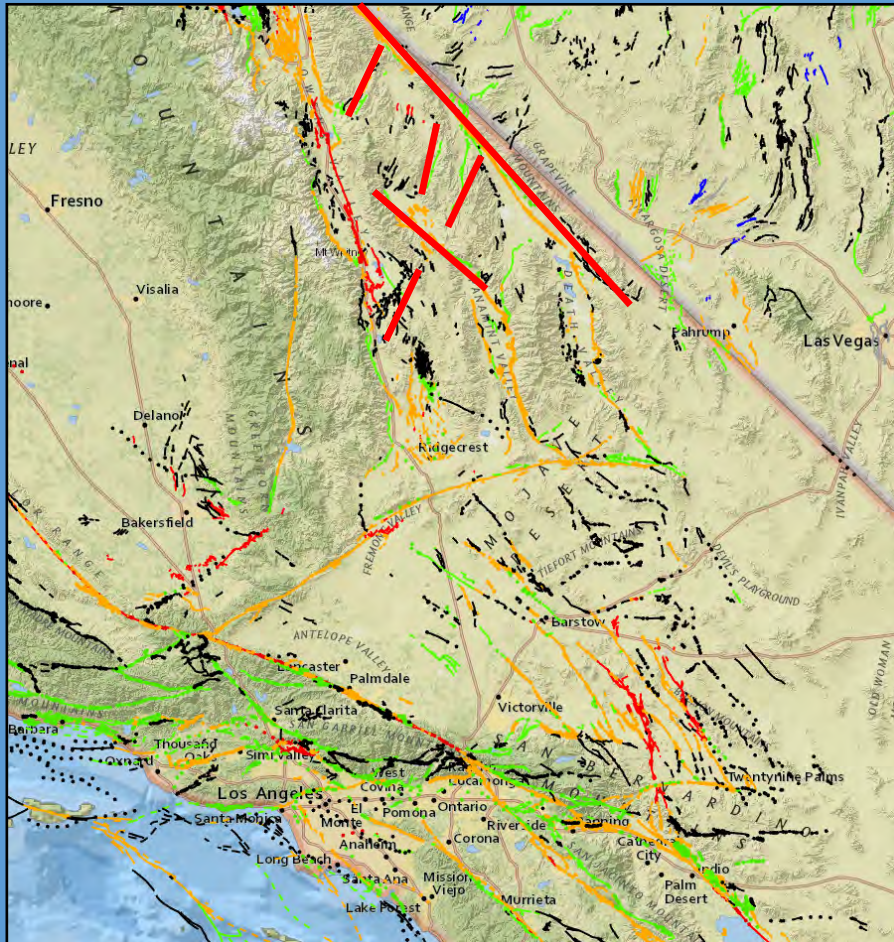


Southern Walker Lane

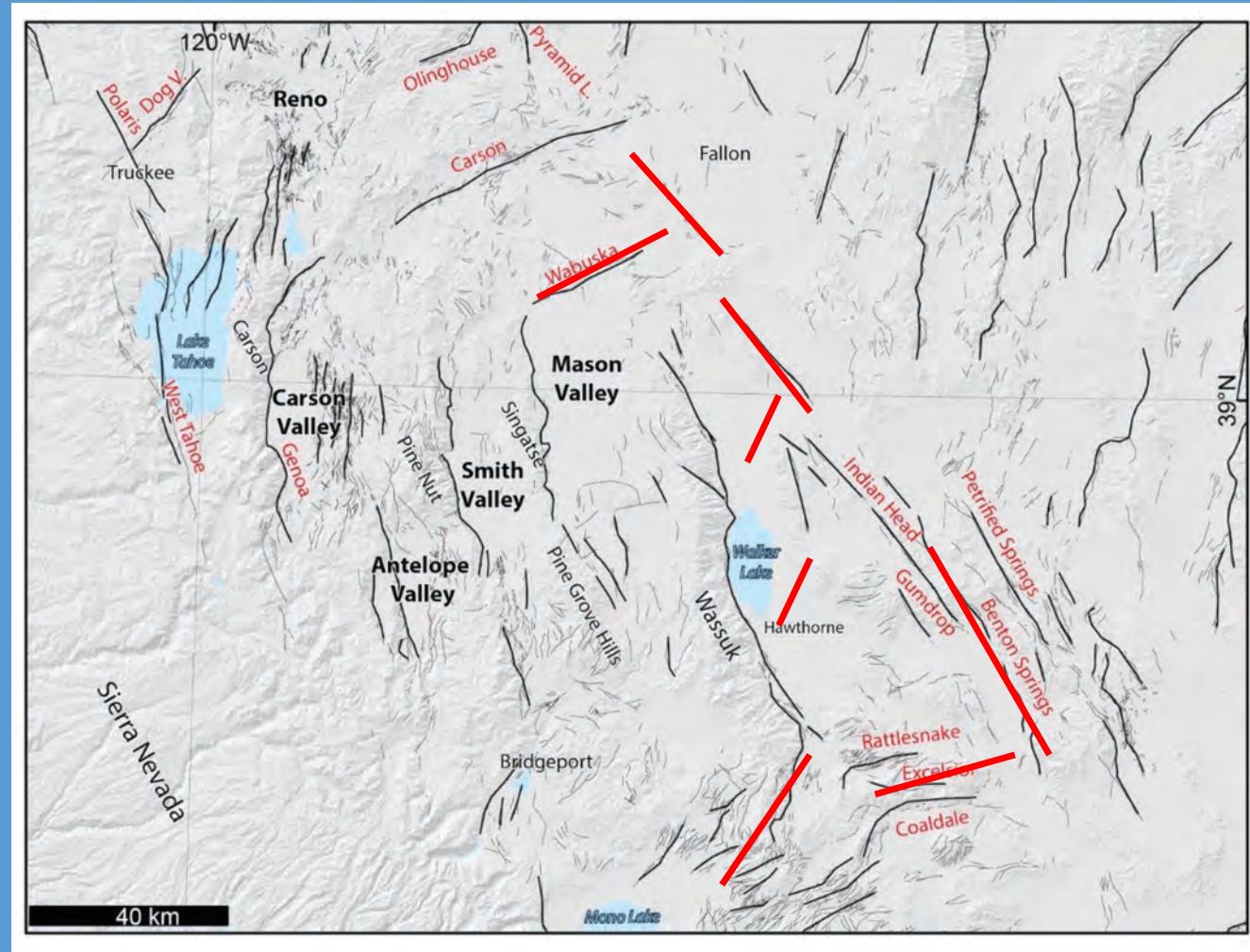


Central Walker Lane

Implications for the Walker Lane



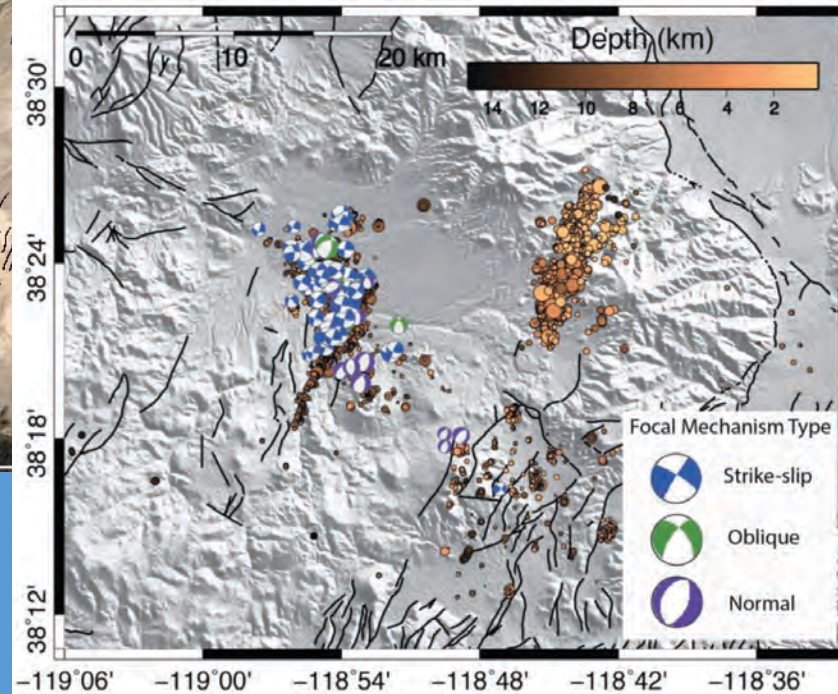
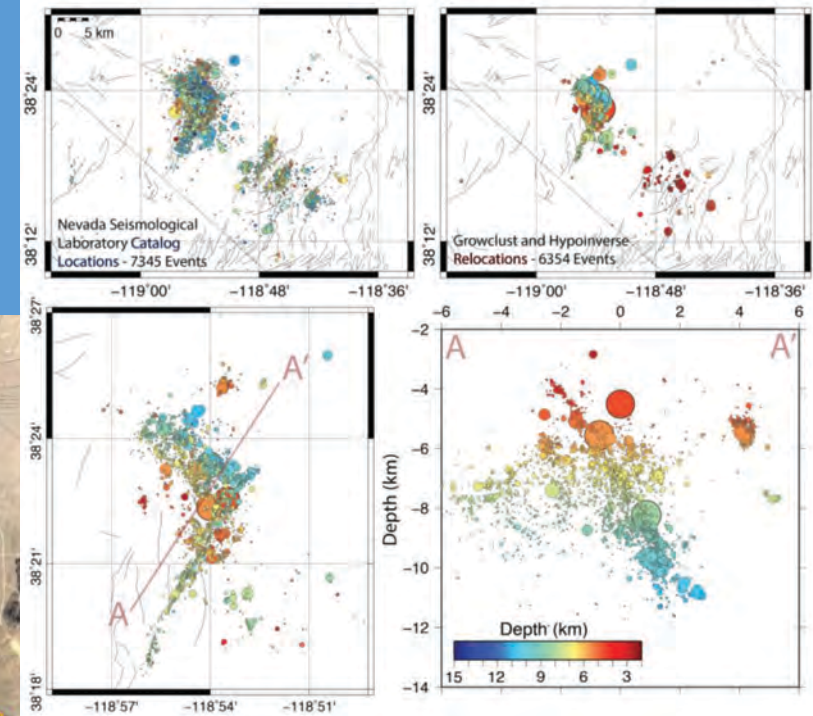
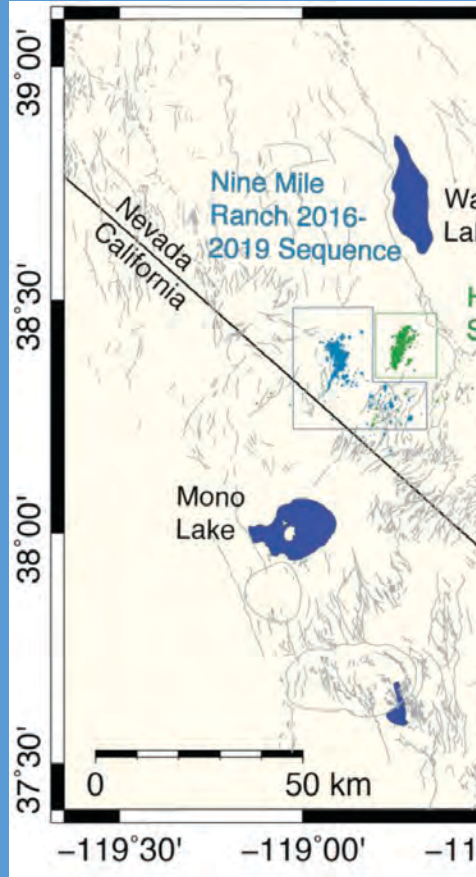
Southern Walker Lane



Central Walker Lane

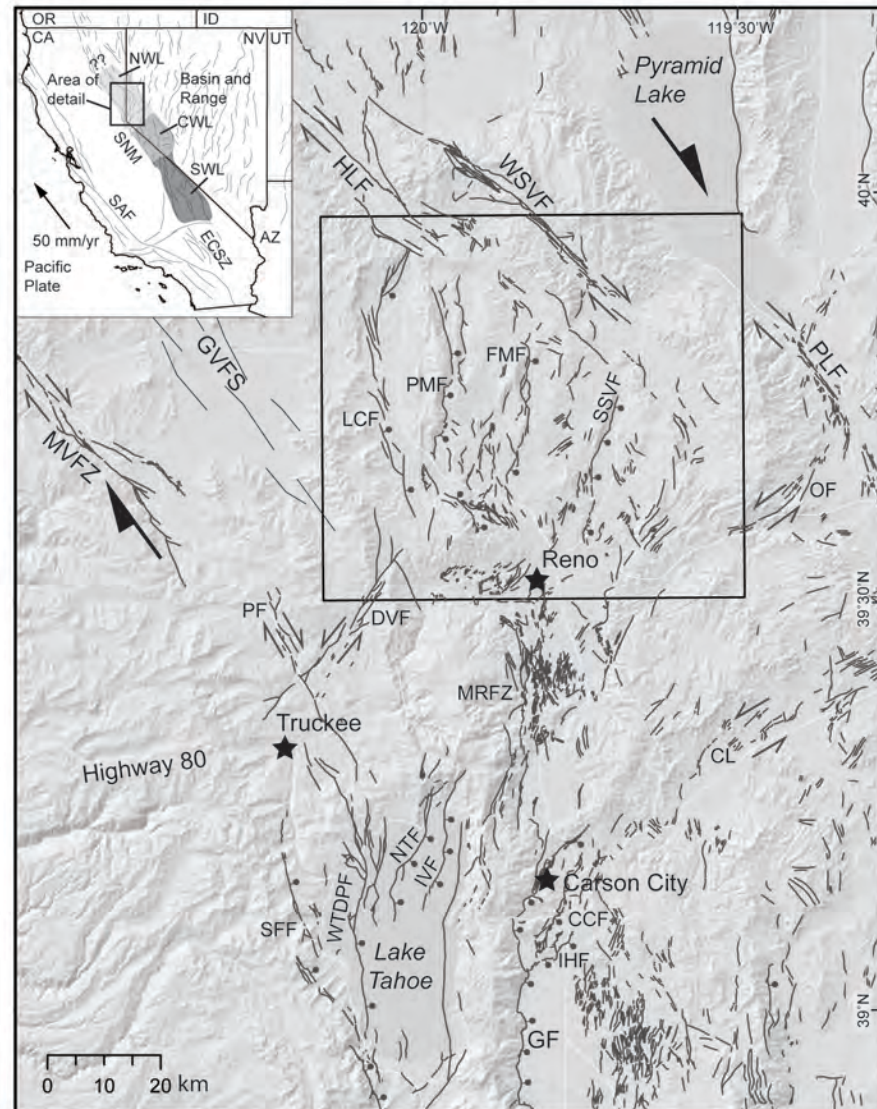
Nine Mile Ranch Earthquake sequence Dec. 28, 2016

3 Mw 5.4-5.6 events

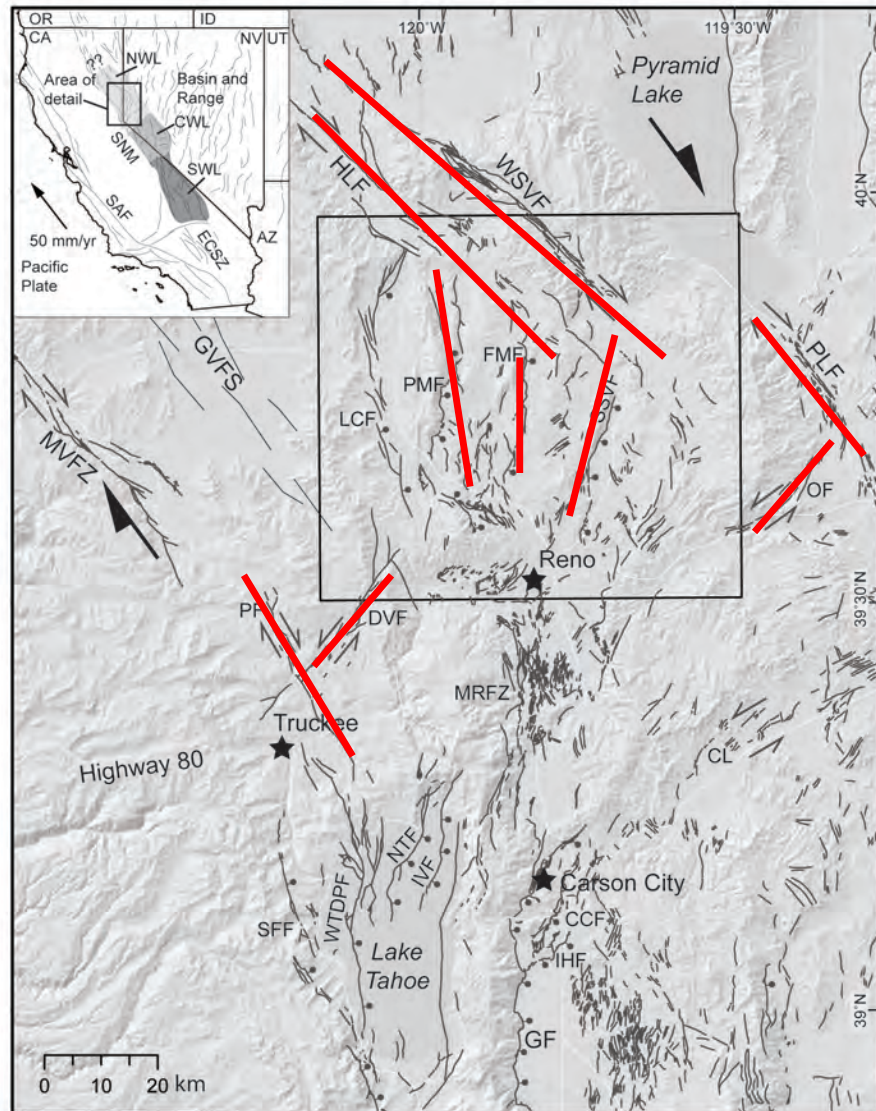


Hatch, 2019

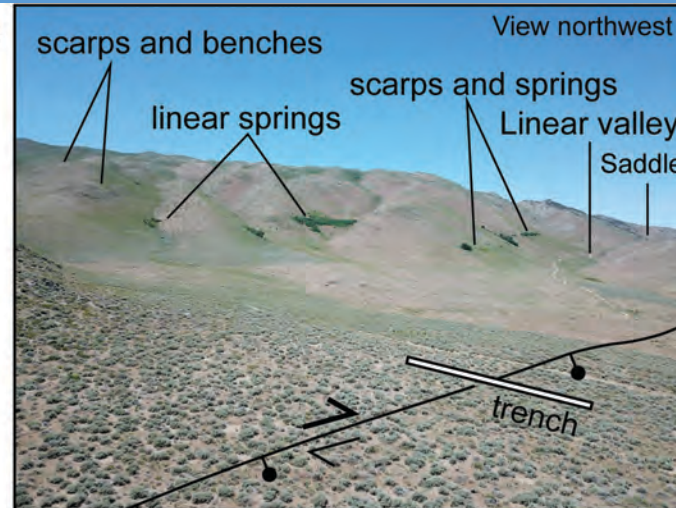
Northern Walker Lane



Northern Walker Lane



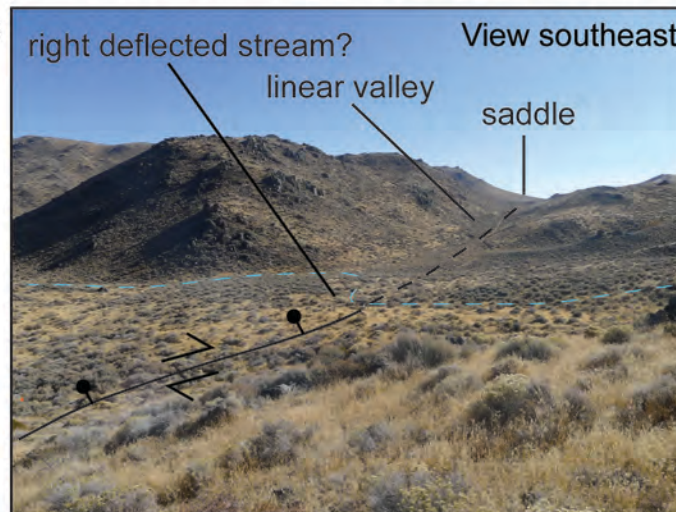
A



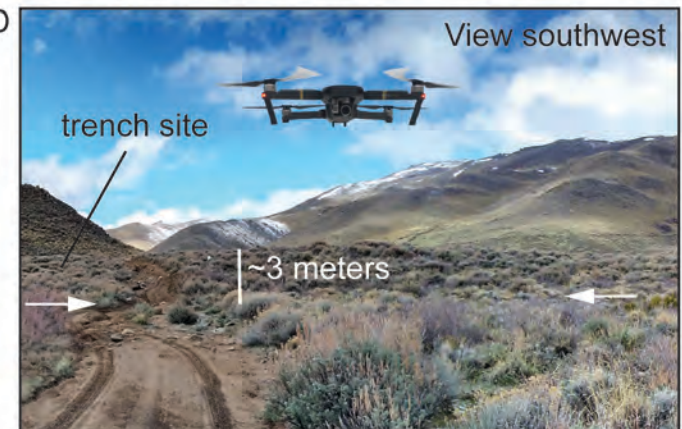
B



C



D



Northern Walker Lane

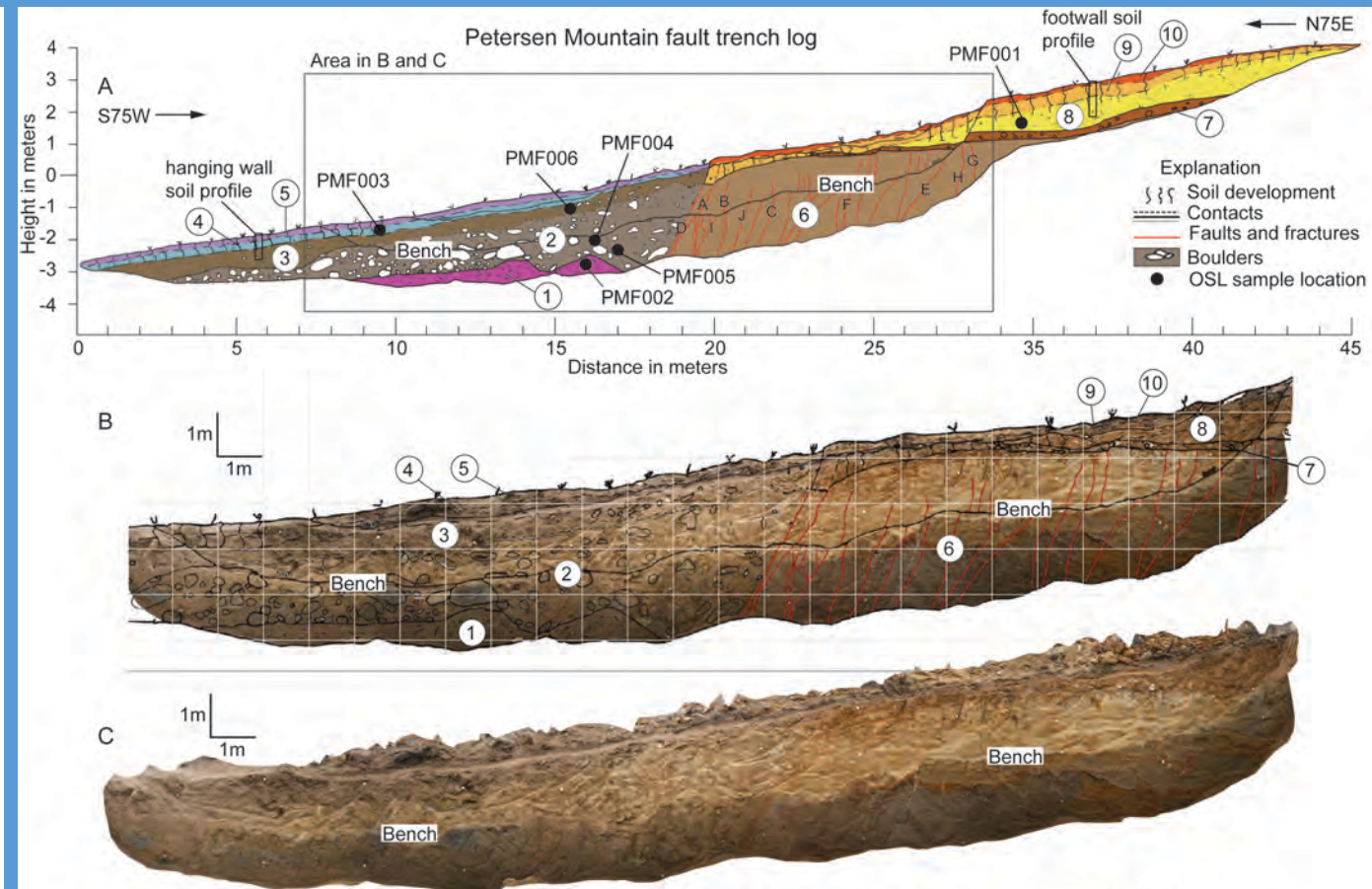
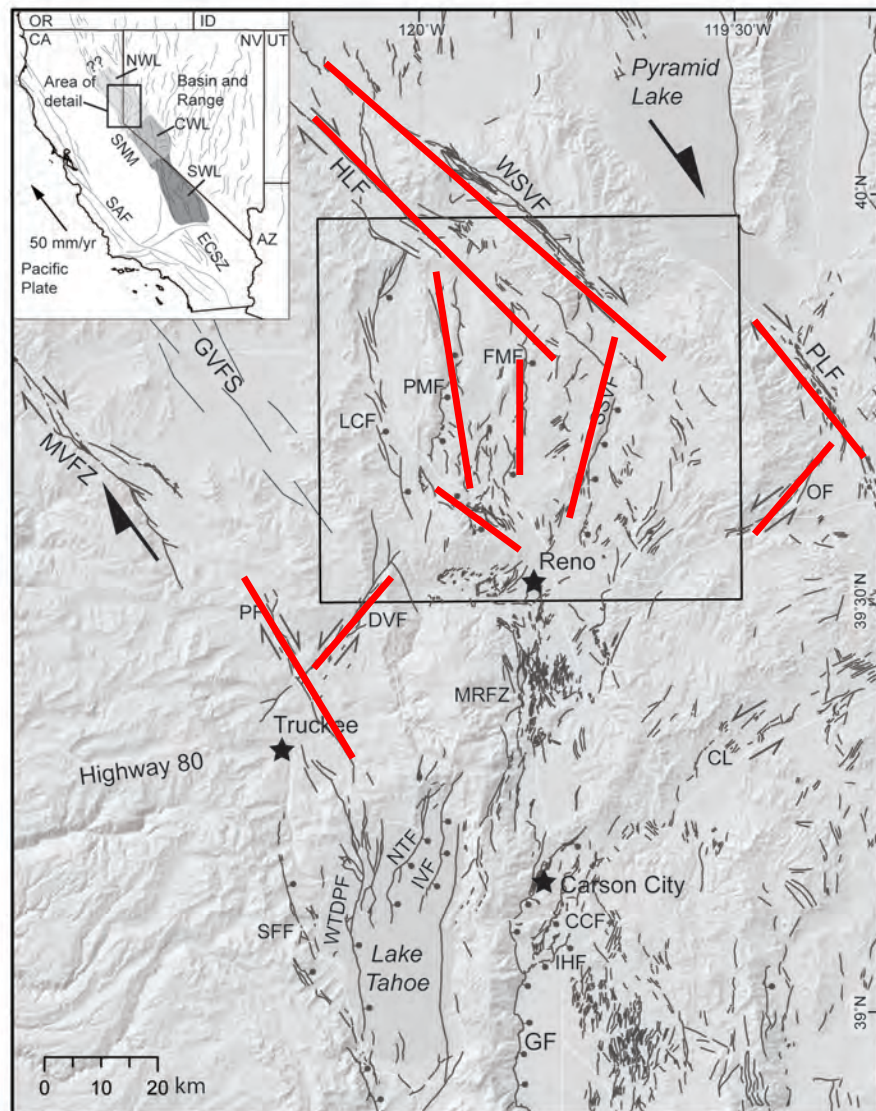


Figure 9. (A) Log of Petersen Mountain trench exposure (south wall) showing stratigraphic and structural relations. Open circles show unit numbers, solid circles are OSL samples, and letters are fracture attitude locations. (B) Interpreted photomosaic. (C) Uninterpreted photomosaic.

Thanks!

