Briefing on the M 6.0 South Napa Earthquake

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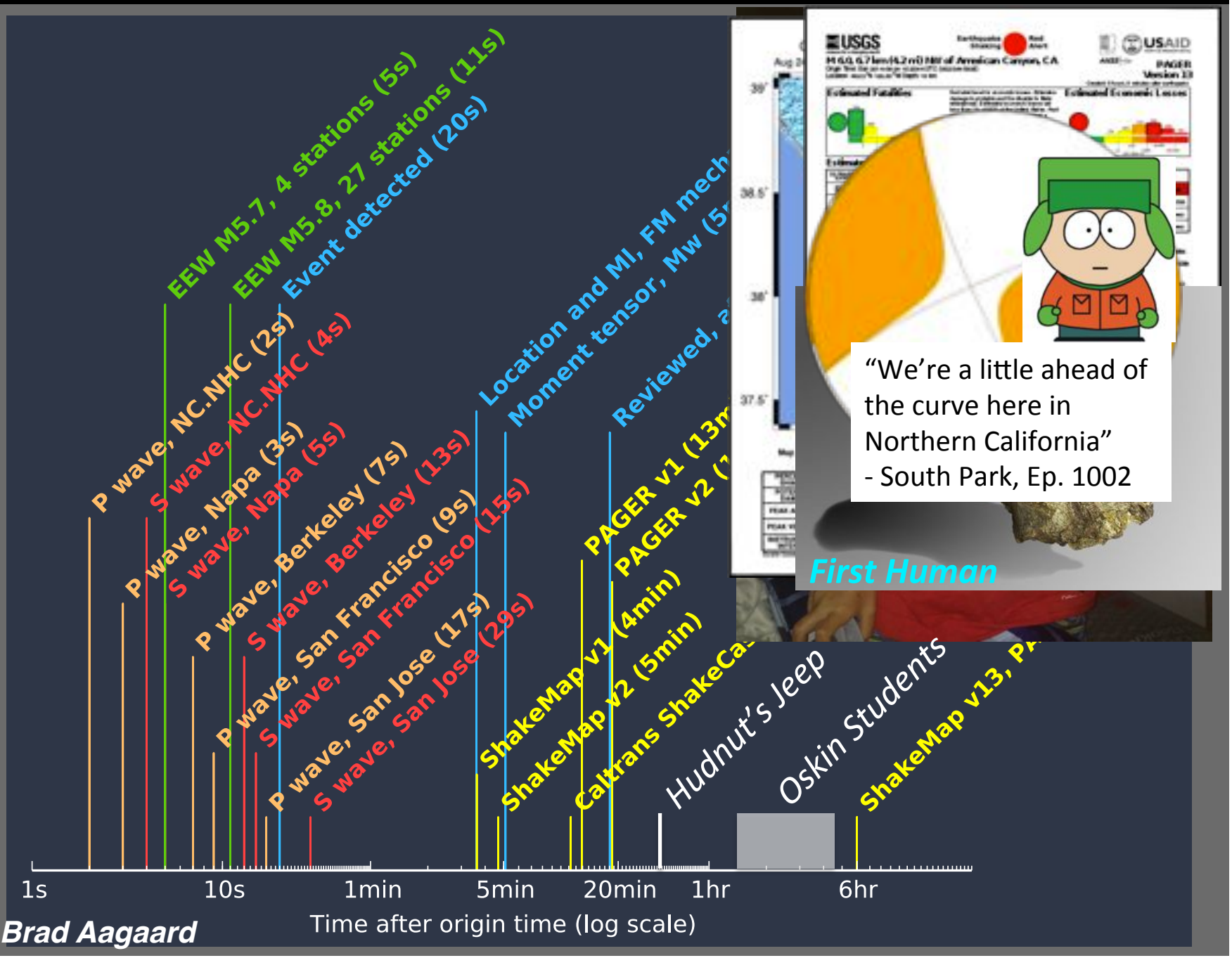
Earthquake Science Center, Menlo Park

- *3:20 AM, Sunday 24 August*
- *West Napa Fault Mw 6.0, 11.3 km depth*
- *1898 M 6.3 near Mare Island*
- *2000-09-03 M5.1 Yountville earthquake*
- *> > $100M damage*
- *Inter-agency response cooperation/coordination*

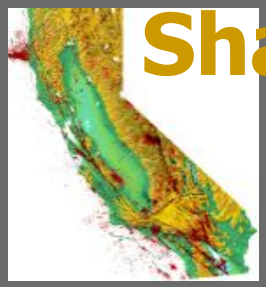
USGS
science for a changing world

Timeline



source: Brad Aagaard

EEW Performance

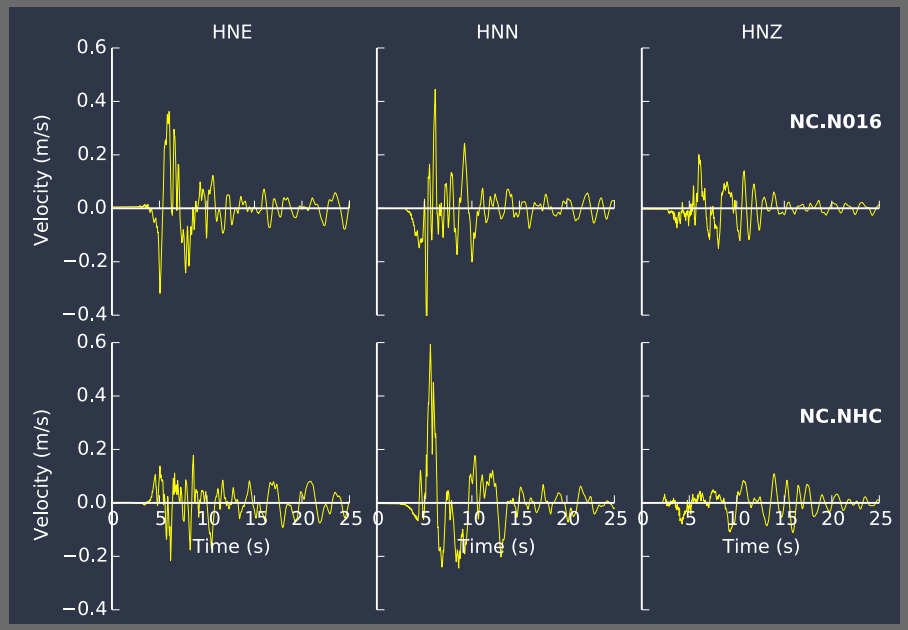


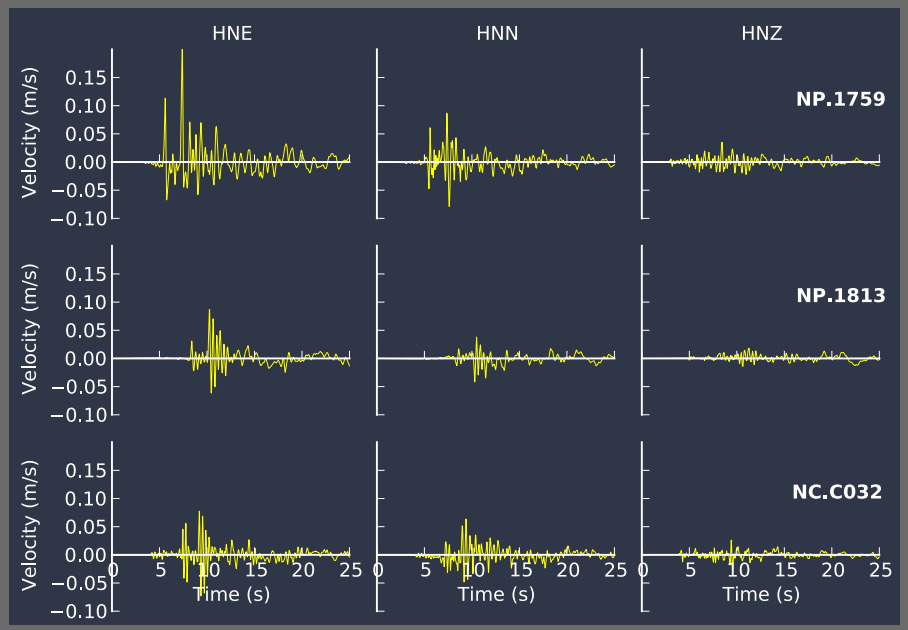
ShakeAlert

- Hypocentral Error: < ~ 3km
- Magnitude Error: < 0.2 within 11 s of origin
- Network approach: 4 stations required for alert
- 3 of 4 triggering stations would have been faster if upgraded
- Size of the "zone of no warning" is a choice based on alert thresholds.
- Variation in data transmission latency was from 0.27s (BK.CVS) to 2.62s (NC. NHC). If all stations had same latency as BK.CVS the alert could have been out in half the time.

source: Doug Given, Richard Allen

Ground Motion





source: Brad Aagaard

Shorter duration of strong shaking at N016 compared to NHC is consistent with northward directivity

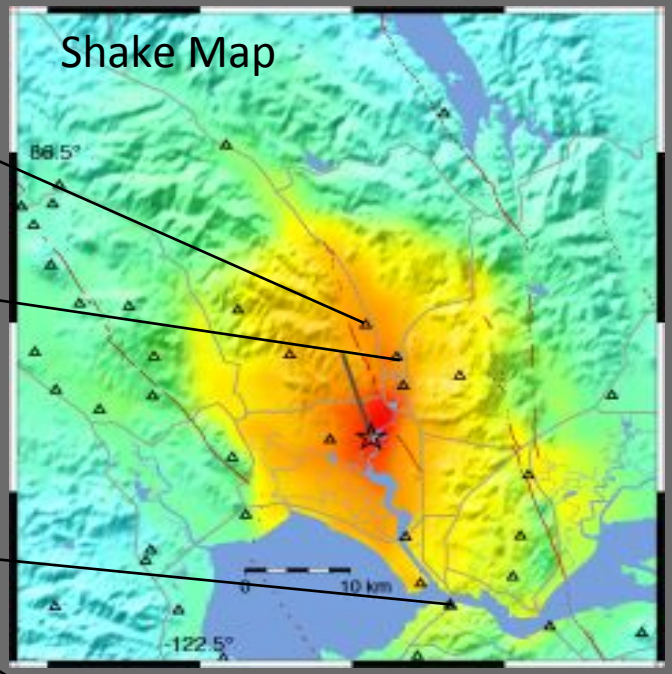
*Distinct pulses with separation in time **independent of distance from the rupture** suggest more source complexity (i.e., two asperities) than preliminary rupture models indicate.*

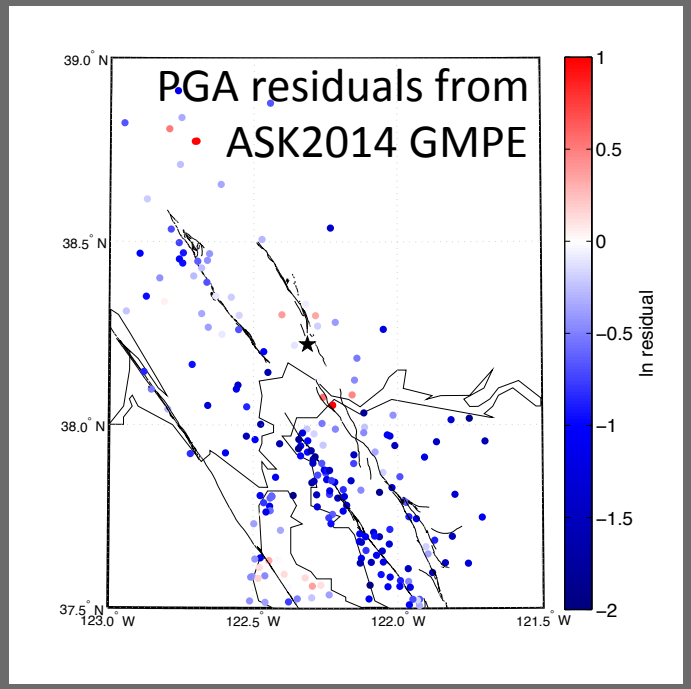
Ground Motion

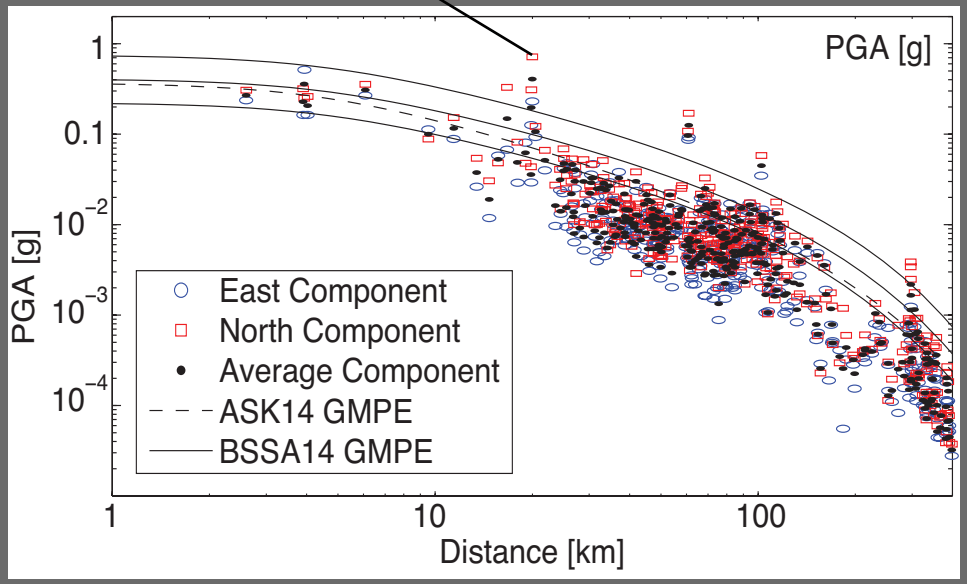
Fire station
45%g PGA
87 cm/s PGV

Main street Napa
64%g PGA
34 cm/s PGV

Carquinez bridge
98%g PGA
22 cm/s PGV







PGA shows small residuals/typical ground motions at close distances, implying a typical stress drop consistent with the NGAWest data (~ 5 MPa). N components larger (true at all periods), consistent with the directivity. At farther distances, attenuation in the napa/delta region is stronger than GMPEs predict. Might not be a big surprise, since the NGA west GMPEs are created with data that is sparser in NorCal than SoCal, so attenuation might be different.

source: Annemarie Baltay

Data from ShakeMap; ASK14=Abrahamson et al, 2014; BSSA14=Boore et al, 2014

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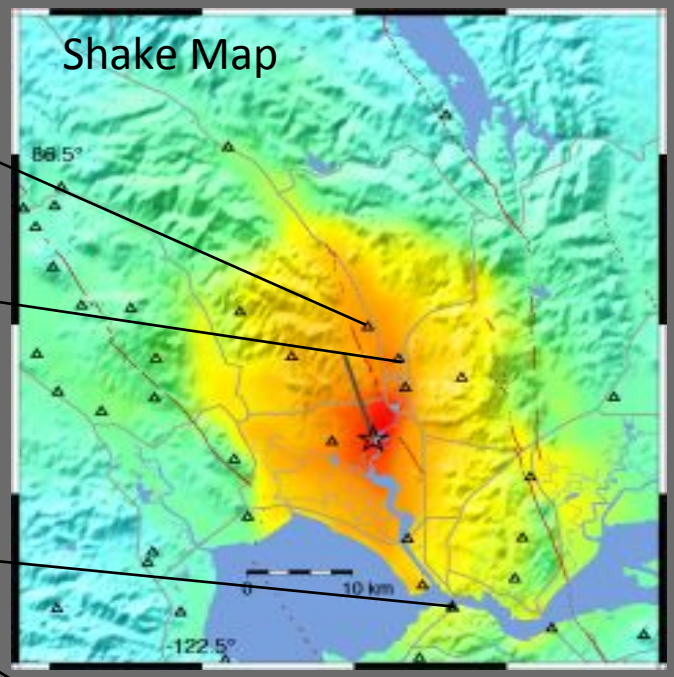
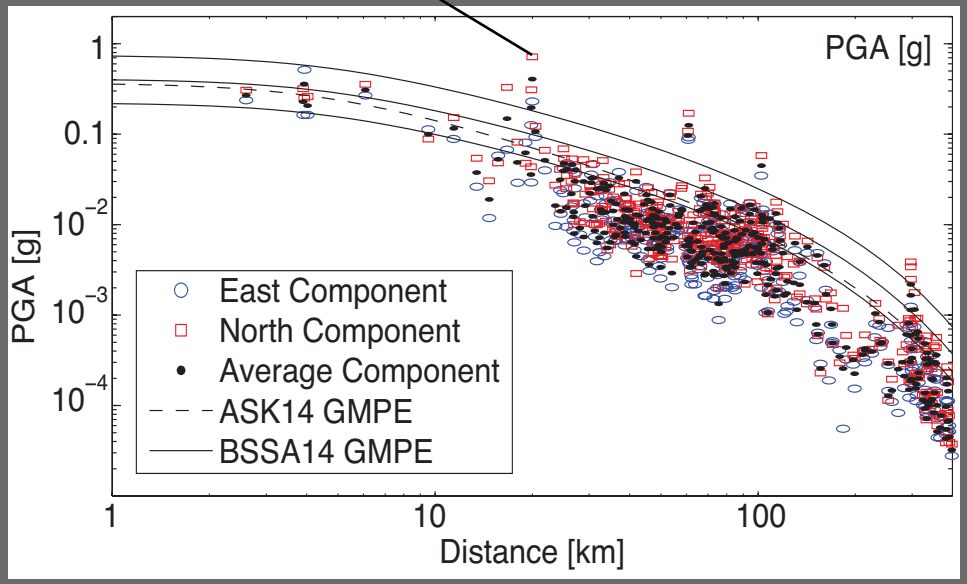
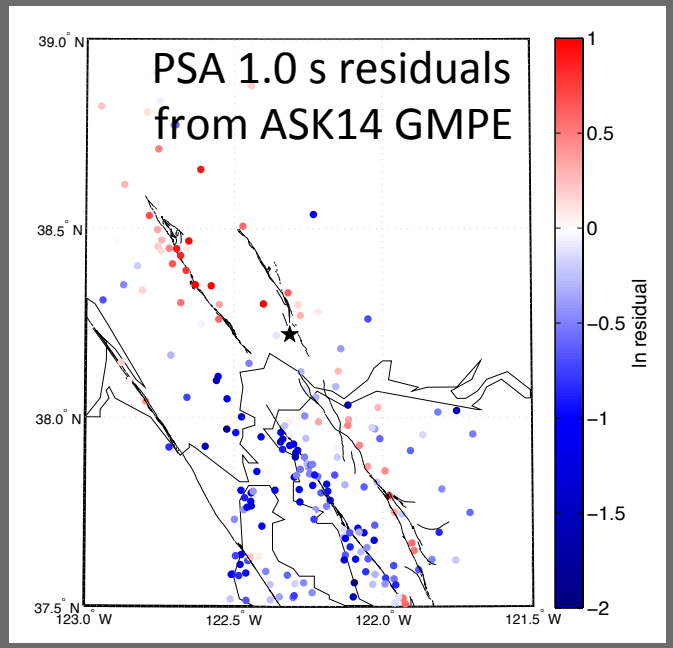


The psa1.0 second map shows strong attenuation to the north, but also a possible wave guide to the south along the older franklin/Southampton fault system.
In both the PGA and psa1.0 s map, and the distance vs PGA plot, you can see the few stations pointed out on the shake map with large ground motions.





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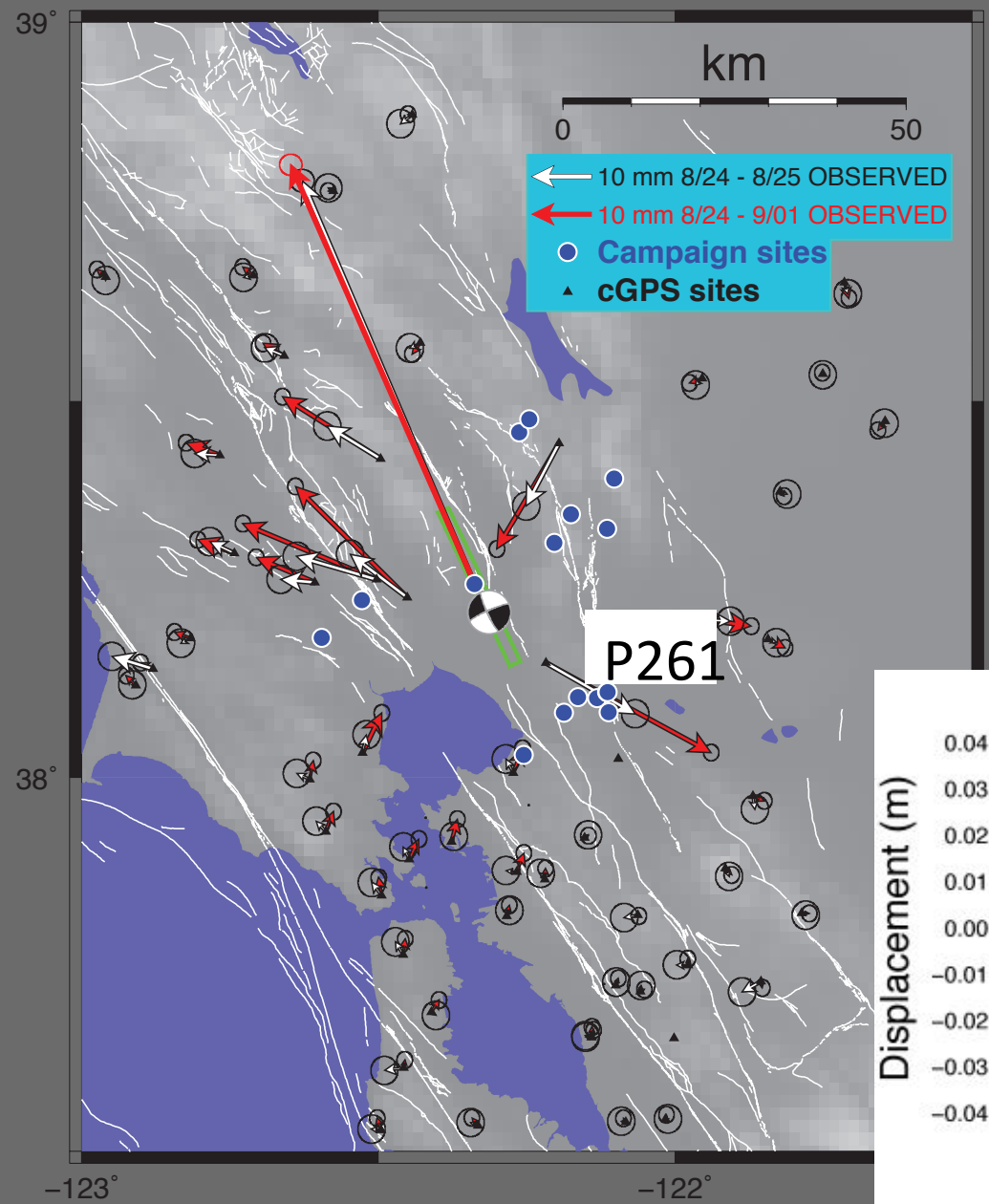
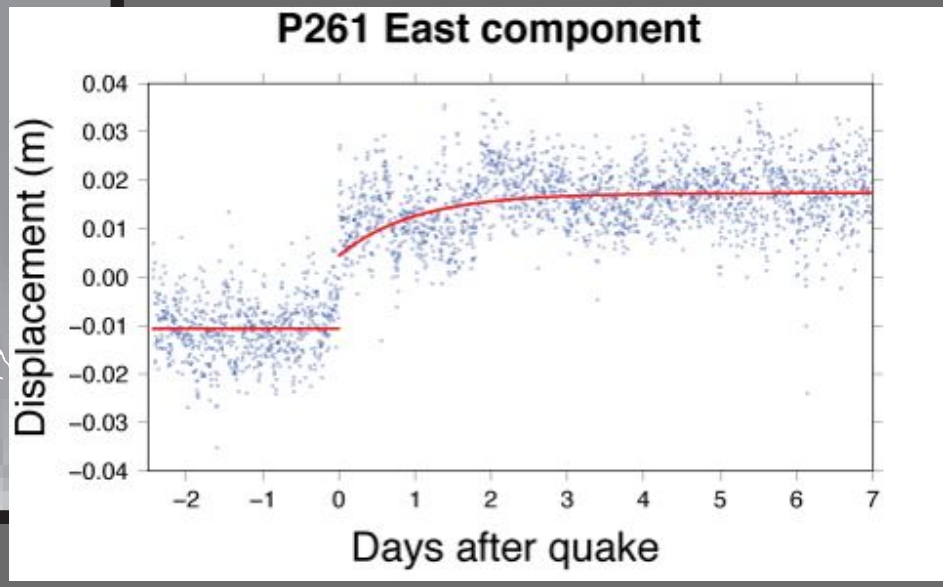
Data from ShakeMap; ASK14=Abrahamson et al, 2014; BSSA14=Boore et al, 2014

GPS Geodesy

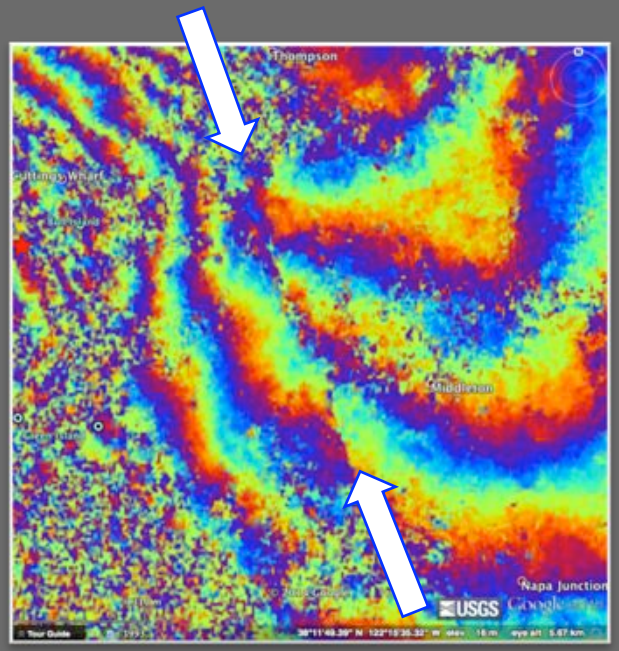


Static displacements nearly double after first day

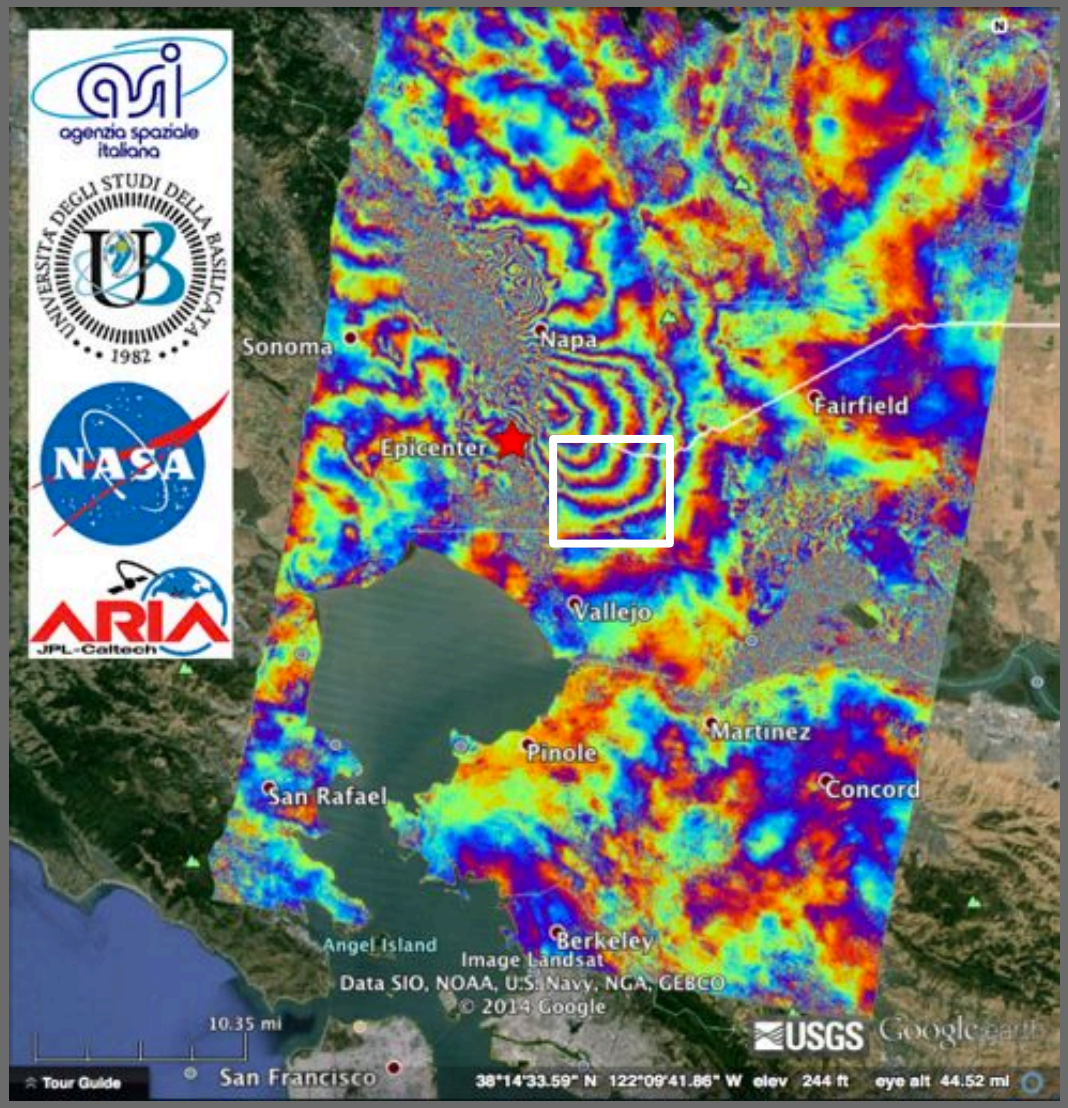


source: Fred Pollitz

InSAR: Cosmo-Skymed (x-band, ~3cm)



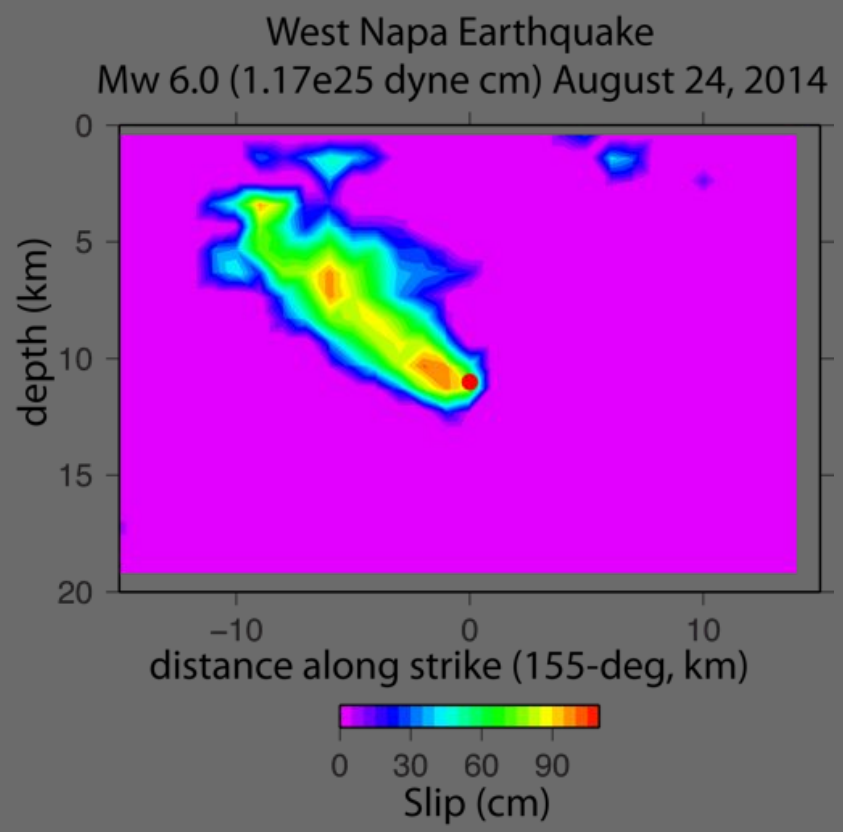
Fault Trace



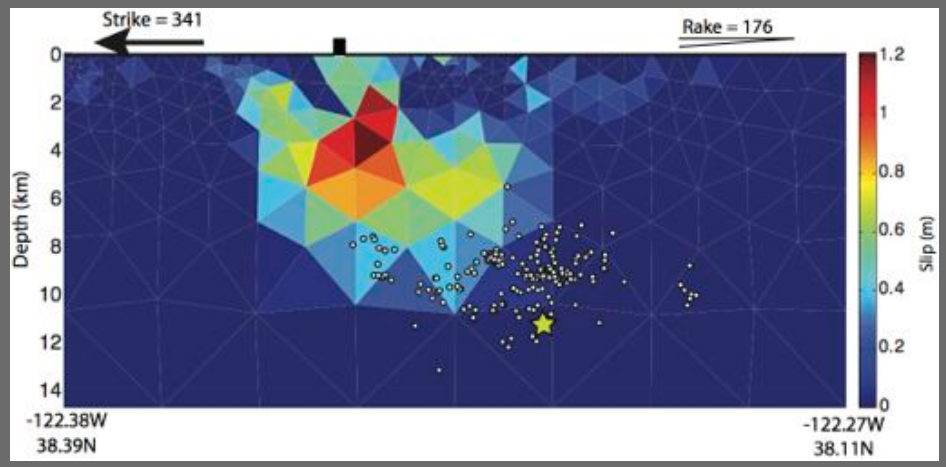
- *Cosmo-Skymed: X (~3cm)*
- *Sentinel 1-A: C (~5cm)*
- *UAVSAR: L (~20 cm)*

source: Andrea Donnellan

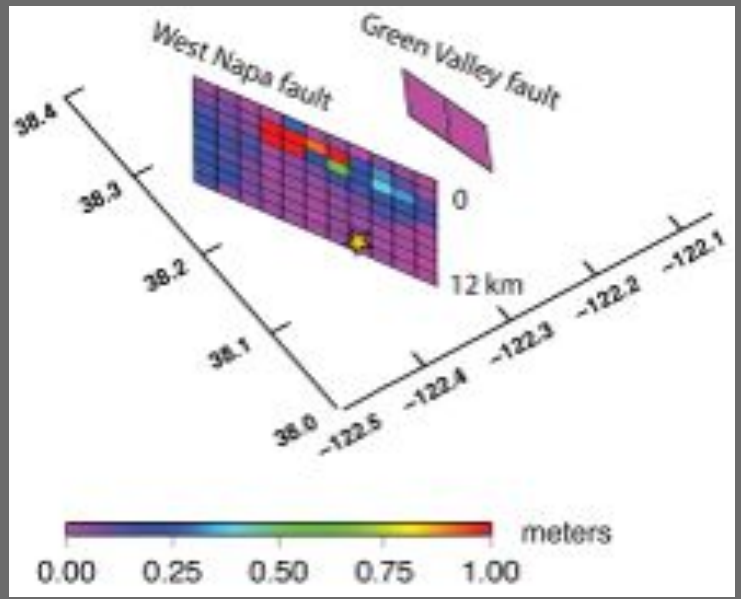
Finite Fault Models



source: Doug Dreger

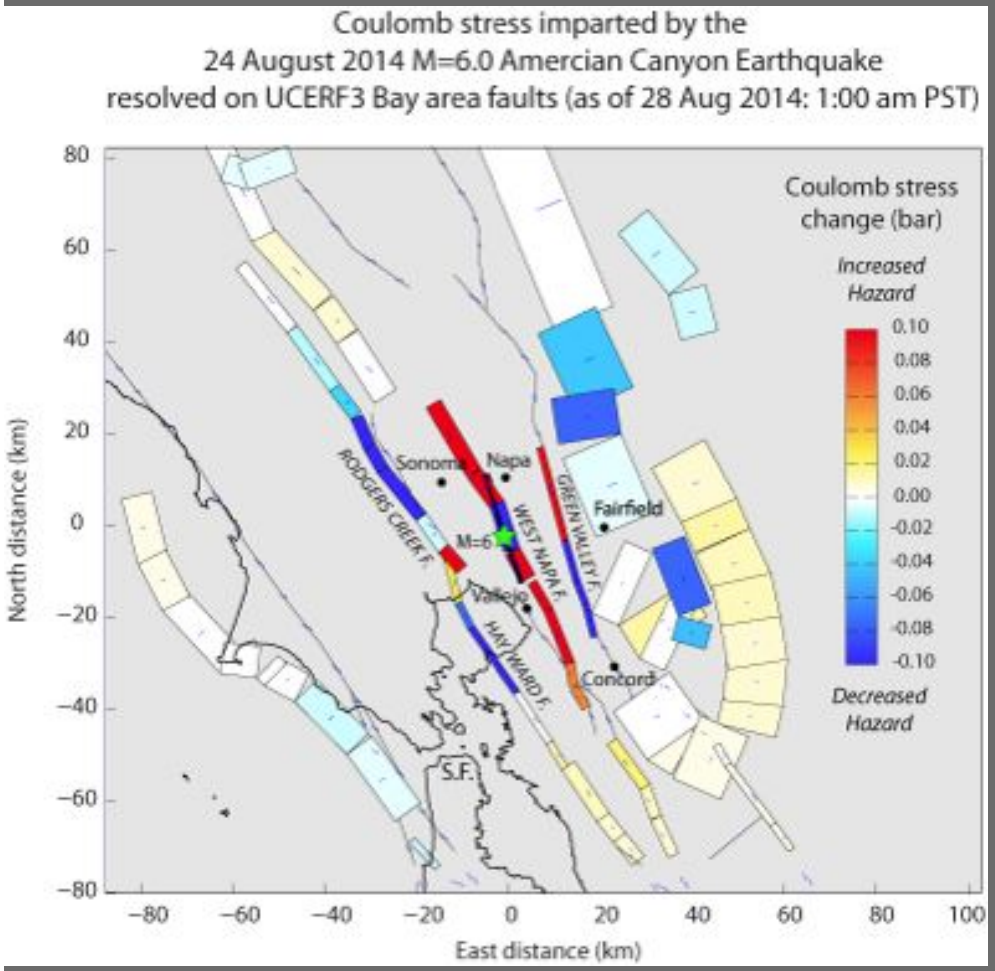


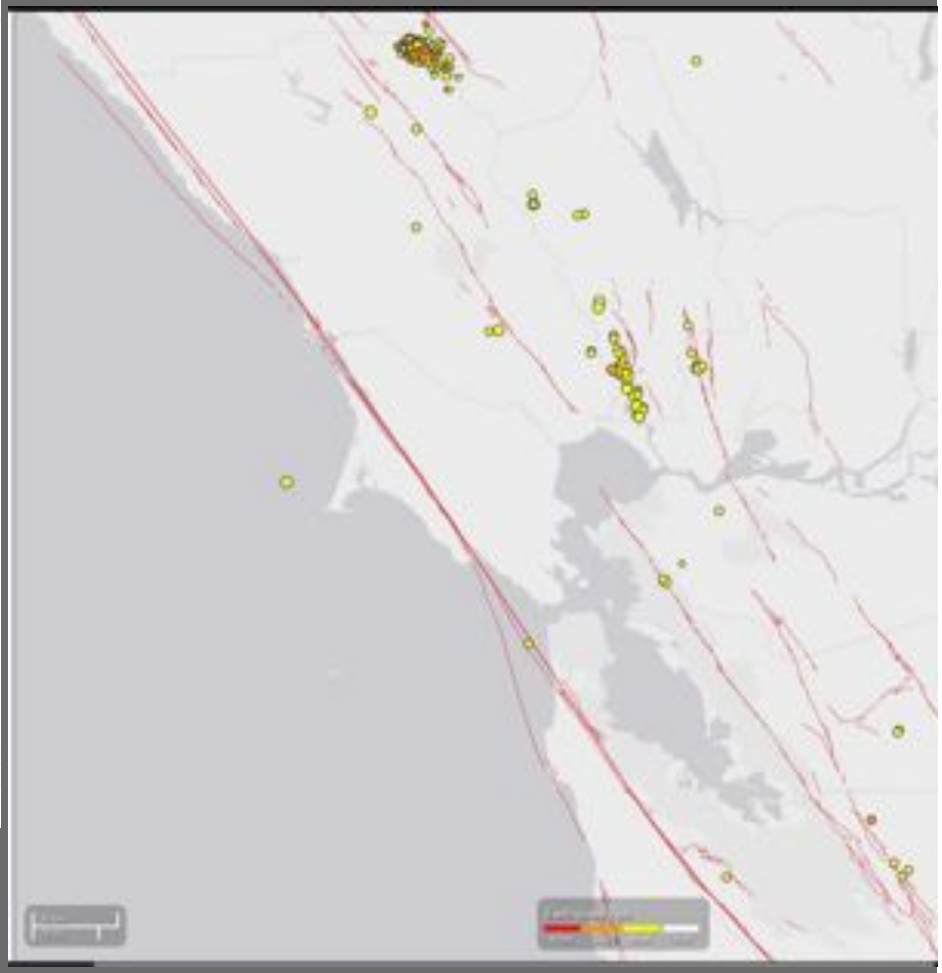
source: Bill Barnhart



source: Fred Pollitz, Jessica Murray

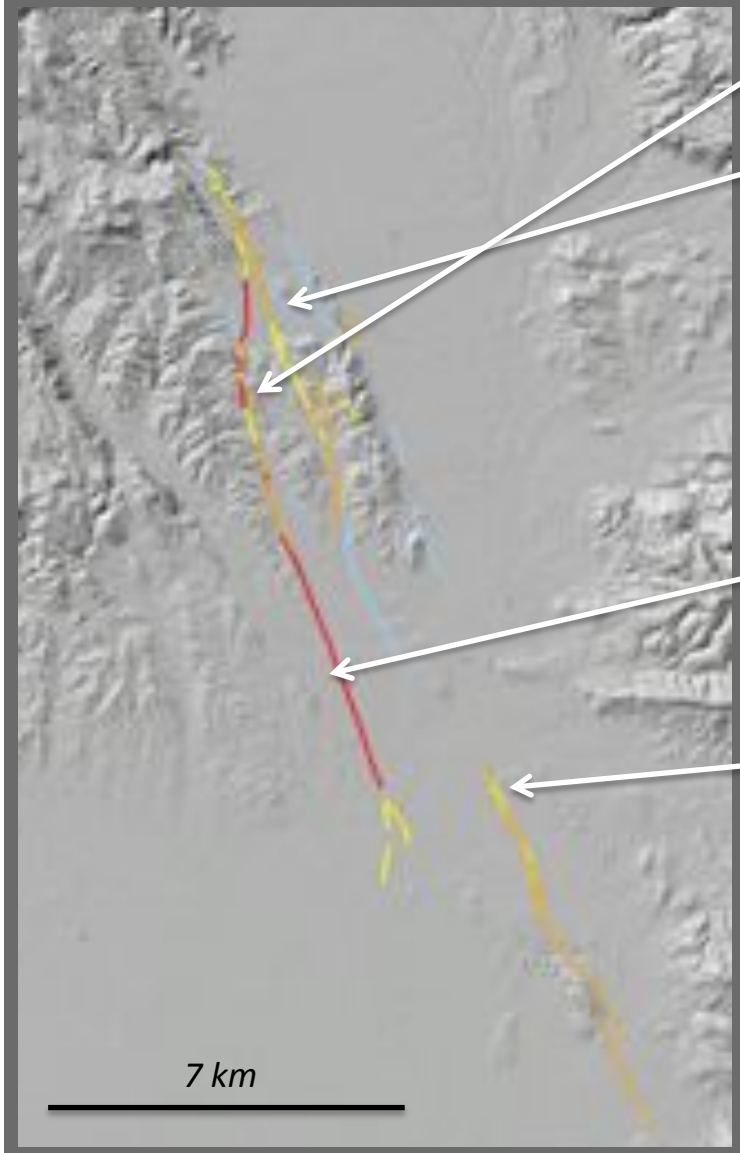
Triggered slip on Green Valley fault?





source: Ross Stein & Jian Lin

Surface Rupture



source: Dan Ponti

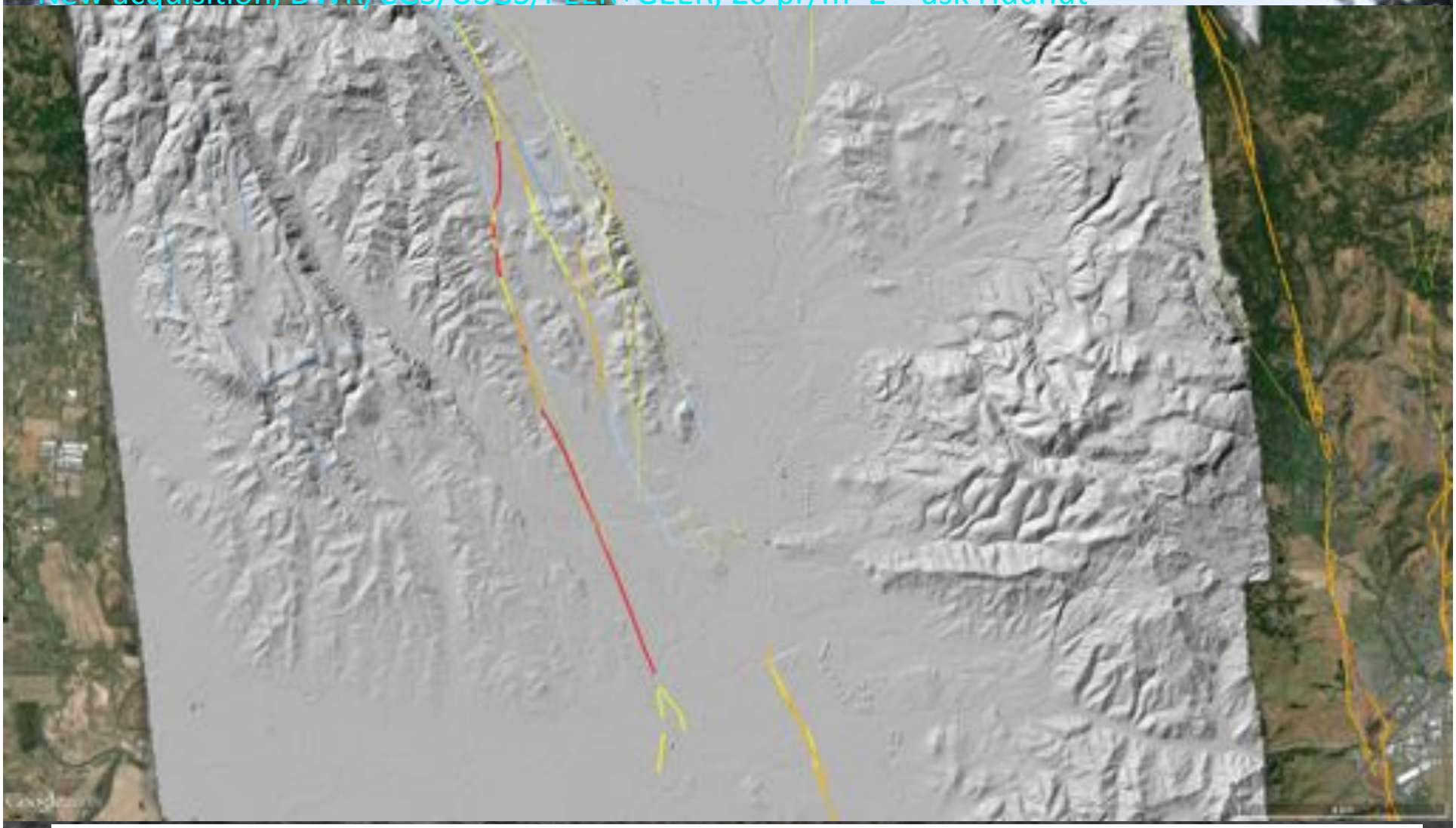
source: Dan Ponti

source: Tim Dawson

source: Tim Dawson

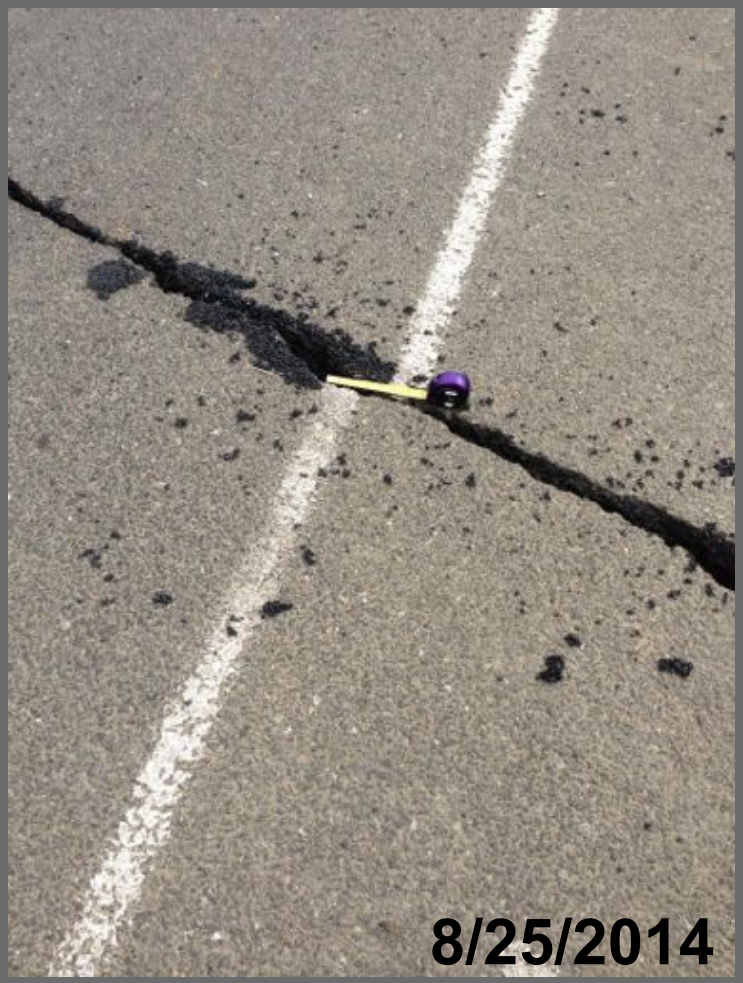
Pre-existing Scarp

- Napa Watershed Airborne Lidar; NCALM, 2003, 1 pt/m^2; see Open Topo
- New acquisition, DWR/CGS/USGS/PEER+GEER, 20 pr/m^2 – ask Hudnut



Ron Rubin, Tim Dawson (CGS) in the trench at Alston Park ~1 month prior:
"I guess we'll just have to wait for an earthquake to show us where the fault is"

Afterslip



source: Tim Dawson

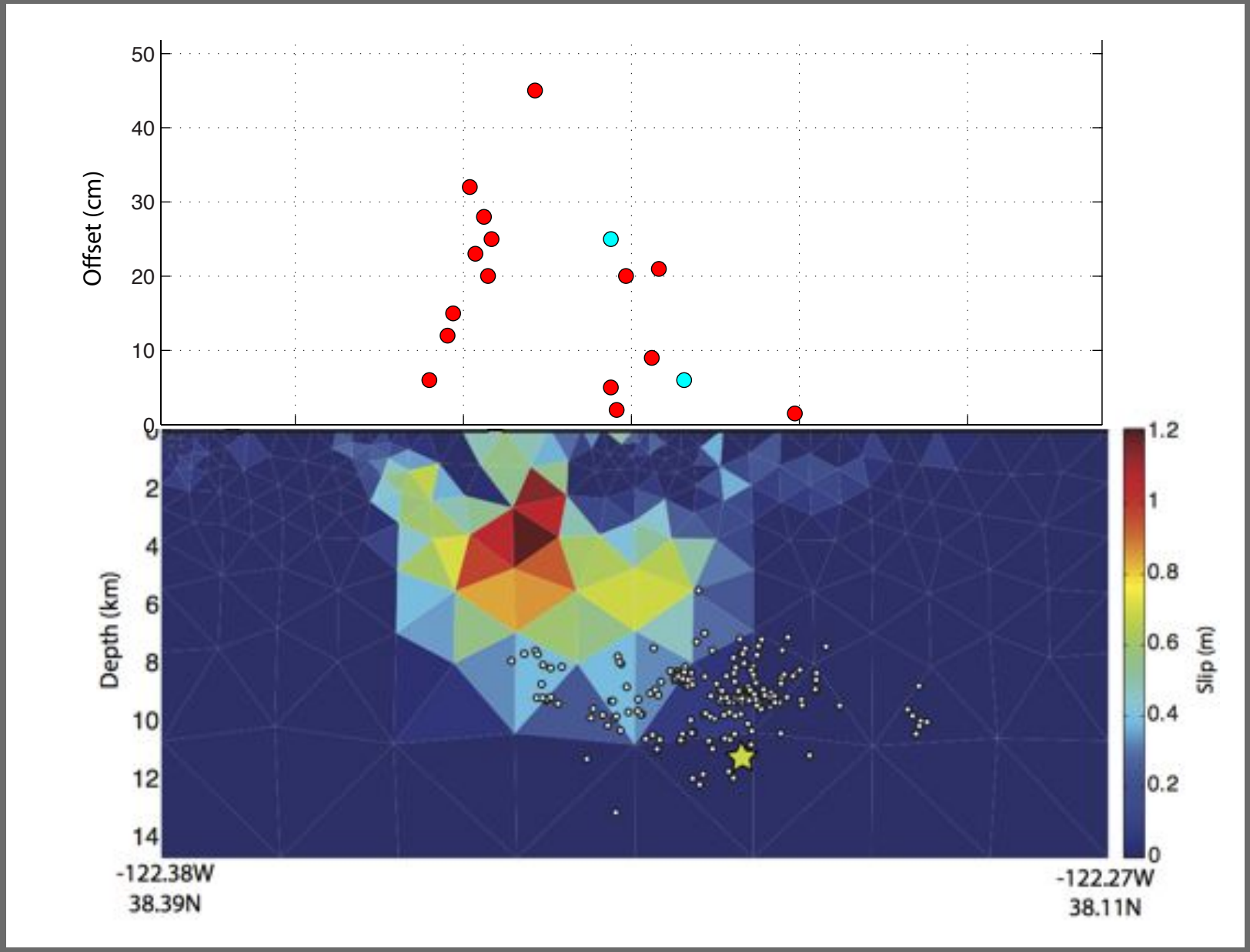
Afterslip: Saintsbury Winery

8/24/2014

9/1/2014

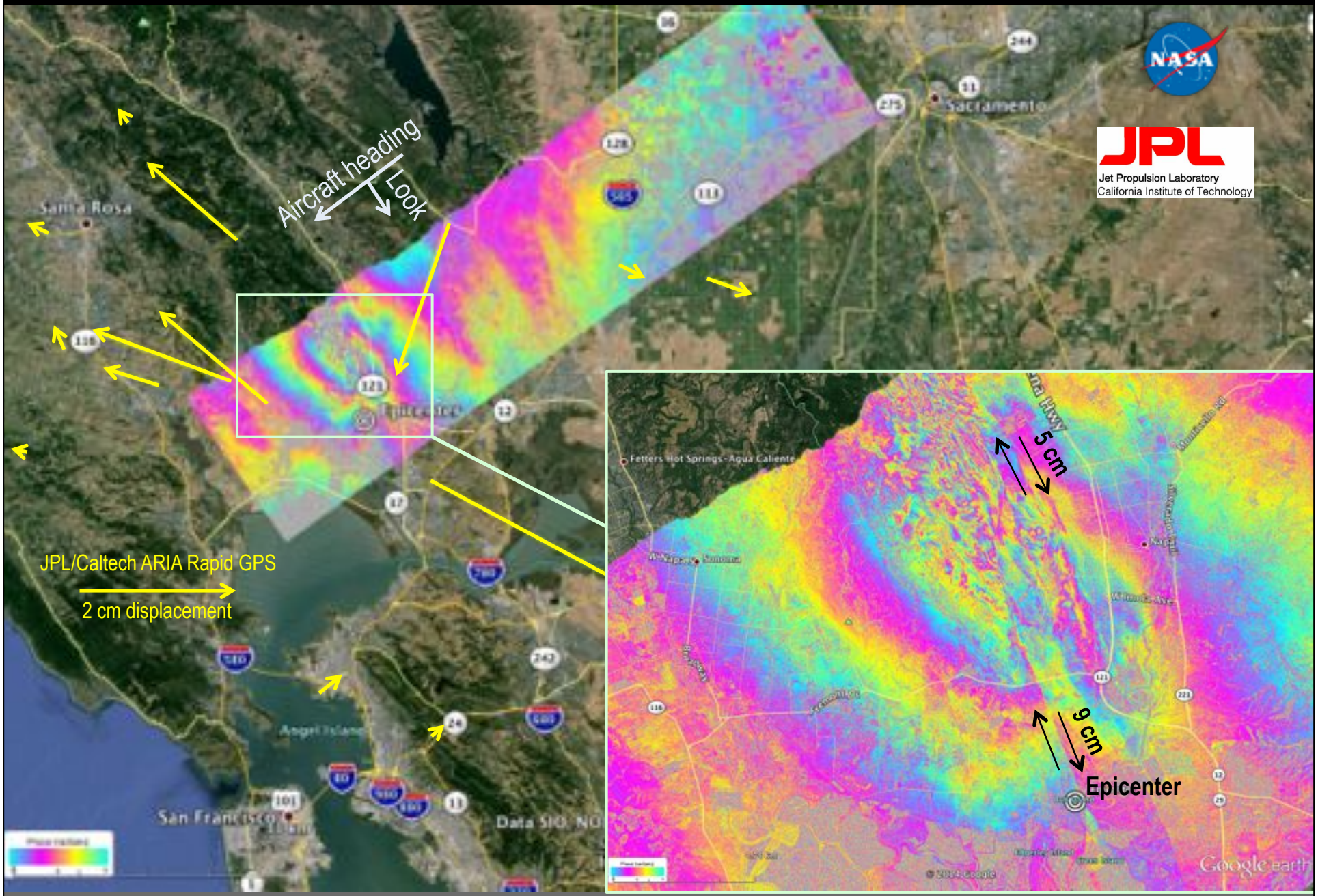
source: Dan Ponti

Subsurface & Surface Slip Distribution



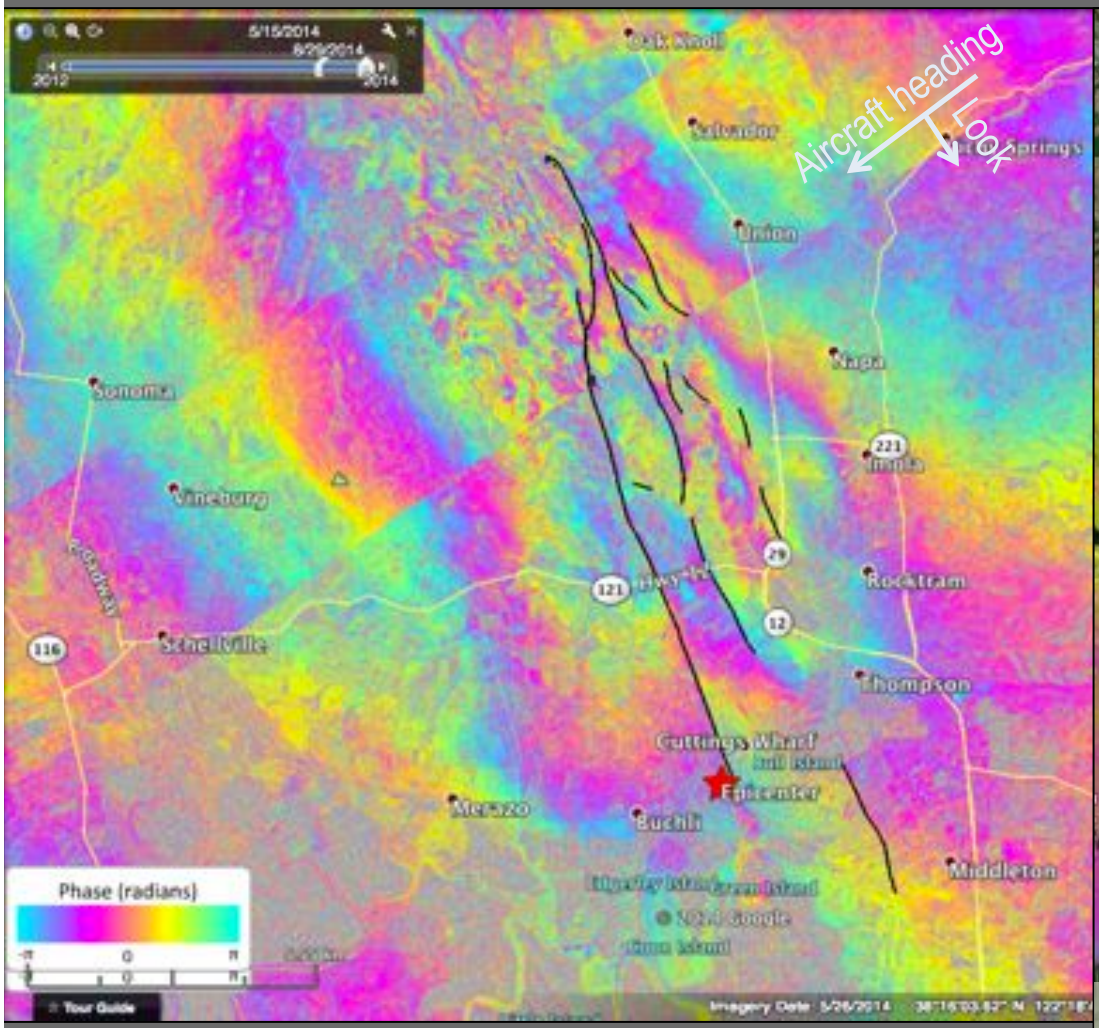
source: Morelan, Trexler, Brooks, Hudnut, Lienkamper, Barnhart

UAVSAR

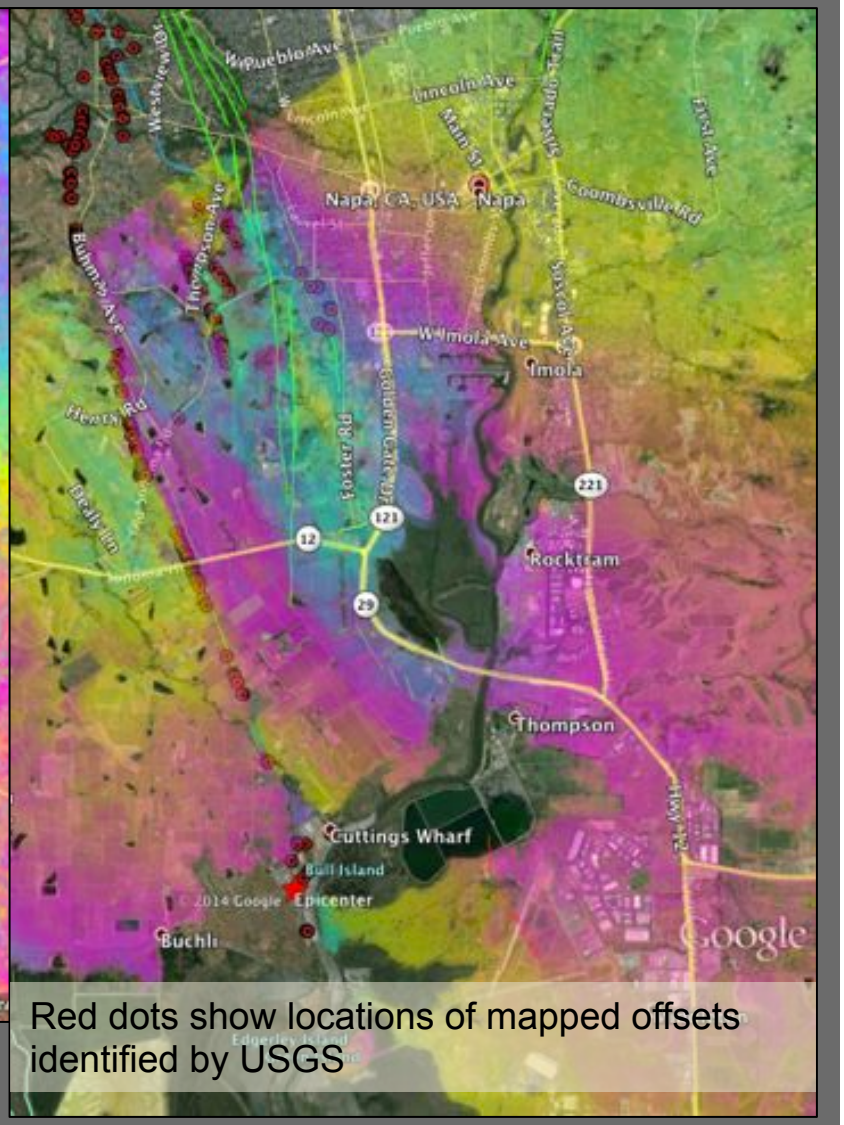


source: A. Donnellan

UAVSAR & Surface Rupture



Fault trace interpretation from Dan Ponti



Red dots show locations of mapped offsets identified by USGS

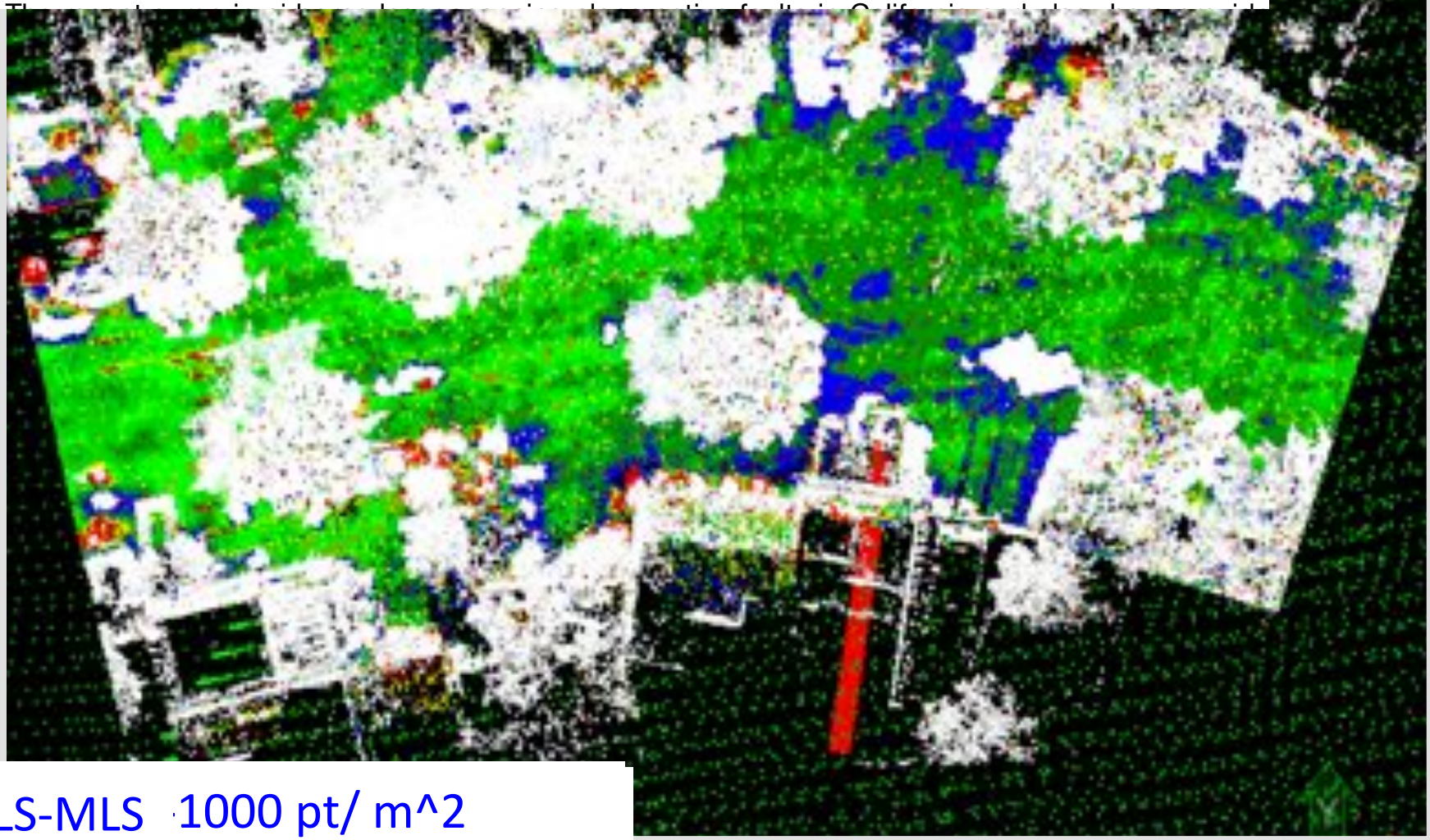
source: Andrea Donnellan

Mobile Laser Scanning

Legacy Airborne LiDAR Datasets

Differential LiDAR – a new tool for mapping coseismic fault-zone deformation, *Edwin Nissen (CSM), J Ramon Arrowsmith (ASU), Adrian Borsa (UCSD), Craig Glennie (Terrapoint), Alejandro Hinojosa-Corona (CICESE), Tadashi Maruyama (JAMSTEC), and Michael Oskin (UC Davis)*

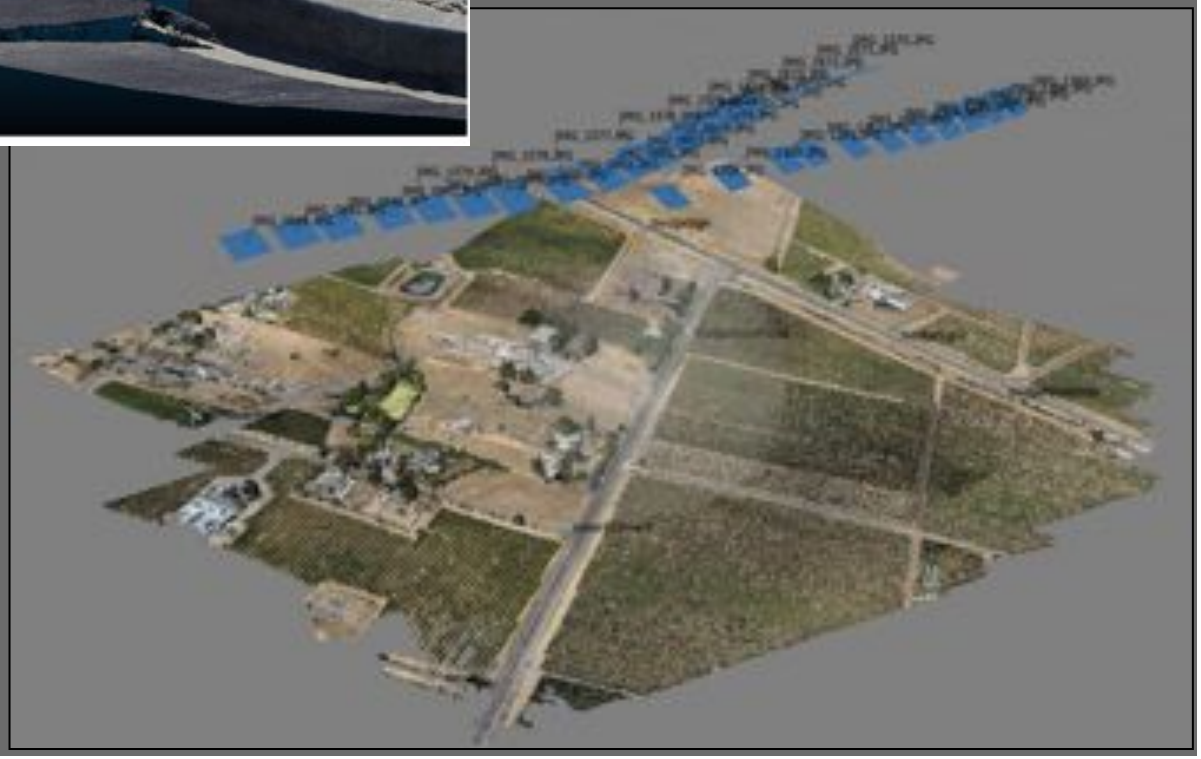
Tuesday, September 9, 2014 (14:00)



ALS-MLS 1000 pt/ m^2

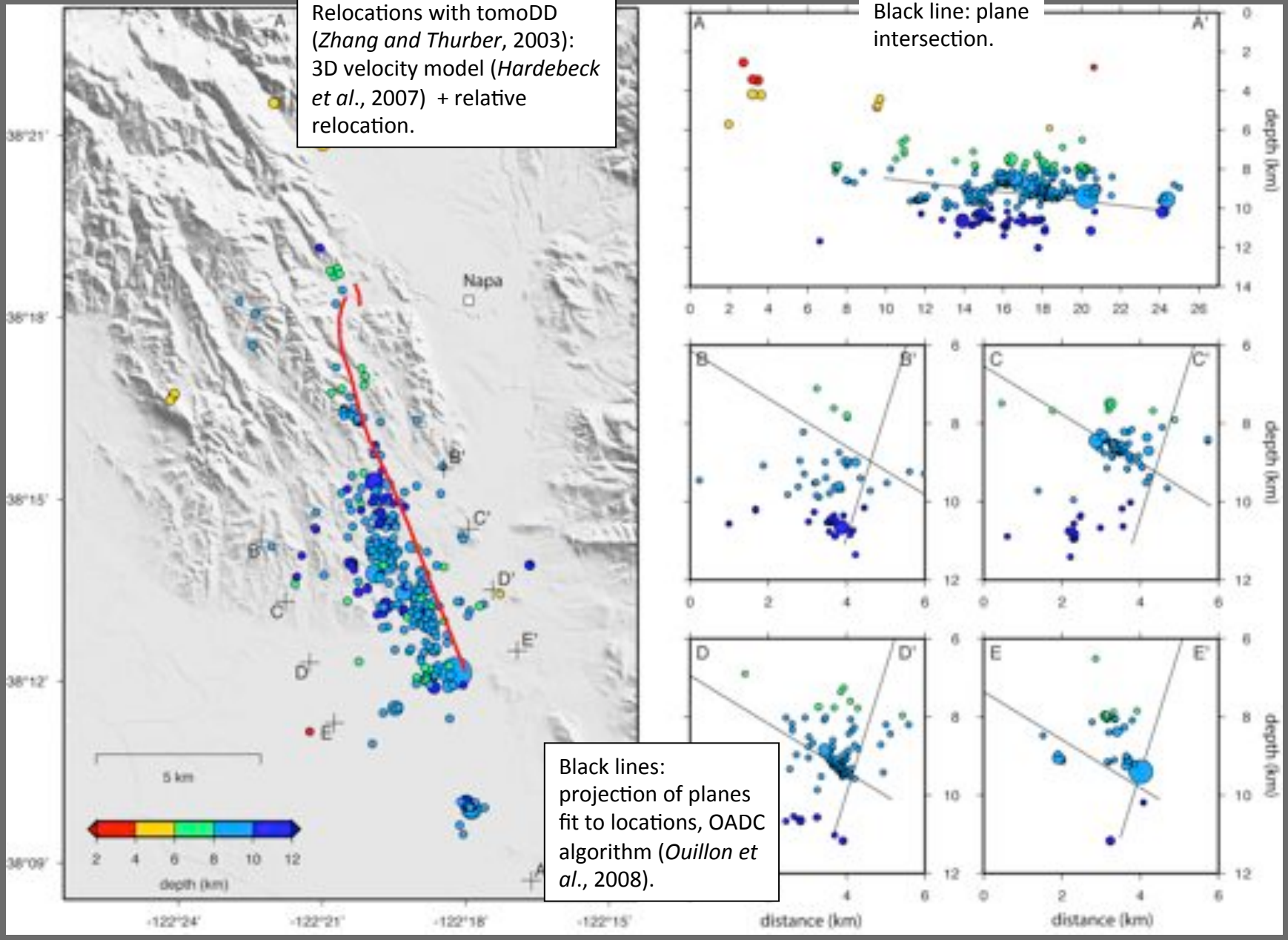
Structure From Motion

source: Mike Oskin



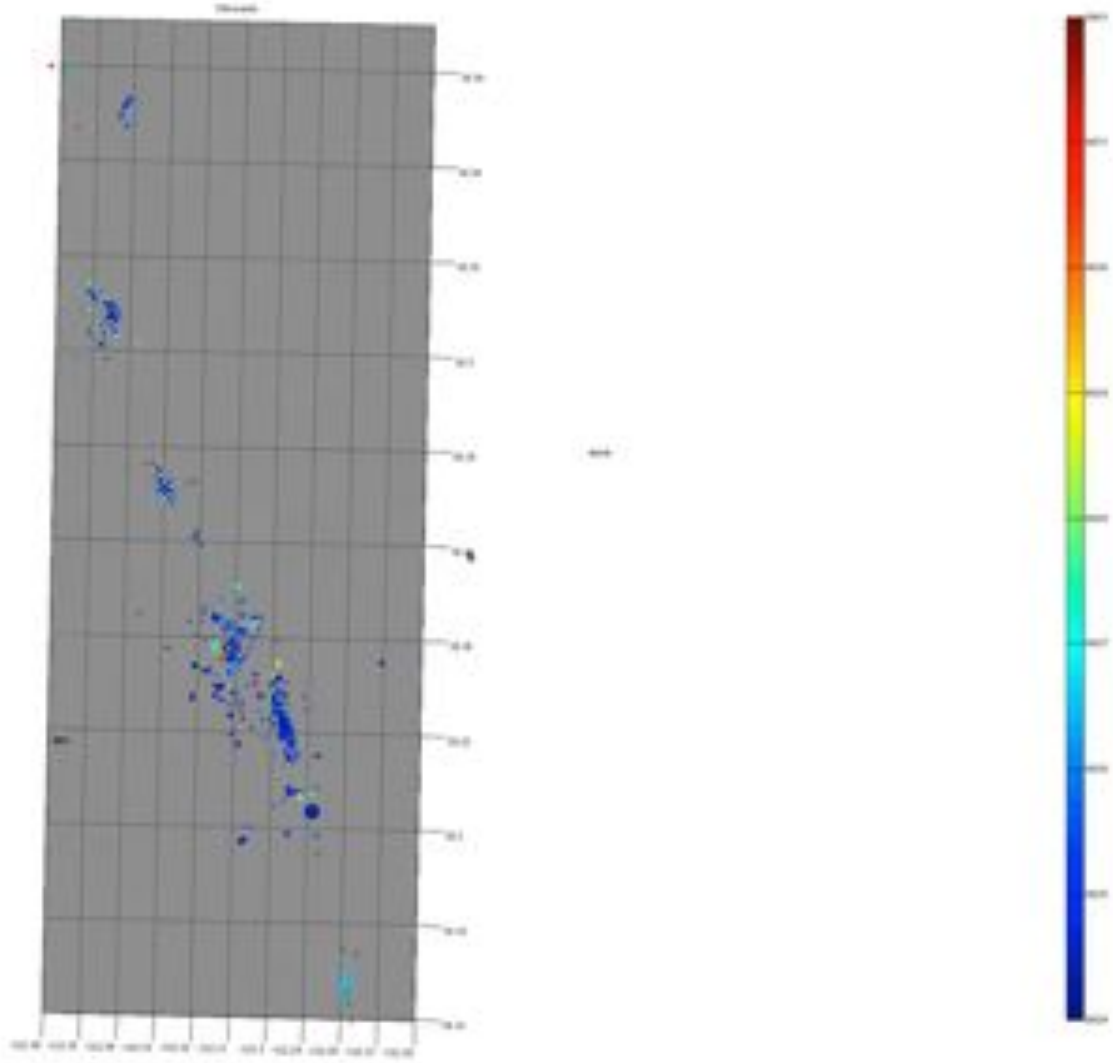
source: Kate Scharer

Aftershock Locations



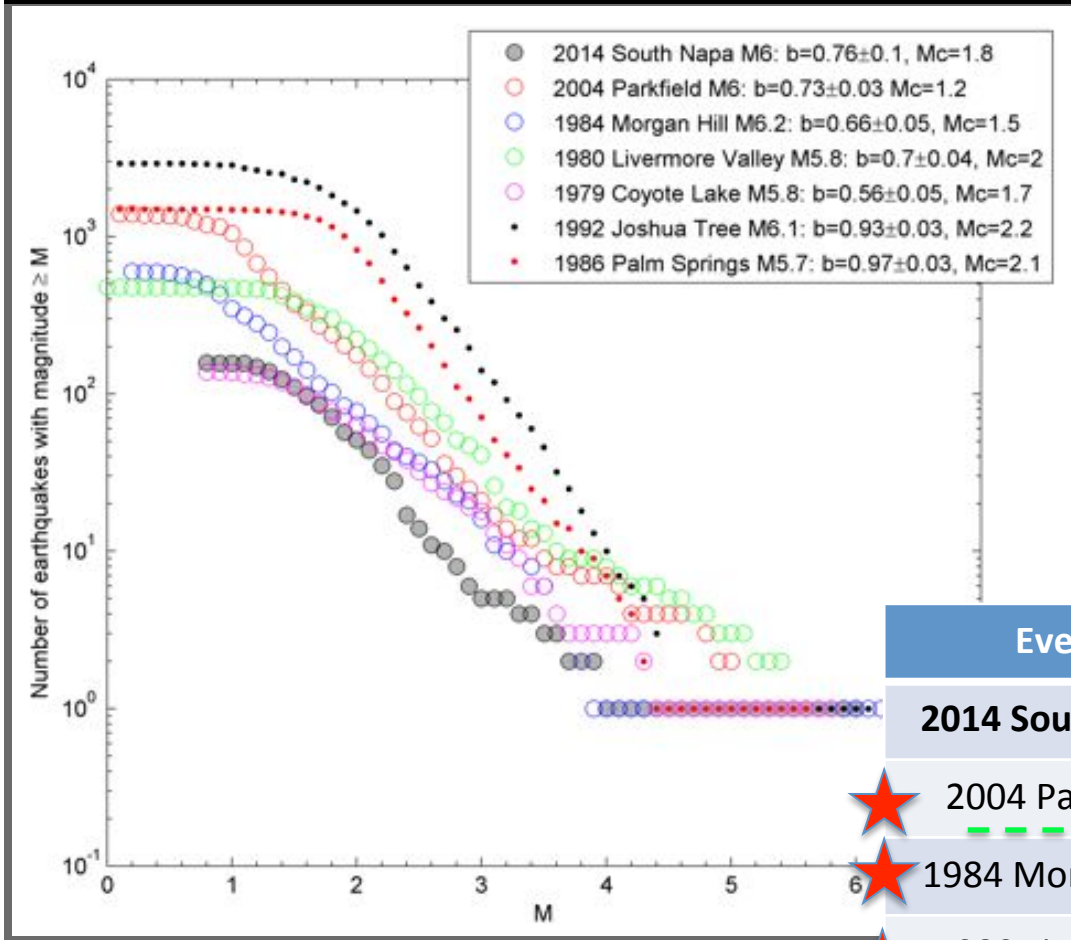
source: Jeanne Hardebeck

Aftershock Relocation



source: David Shelly

Aftershock Comparison



While the one-week aftershock counts for the South Napa event are relatively low , there is a fair amount of variability even among just the N. CA mainshocks.

Magnitude distributions (left) show relatively similar b-values among the N. CA earthquakes , which are low compared to the S. CA earthquakes.

Event	M	N(M≥1.8)	N(M≥4)	Mmaxaft
2014 South Napa	**6**	**70**	**0**	**3.9**
2004 Parkfield	6	243	6	5
1984 Morgan Hill	6.2	102	0	3.85
1980 Livermore Valley	5.8	300	7	5.4
1979 Coyote Lake	5.8	77	2	4.3
2000 Yountville	5	9	0	2.57
1992 Joshua Tree	6.1	1880	9	4.47
1986 Palm Springs	5.7	1153	6	4.3

- 1947 Manix: ML 6.5, 6km rupture; shallow
- 1975 Galway Lake; ML 5.0 6.8 km rupture, 5.8km depth
- 1987 Elmore Ranch; Mw 6.2, 10 km rupture, 10.6km

source: Andrea Llenos, David Schwartz

Coulomb Grape Stress

source: Andy Lutz