Seismic Hazard in the Delta and the M6.0 2014 South Napa Earthquake

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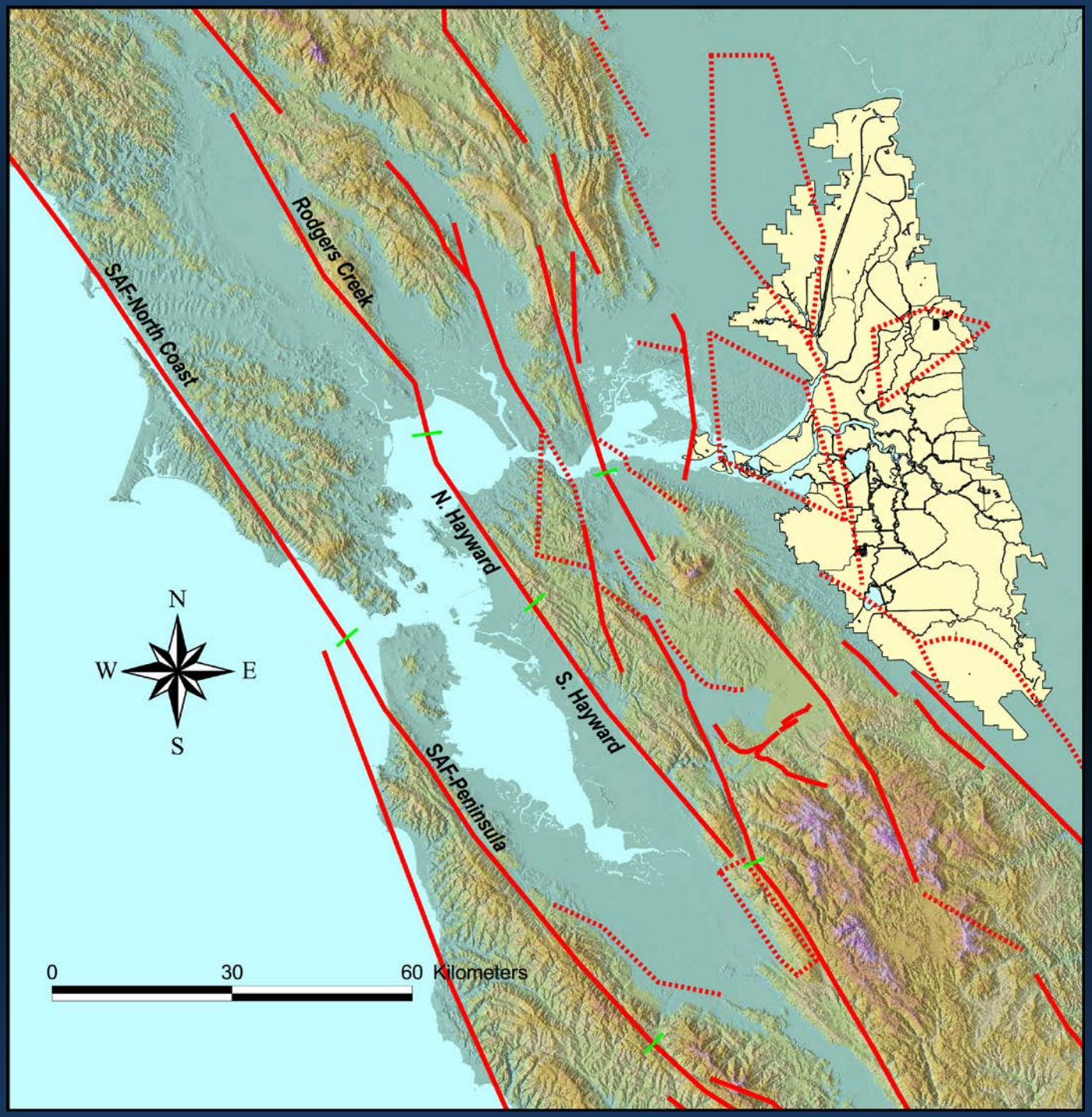
- **Summarize the Probabilistic Seismic Hazard Analysis in the 2011 DRMS Report**
- **Consider how the recordings of the 2014 South Napa earthquake will modify the PSHA**

The Delta lies 70-120 km from the San Andreas fault

but the plate boundary strain is diffused east across the Bay Area

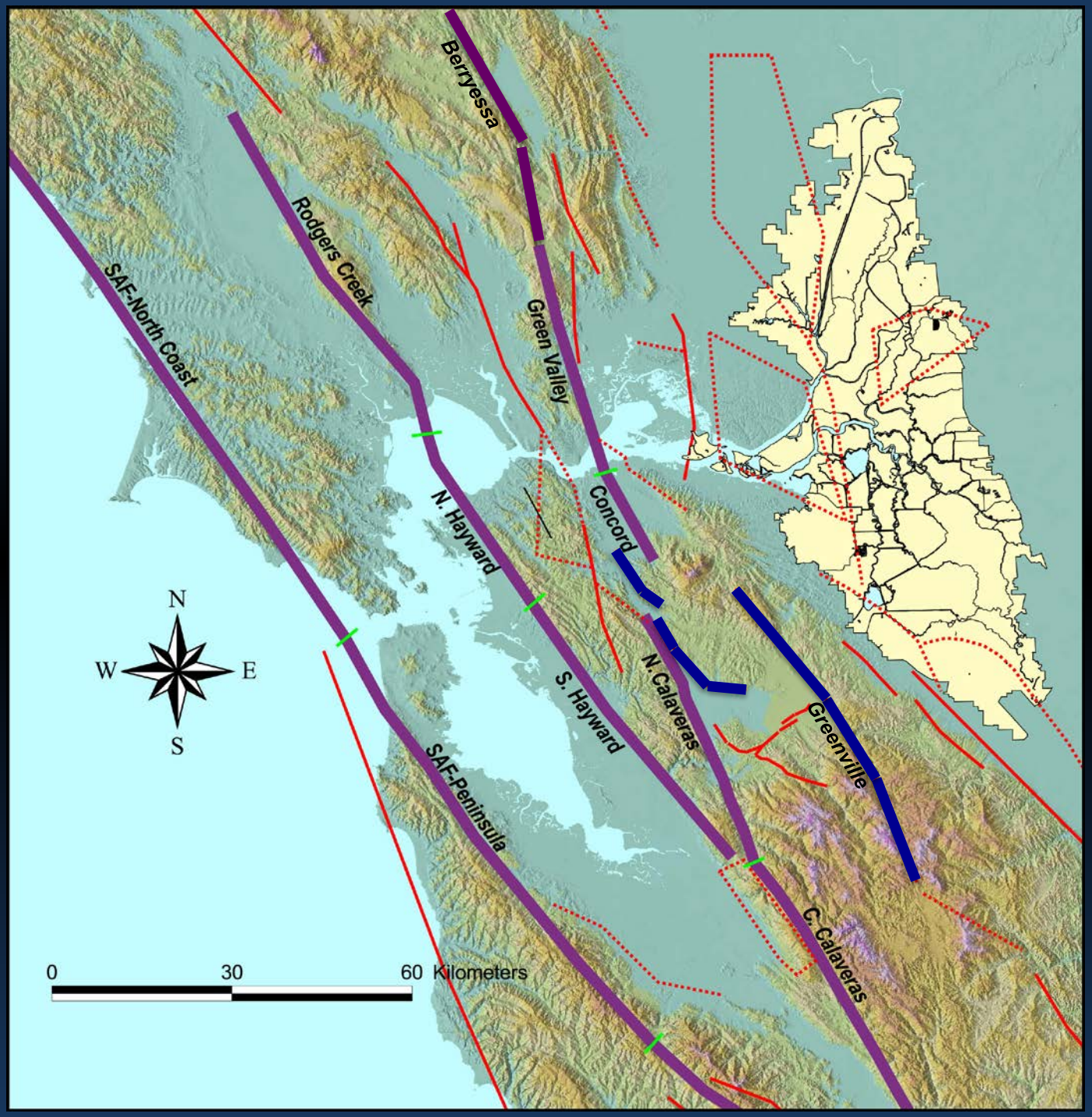
and there are thrust faults on the western edge and beneath the Great Valley



The 100-year seismic hazard in the Delta

is dominated by ground shaking from earthquakes on

the Concord-Green Valley, Hayward-Rodgers Creek, Calaveras, and San Andreas fault systems



2011 DRMS Report

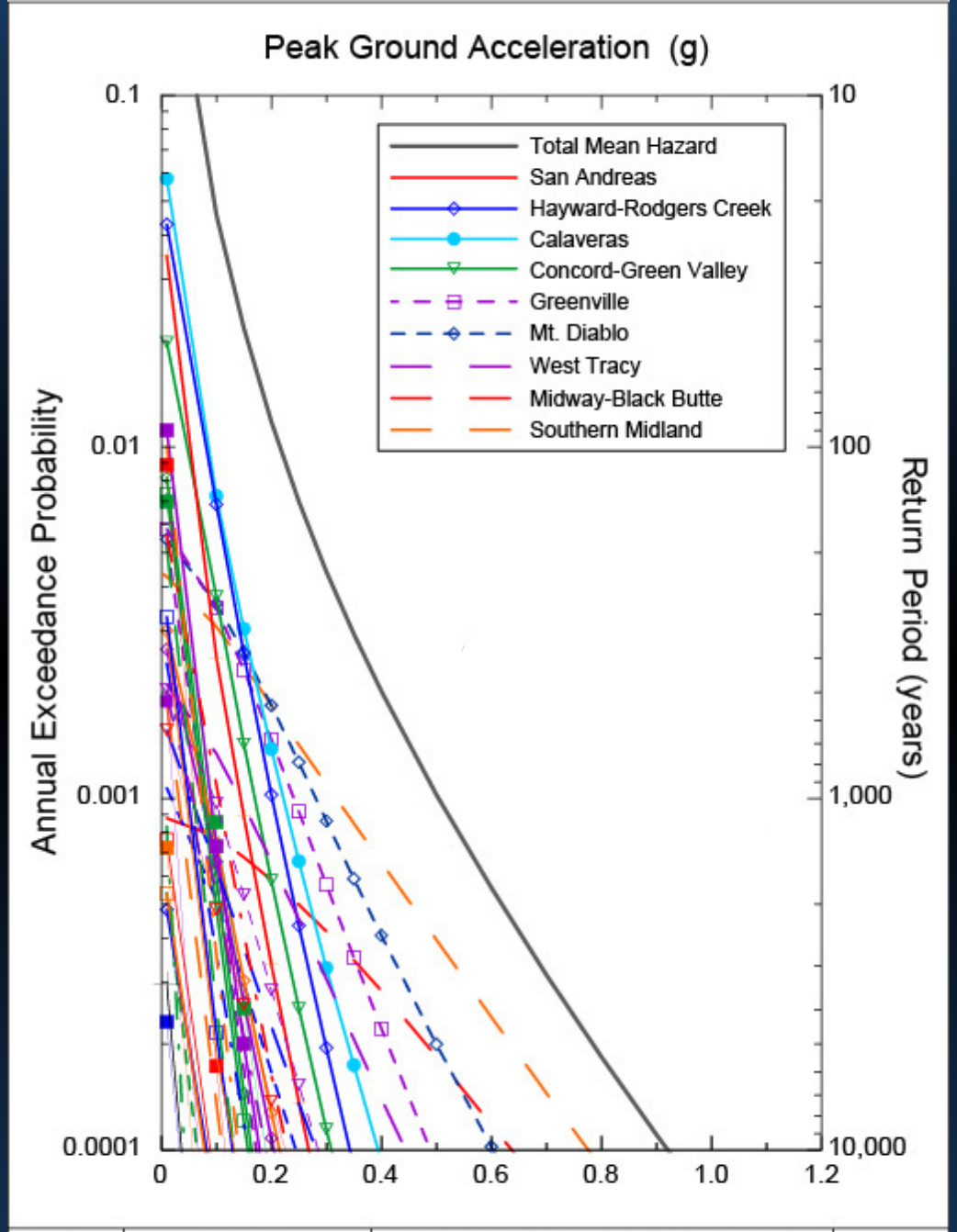
determined a PSHA (Probabilistic Seismic Hazard Assessment) for the Sacramento - San Joaquin Delta

combining the new NGA West GMPEs w/ WG03 sources & near-Delta faults

Exceedance Diagrams are the Accounting Ledgers for the PSHA

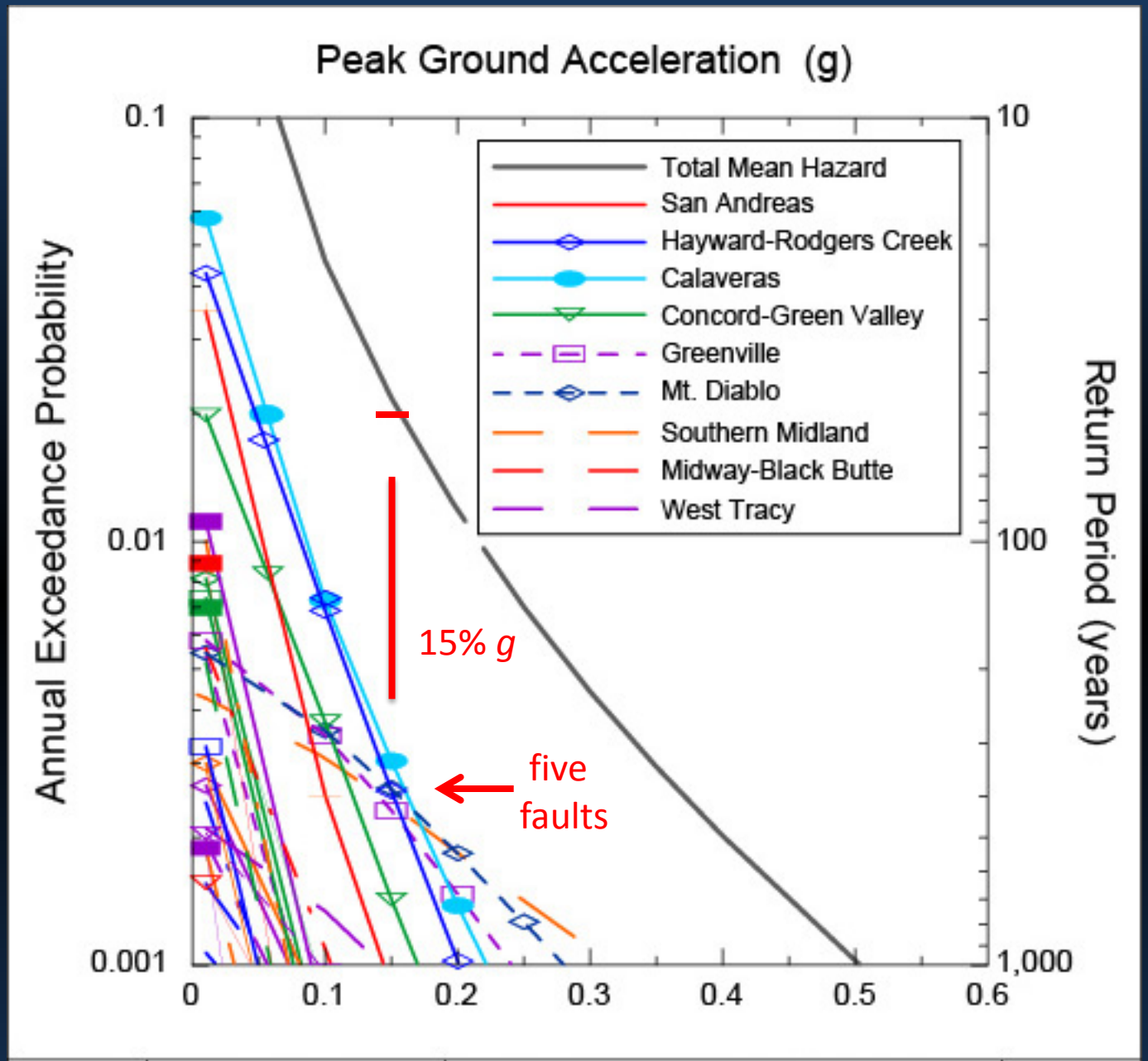
for any given locality each fault system gives an exceedance curve and you sum the curves to get the Total Hazard

what is remarkable about the Delta is the profusion of sources



URS | DELTA RISK MANAGEMENT STRATEGY CALIFORNIA | SEISMIC SOURCE CONTRIBUTIONS TO MEAN PEAK HORIZONTAL ACCELERATION TIME-DEPENDENT HAZARD FOR CLIFTON COURT FOR 2005 | Figure 6-13a

Project No. 26815900



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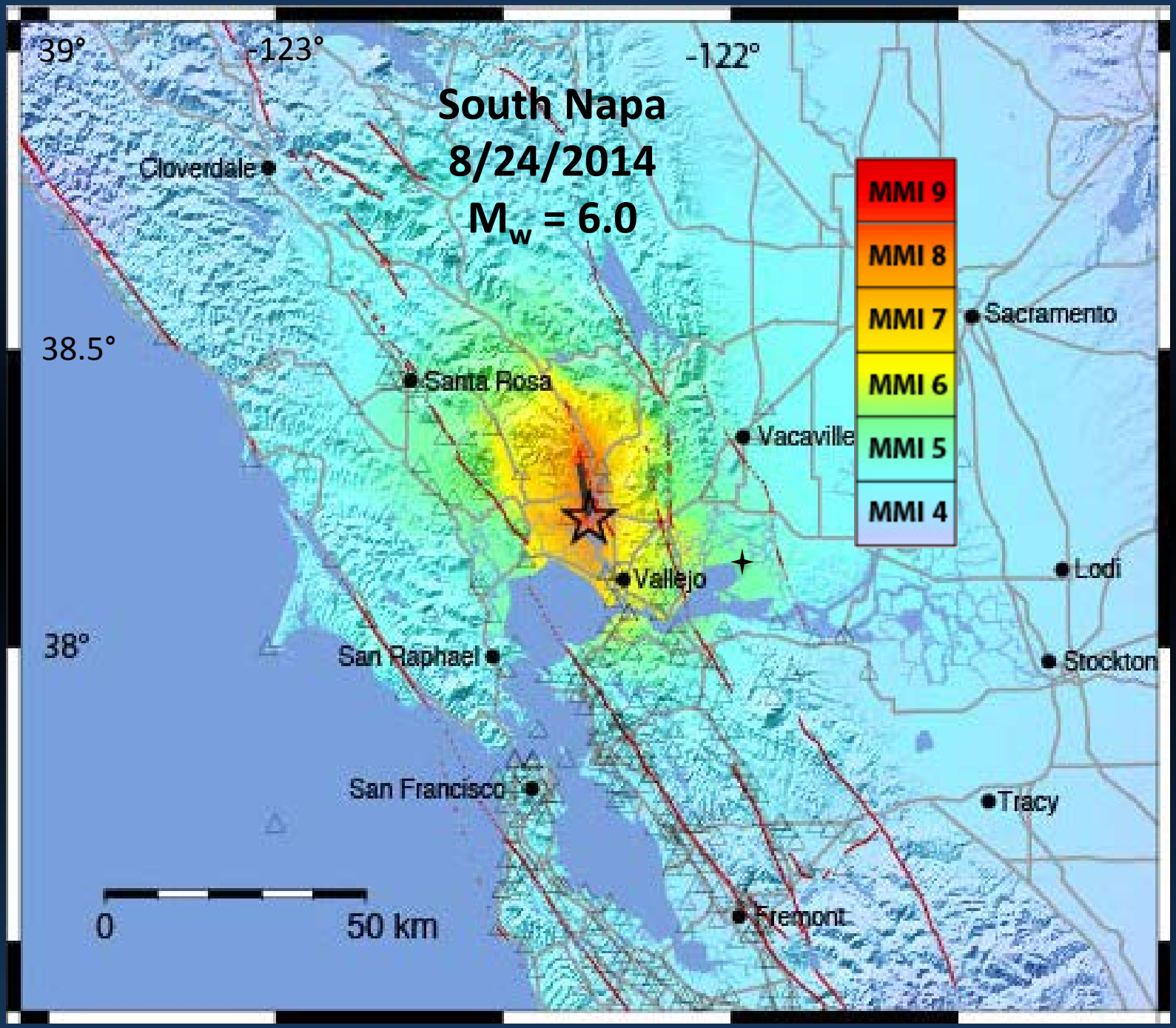

South Napa
8/24/2014
M_w = 6.0
39°
-123°
-122°
38.5°
38°
Cloverdale
Santa Rosa
Vacaville
Vallejo
San Raphael
San Francisco
Sacramento
Lodi
Stockton
Tracy
Fremont
MMI 9
MMI 8
MMI 7
MMI 6
MMI 5
MMI 4
0
50 km

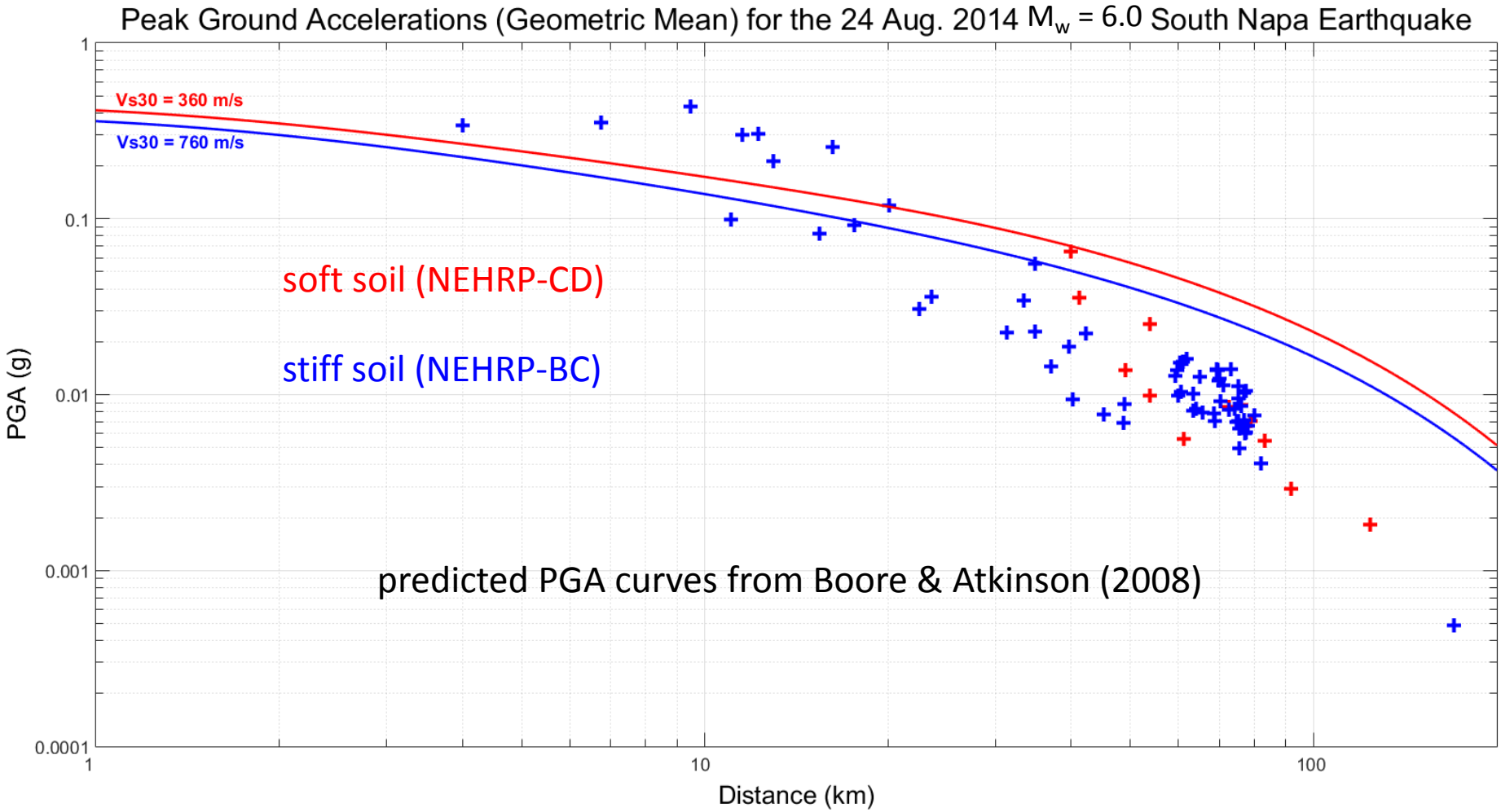
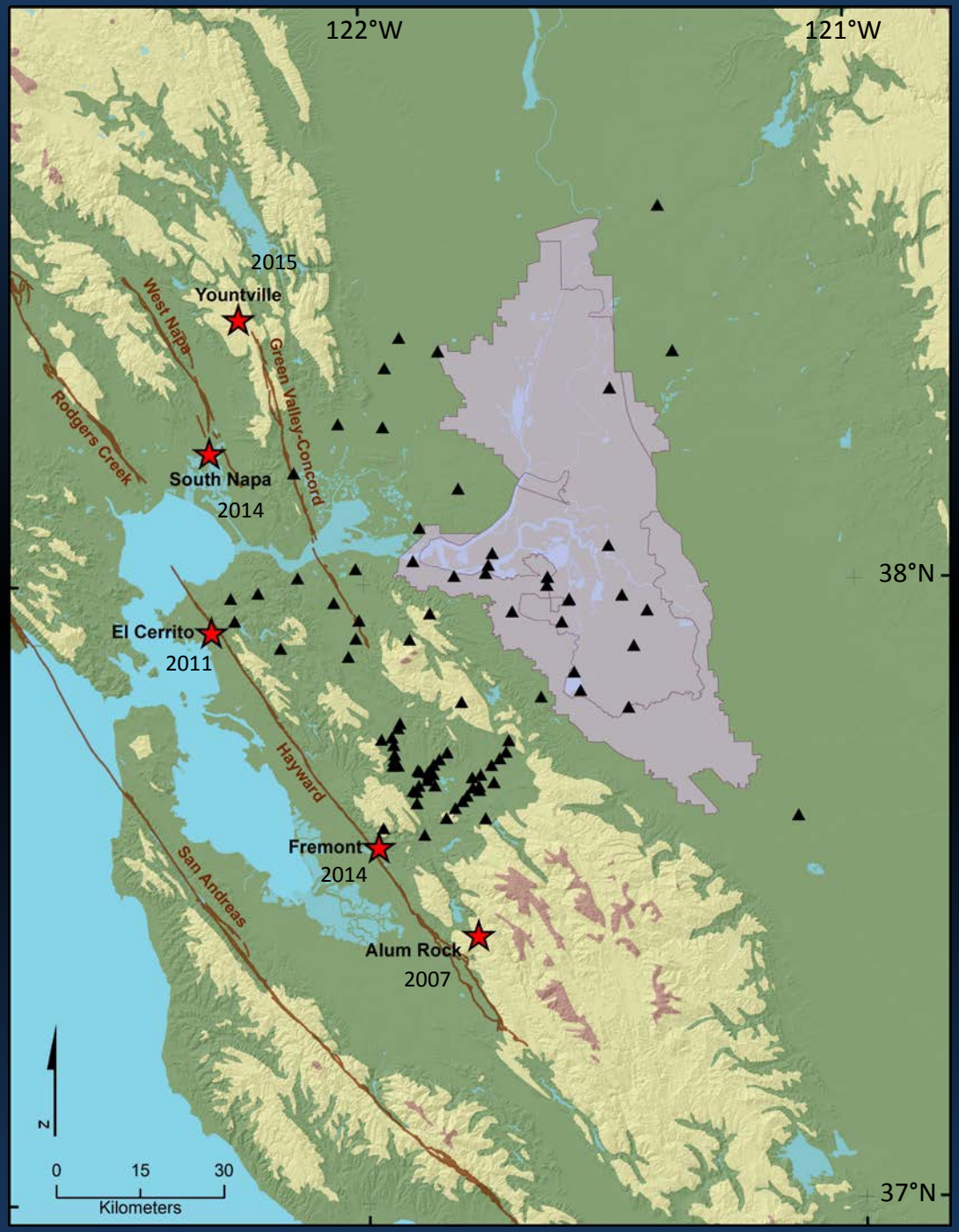


Figure 1. Peak ground accelerations from the 2014 South Napa earthquake compared to the Boore and Atkinson (2008) GMPE. The colors distinguish the site conditions: red corresponds to soft-soil sites and blue to stiff-soil sites. The Suisun Marsh is 15 to 30 km from the earthquake while the Delta is 30 to 70 distant from the earthquake. The Boore and Atkinson (2008) GMPEs over-predict the accelerations by a factor of 2 to 3.

Jon Fletcher (USGS, ESC, Menlo Park) has maintained an array of broadband seismometers in the Delta since 2006

these instruments obtain good recordings from M_W~ 4 events Δ < 250 km

on the Green Valley, West Napa, Hayward, and Calaveras faults, although not the San Andreas or Rodgers Creek



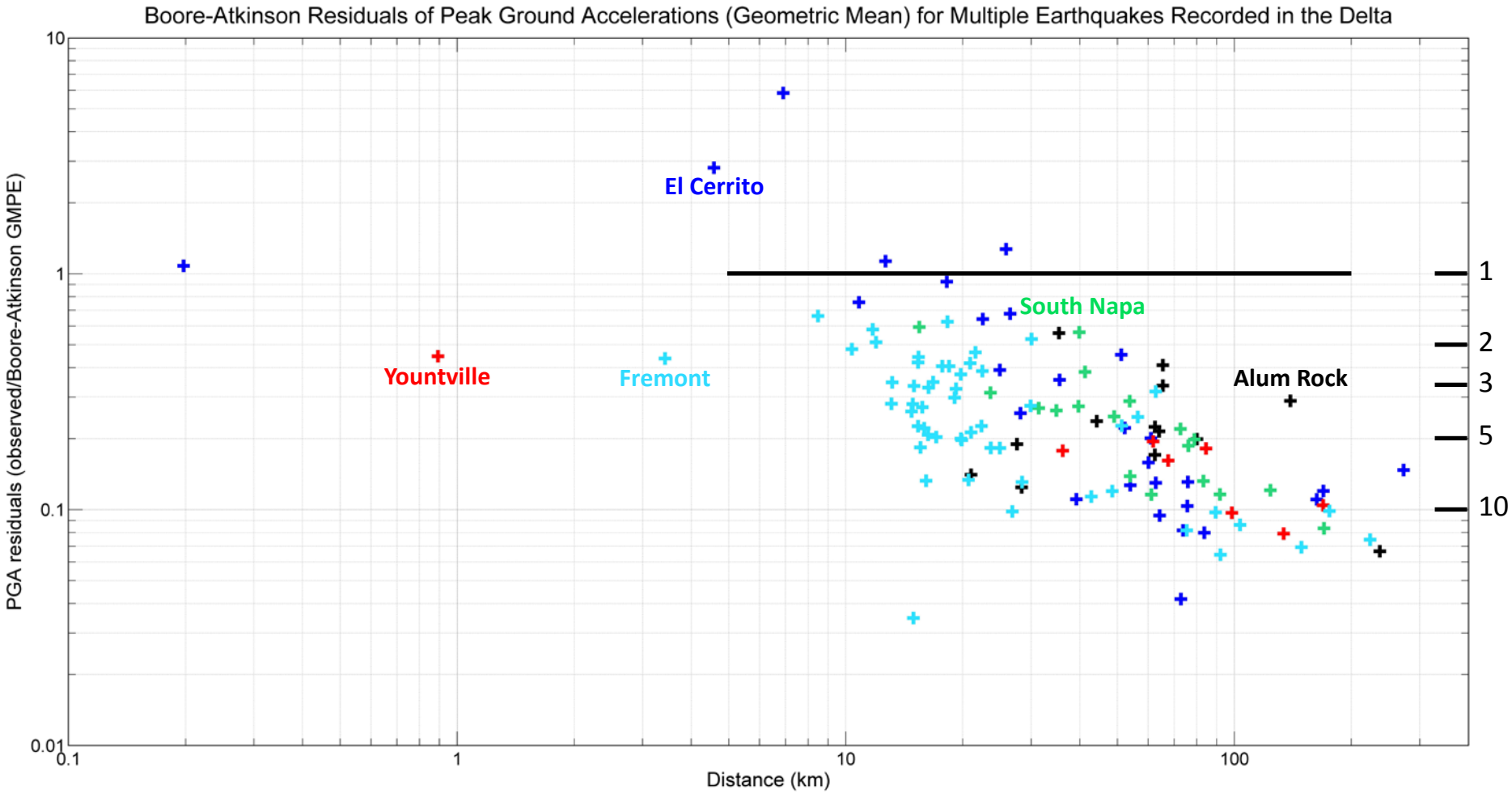
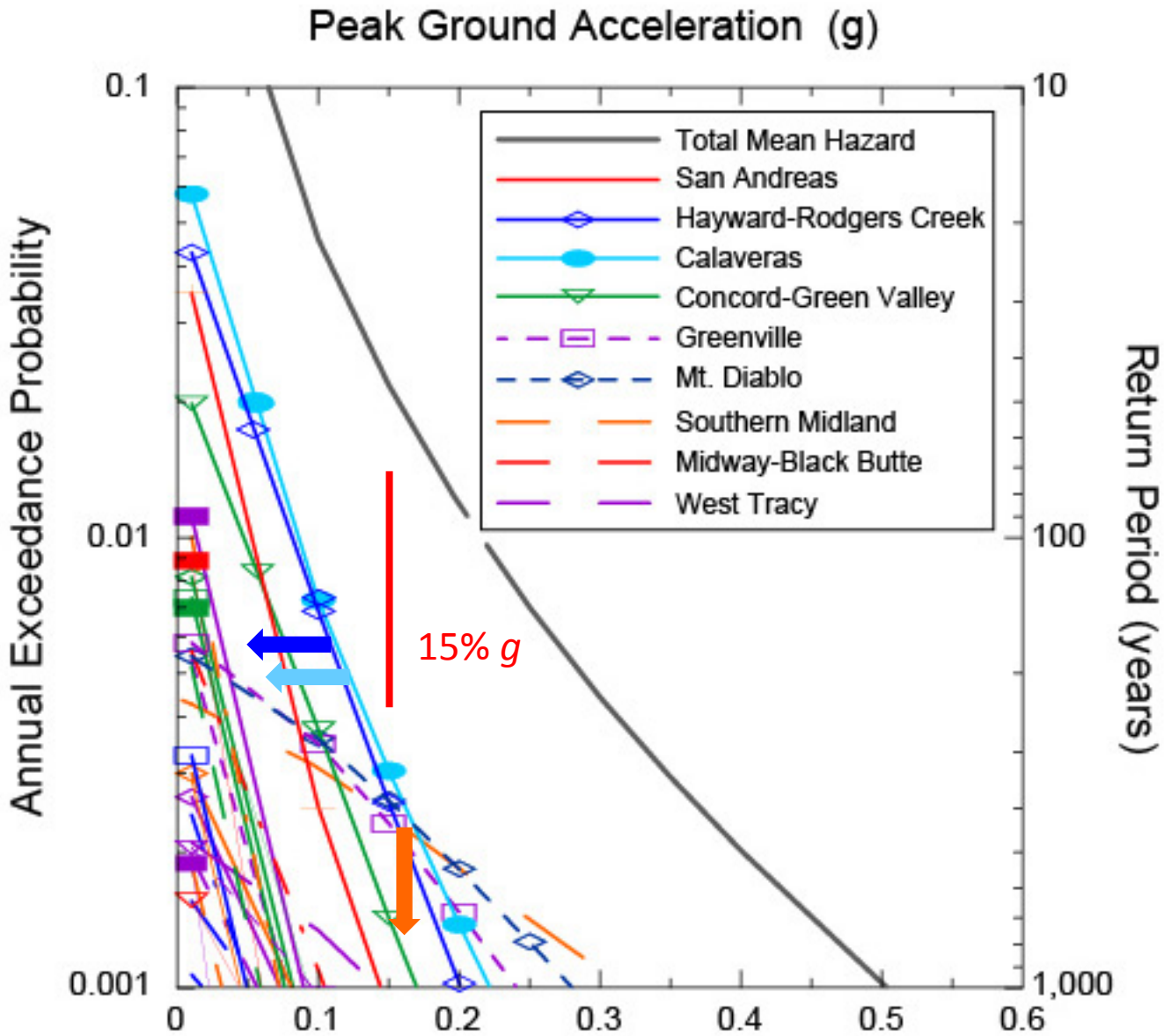


Figure 3. Residuals of the peak accelerations recorded for five earthquakes with respect to the Boore and Atkinson (2008) GMPEs. The colors correspond to specific earthquakes: blue is the 2012 El Cerrito earthquake, red is the 2015 Yountville earthquake, black is the 2007 Alum Rock earthquake, green is the 2014 South Napa earthquake, and cyan is the 2015 Fremont earthquake. The residuals to the Boore and Atkinson (2008) predictions are very similar as a function of distance.



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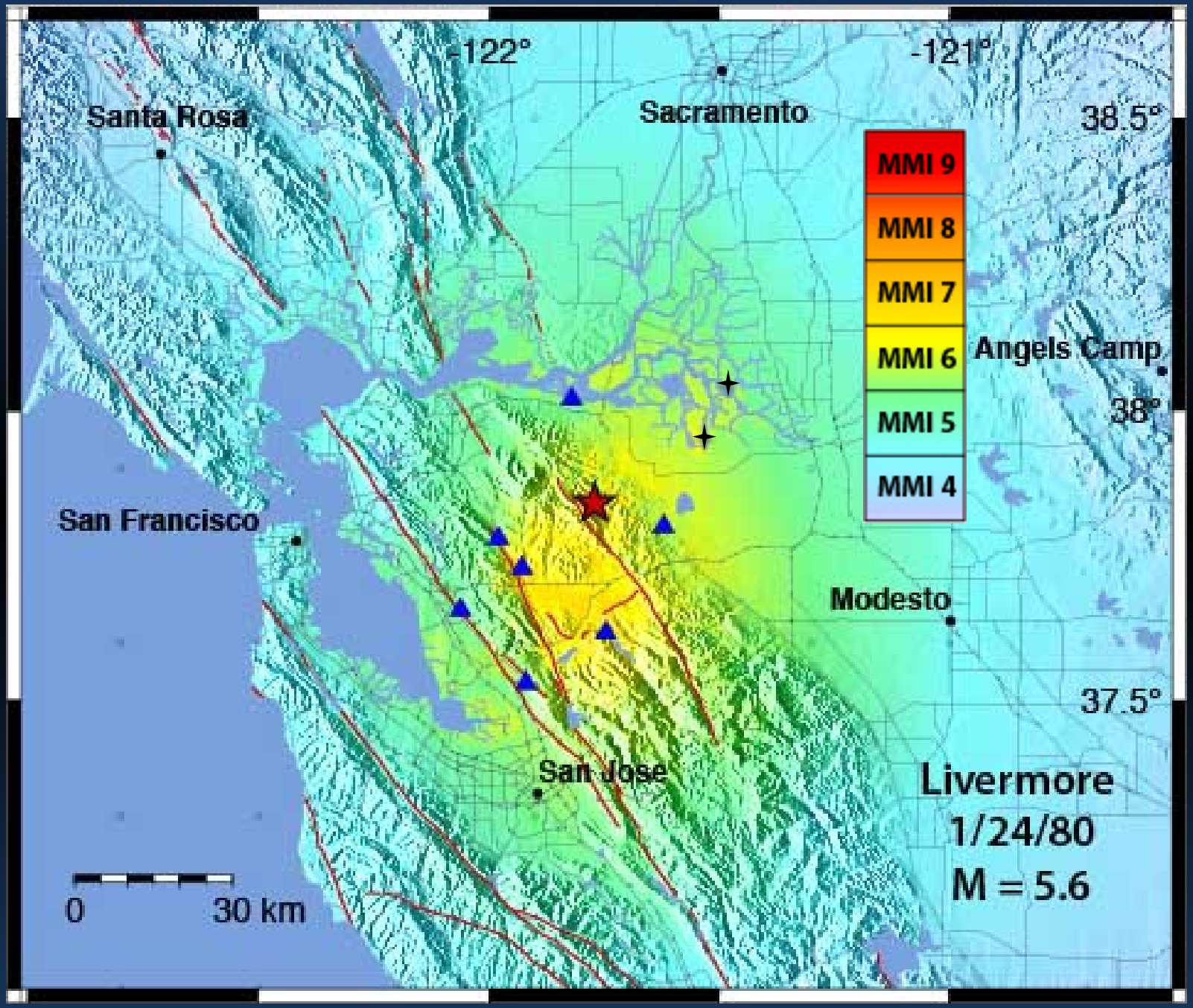

-122°
-121°
Santa Rosa
Sacramento
38.5°
MMI 9
MMI 8
MMI 7
MMI 6
MMI 5
MMI 4
Angels Camp
38°
San Francisco
Modesto
37.5°
San Jose
Livermore
1/24/80
M = 5.6
0
30 km

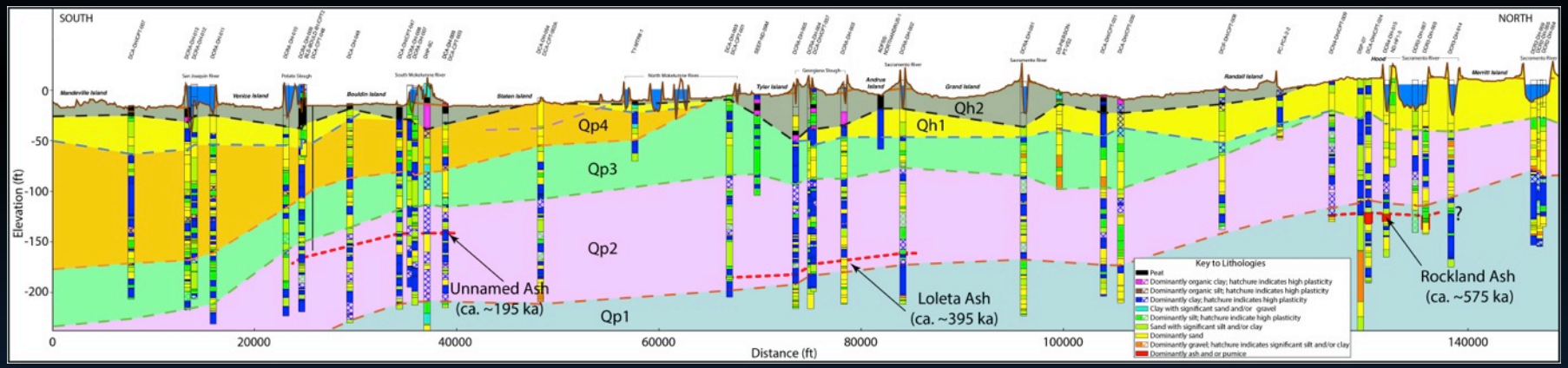
Conclusions

- The 2011 DRMS PSHA obtained a necessary and important description of seismic hazard in the Sacramento-San Joaquin Delta
- Recordings of the M6 2014 South Napa earthquake show that the NGA-West GMPEs over-estimate the ground motion across the Delta by a factor of 2-5
- Revising these GMPEs will significantly lower the seismic hazard in the central and eastern Delta

Holocene Geology in the Sacramento and San Joaquin Delta

Tom Holzer, Dan Ponti, John Tinsley, Emma Gatti, and Katie Coble

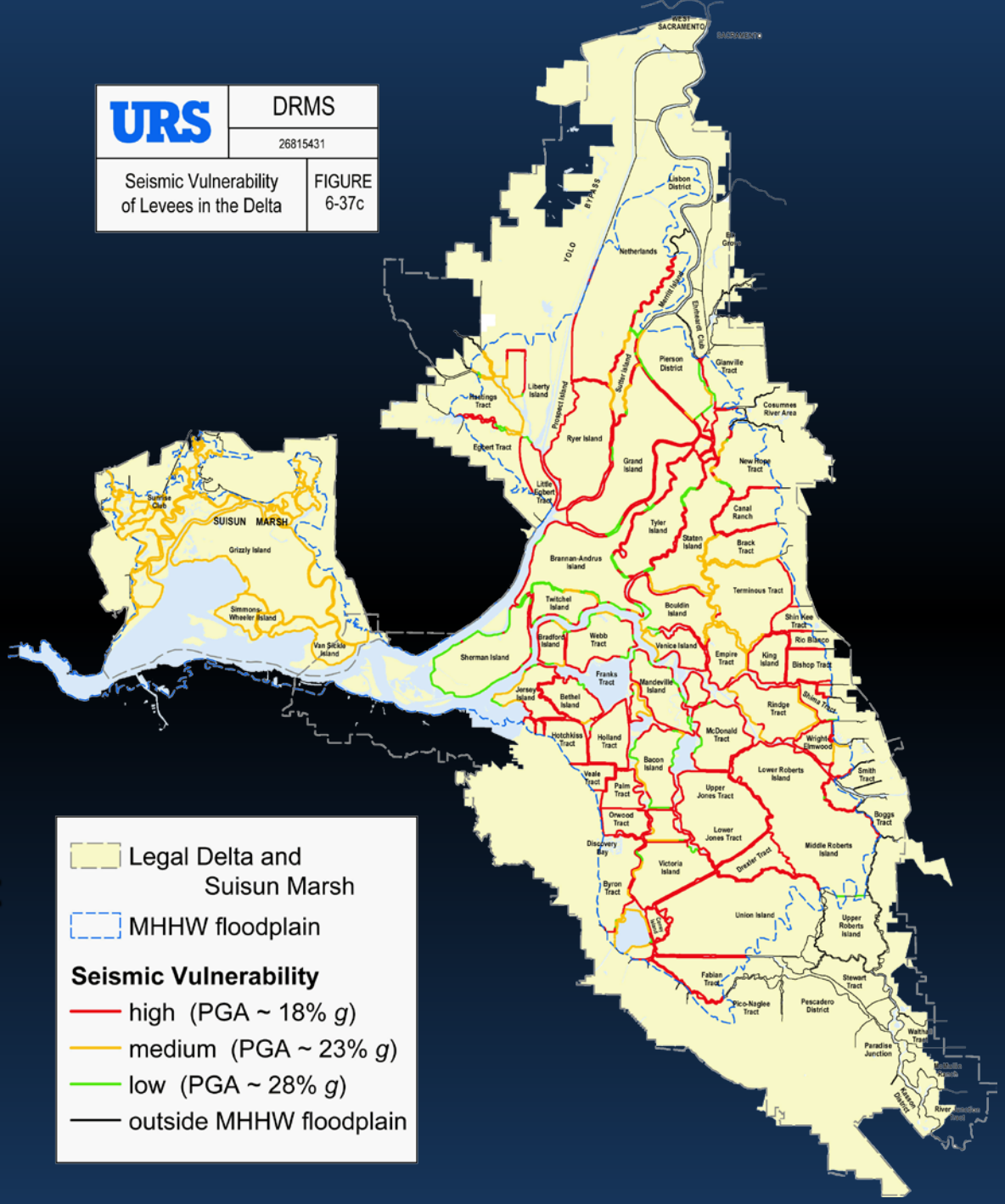
1. Develop a chrono-stratigraphic model of the Quaternary stratigraphy (tectonic deformation constraints)
2. Develop a framework for Quaternary units and their engineering properties (engineering geology)
3. Create liquefaction and Vs30 maps of natural deposits (hazard)



S to N cross-section along the tunnel alignment proposed by DWR

They've identified and dated three water-laid tephras. Subsidence rates are very low, 0.04 and 0.07 mm/yr in the northern Delta, 0.1 mm/yr in the central Delta, and 0.06 mm/yr in the eastern Delta.

there are ~1,100 miles of levees in the Delta

The DRMS Report grades most of the Delta levees as highly vulnerable

where an M6.5 earthquake that produces PGA ≥ 18% *g* could cause failure that breaches the levee