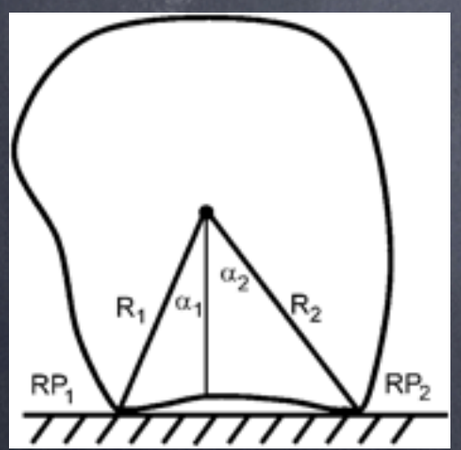
Report: PBR SCIENCE FOR SCEC4:
VALIDATION OF GROUND MOTION PREDICTION AND SIMULATIONS

Glenn Biasi,
J. Anderson, and J. N. Brune
University of Nevada Reno

PBRs as Ground Motion Constraints

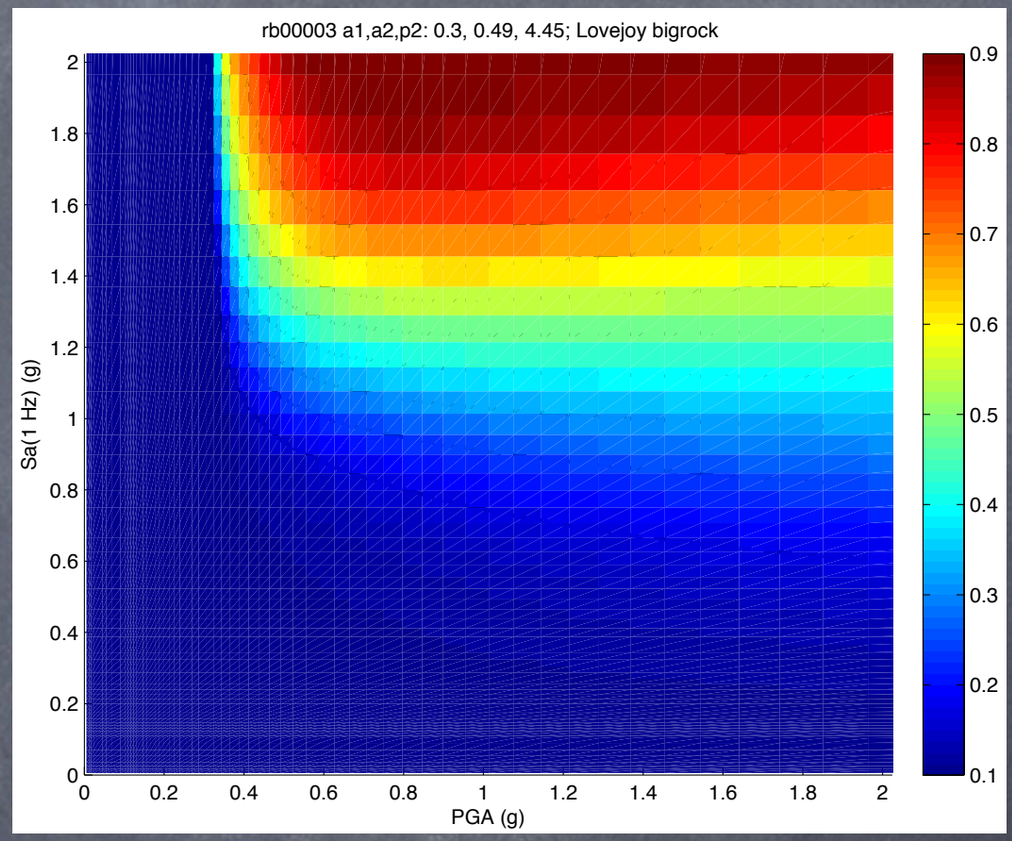
- Static overturning acceleration gtan(α) – a function of geometry.
- Estimate alpha by several methods:
  - Tilt-testing



- Photogrammetry: detailed 3-D photographic analysis
- Expert analysis - spot center of mass, rocking points considering multiple photos and rock 3-D shape
- 2-D analysis - use individual photographs assuming the rock continues as a polygonal cylinder.

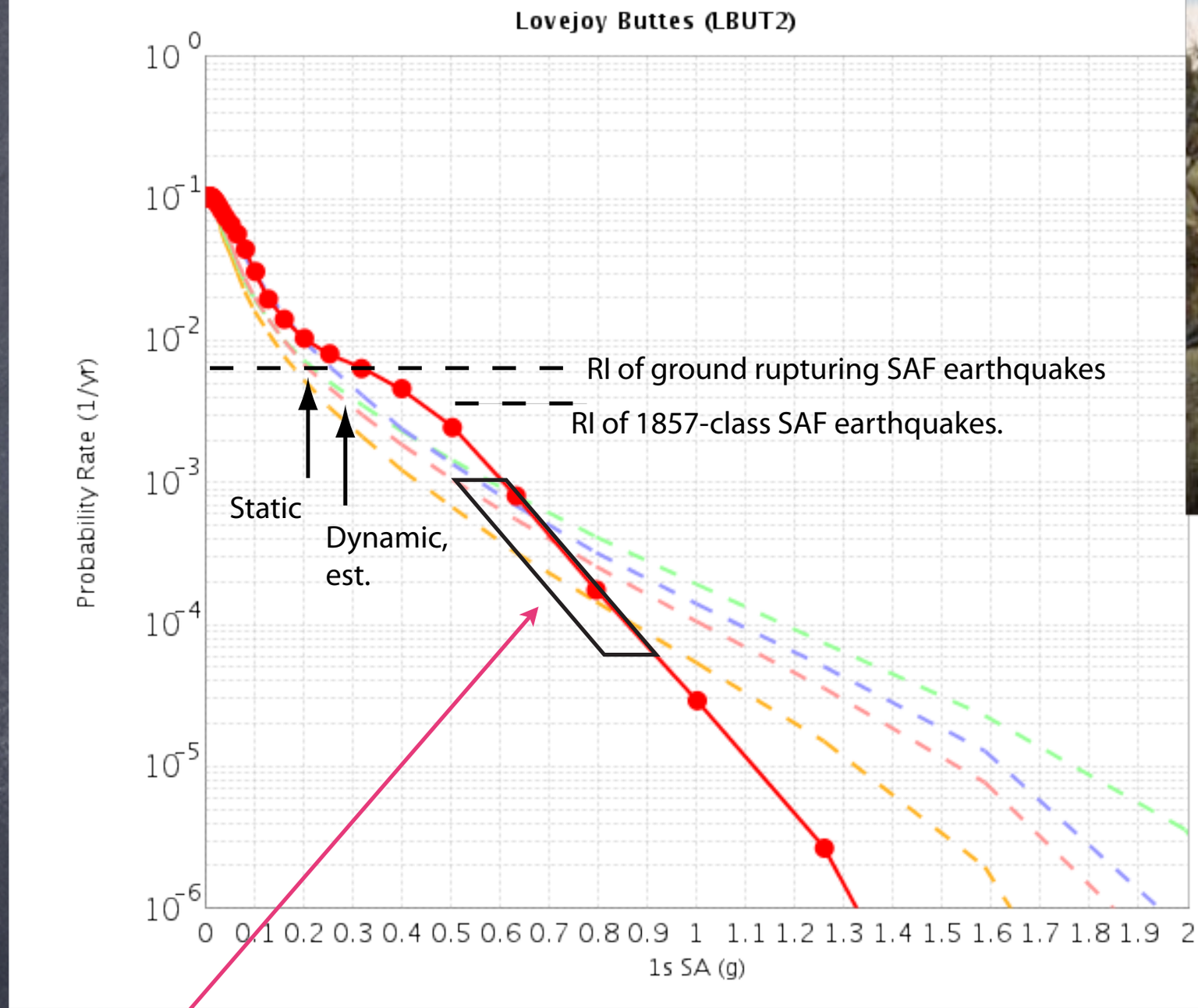
PBRs as Ground Motion Constraints

- Estimating dynamic toppling parameters
  - Empirical scaling: toppling PGA ~1.3* gtan(α) (ignores R)
  - Regression-based estimate (Purvance et al., 2008). Yields probability of overturning as a function of PGA and SA(1). Benchmarked with shake-table and seismograms.



SA, 1 Hz (g)

PGA (g)



Hazard curve predicted by CyberShake (red) and four NGA regressions (Pink: Campbell and Bozorgnia (2008); Blue: Boore and Atkinson (2008); Green: Chiou and Youngs (2008); Orange: Abrahamson and Silva (2008)

Primary return time and ground motion focus of PBRs.

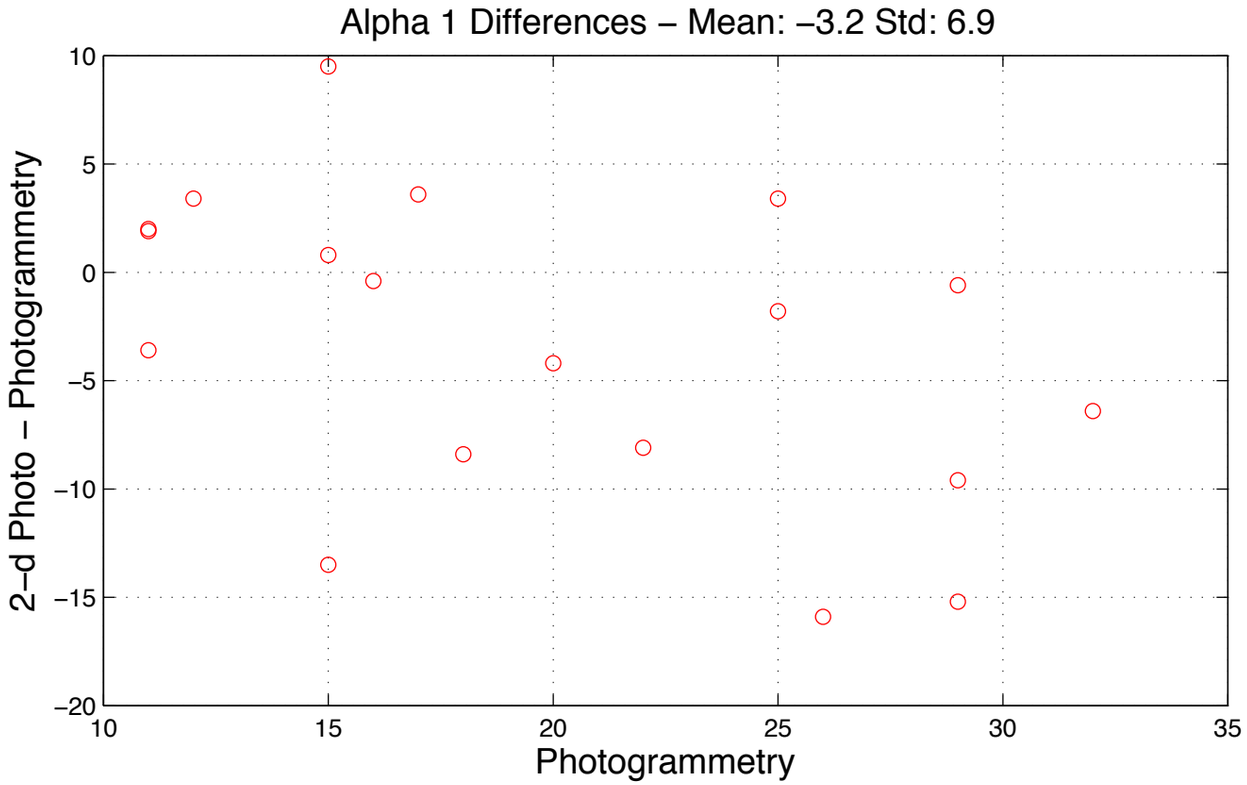
Archive (UNR 2012 goals)

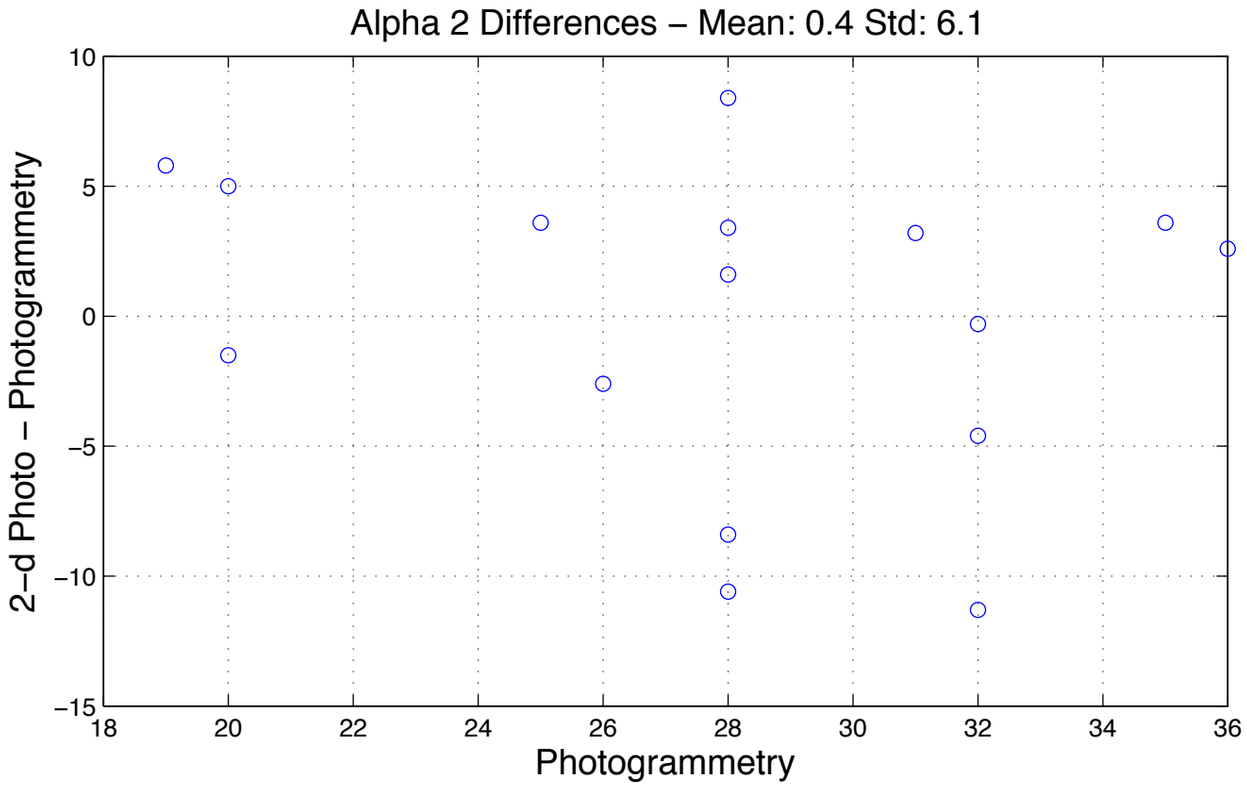
(1) Complete association of locations, photos, and 2-D screening fragility estimates.

(2) Continue work to add scale lengths to all PBR photos.

(3) Integrate new results.

- 9000+ images associated by rock, with locations (~10x)
- Static overturning angles with locations for 1170 rocks (~10x)
- 700+ rocks with alphas, R's, and locations (~10x)

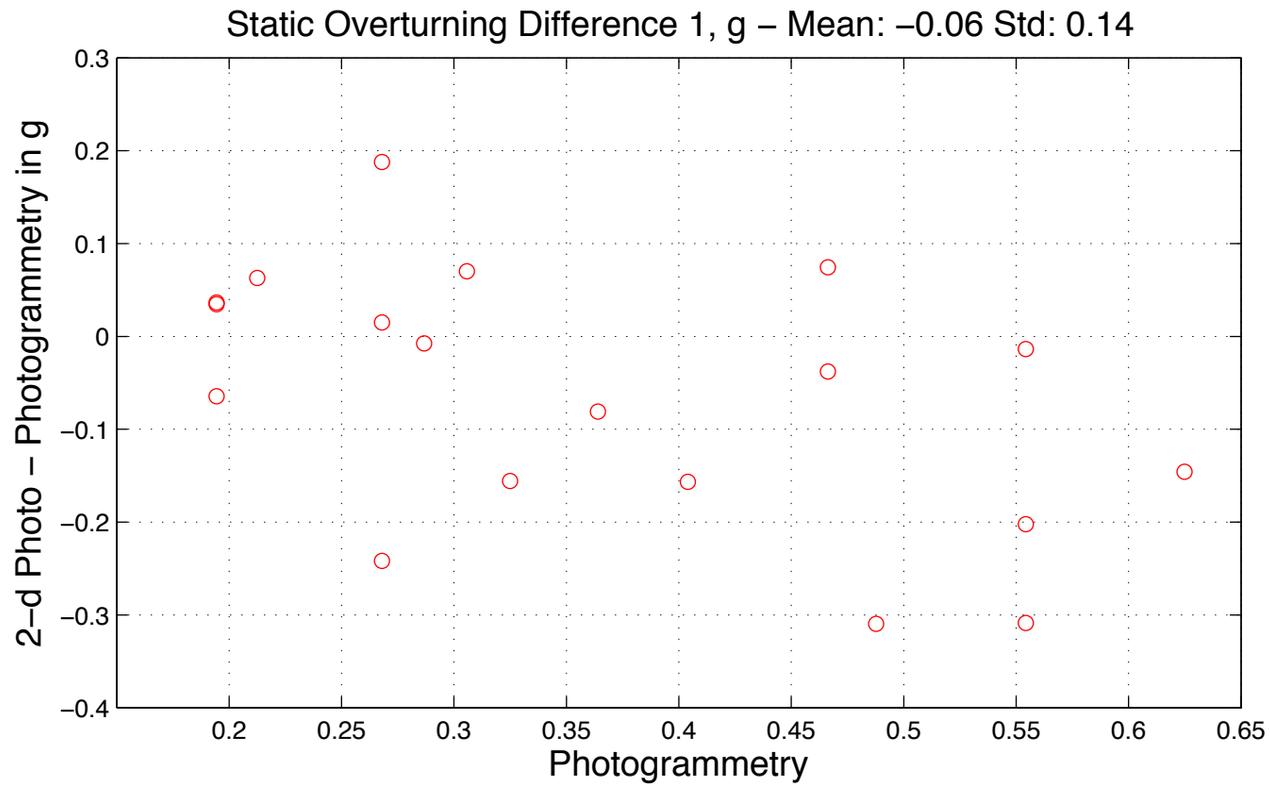


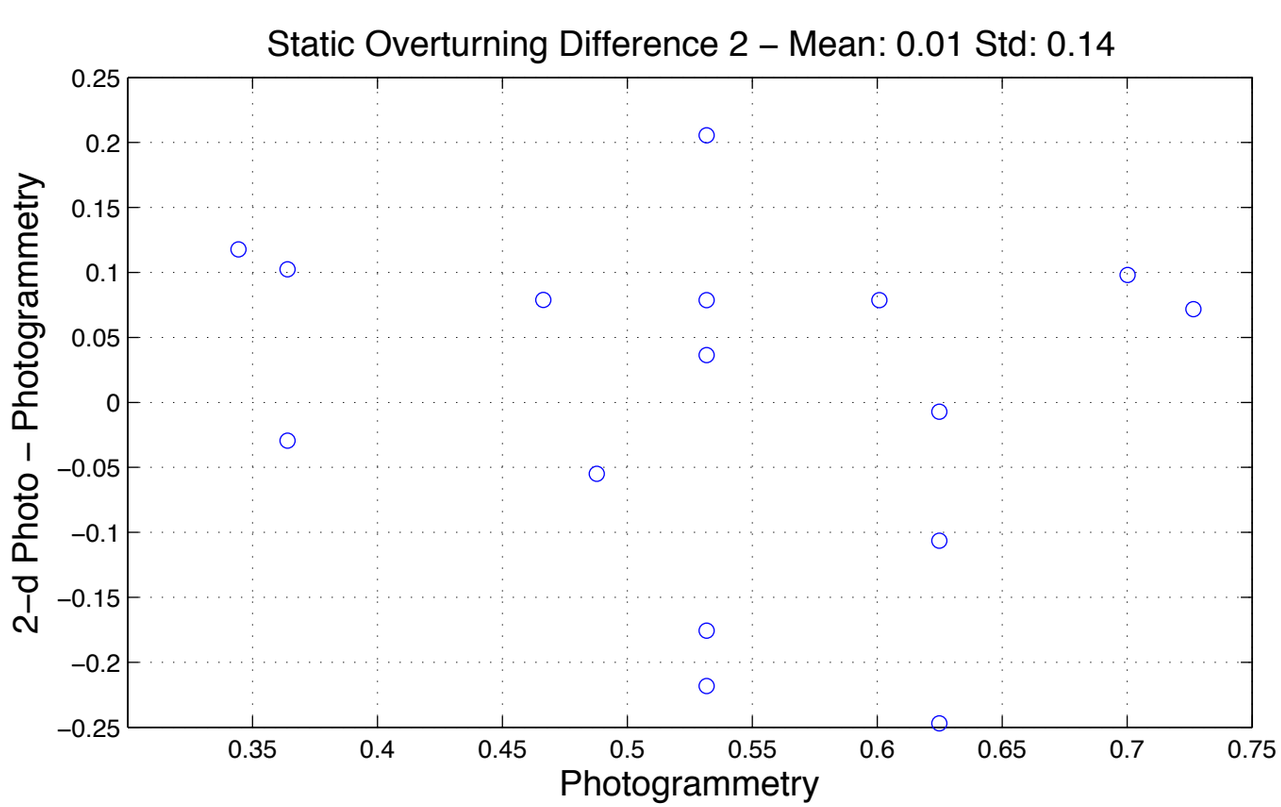


Angle differences between 2-D approximation and detailed photogrammetry are small on average.

Photogrammetry is larger on average by 3.2 degrees in alpha-1. This can occur if rocks do not fit the 2-D out-of-plane assumption. Lower center of gravity gives larger alphas.

The average the 2-D is similar to detailed measurement, but requires more rocks (a resolution-variance tradeoff).

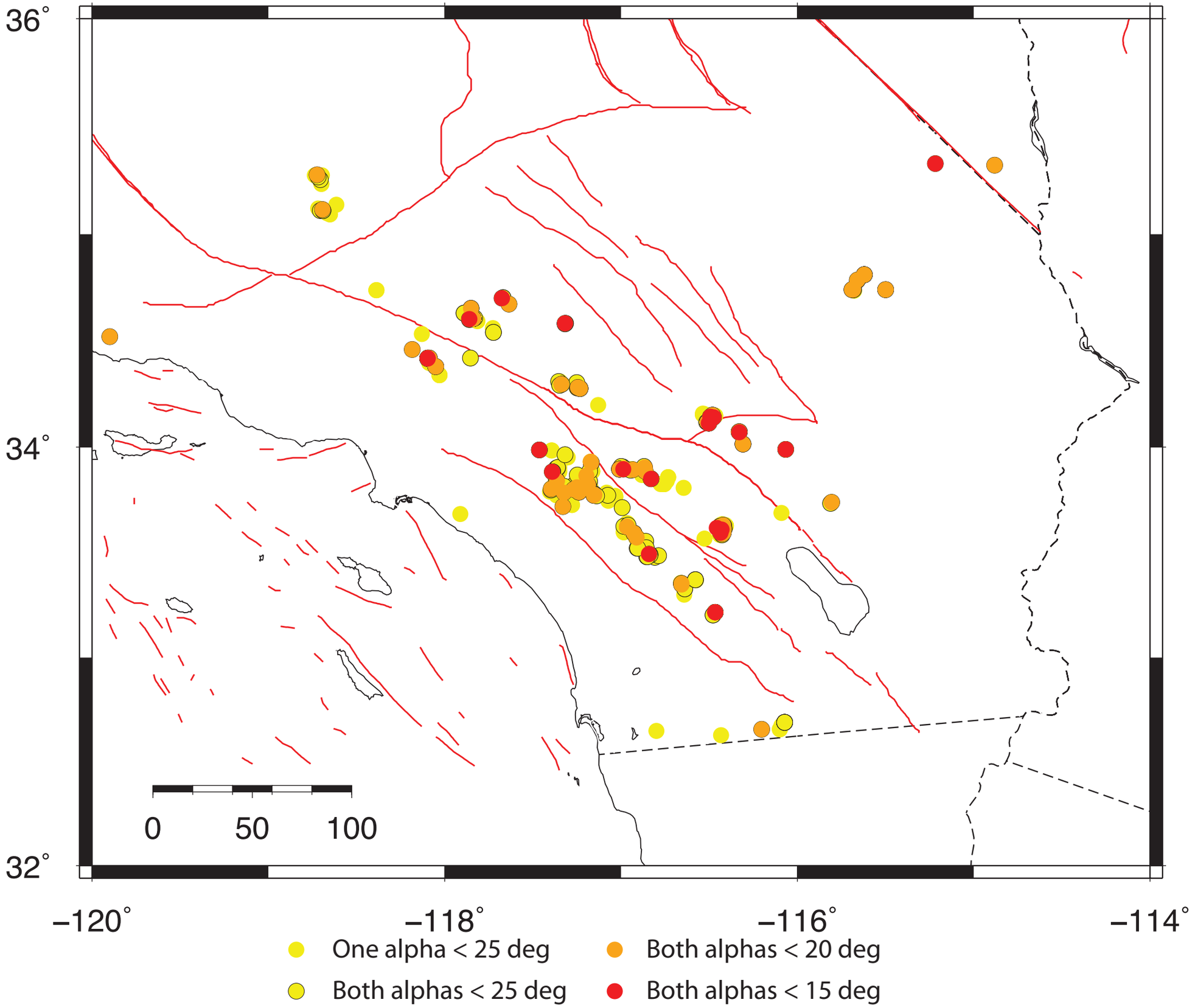




Static overturning acceleration differences between photogrammetric and 2-D estimates.

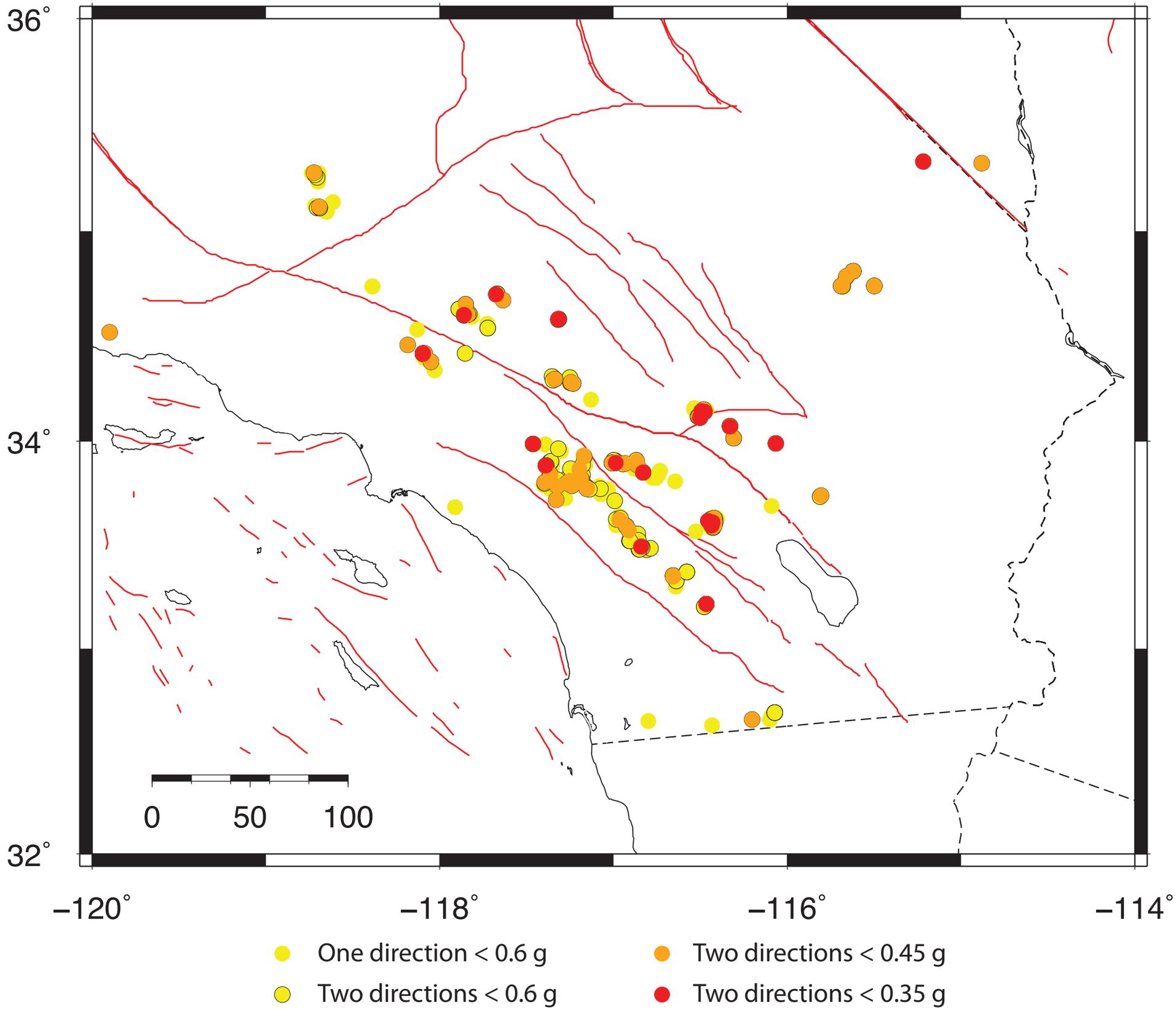
Photogrammetric static overturning acceleration estimates are slightly higher on average.

The standard deviation of 2-D estimates is ~0.14g, assuming photogrammetric estimates are exact.



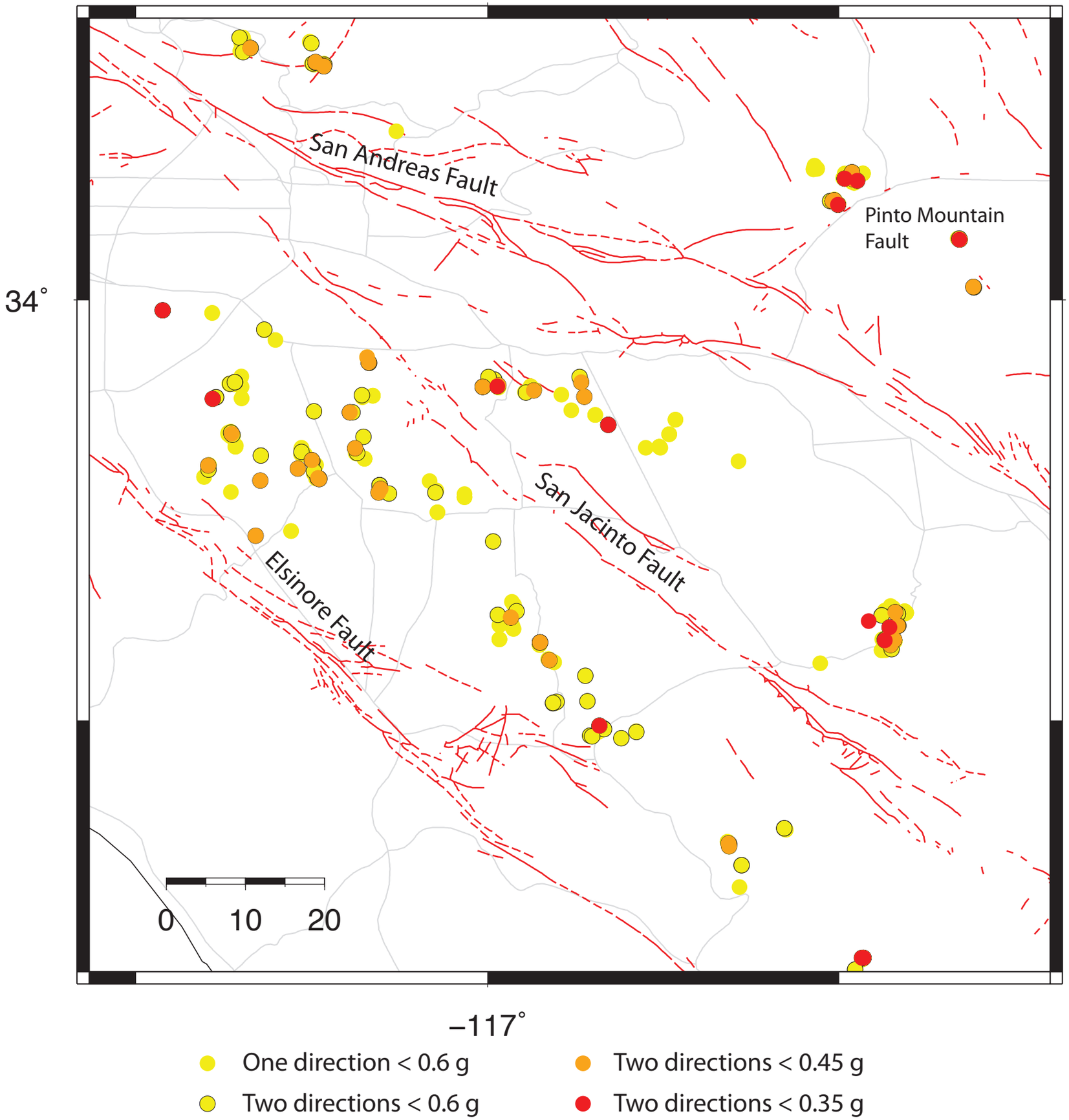
Observations in terms of overturning angle alpha.

Many points have multiple rocks.



Approximate dynamic toppling accelerations.

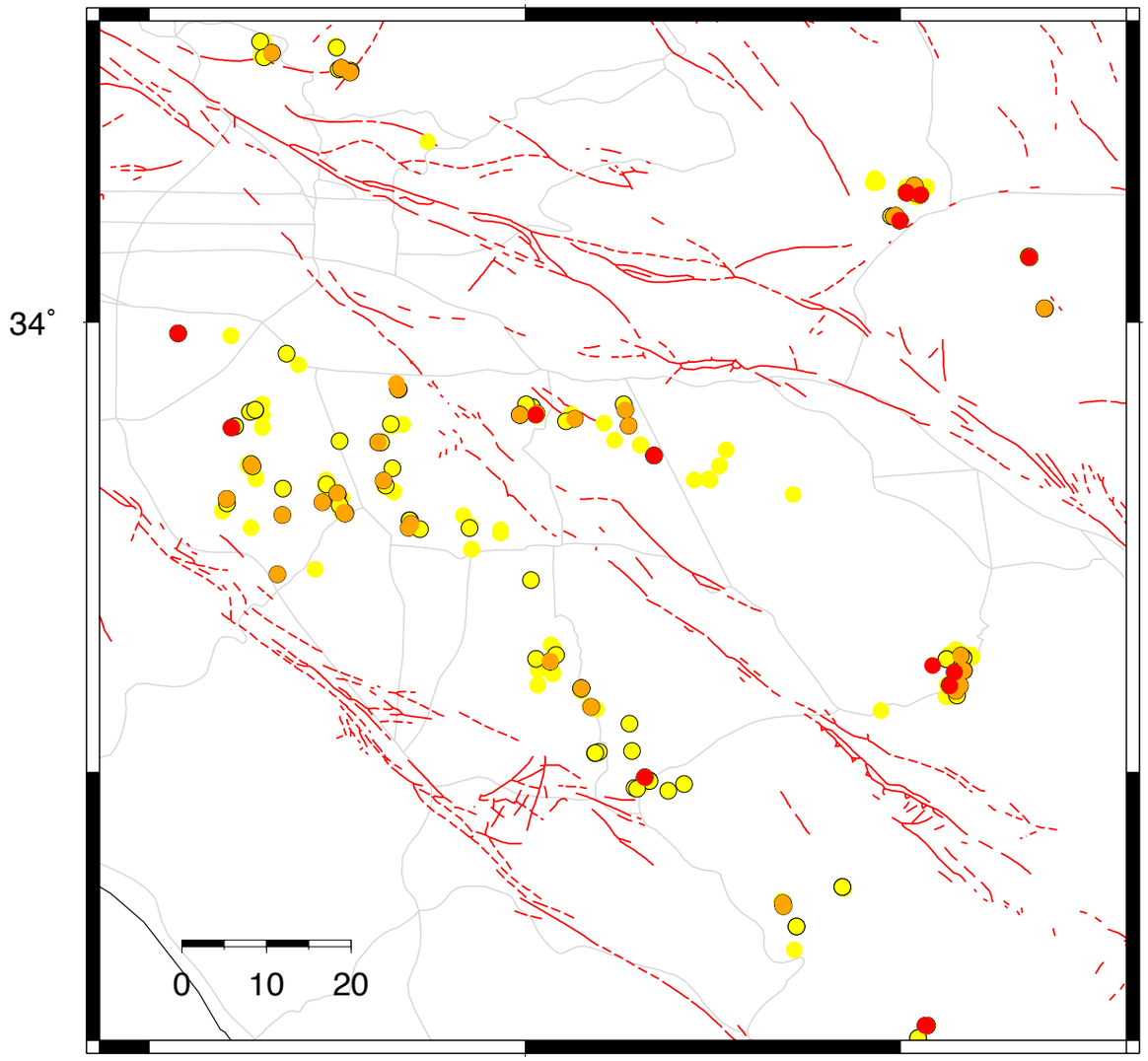
Spatially coherent patterns are observed.

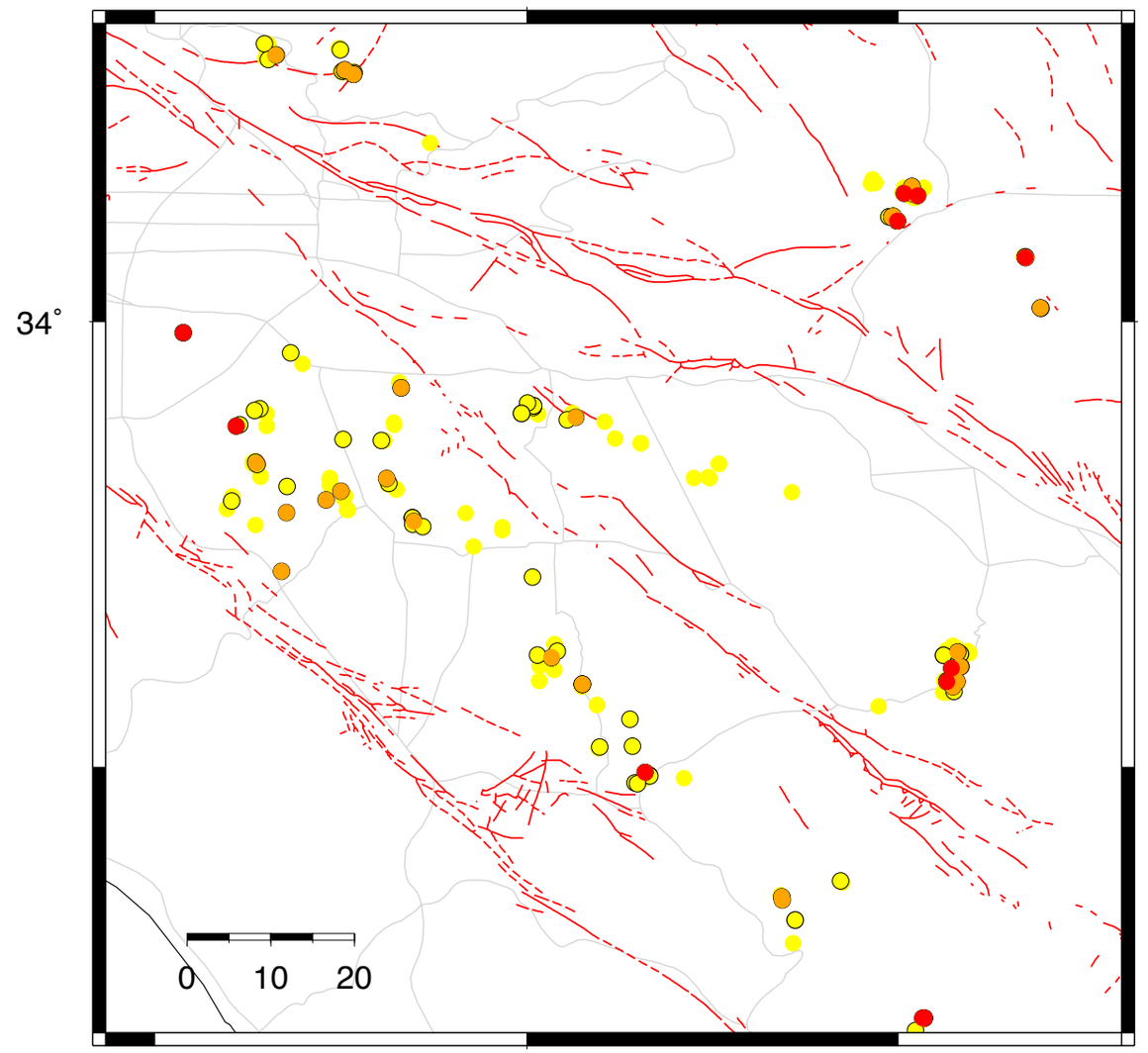


Approximate dynamic toppling accelerations are spatially continuous between the SJF and Elsinore fault.

The reason for the difference between the linear array south of 33.7 N and an areal distribution of rocks to the north is not known.

Multiple rocks near the Pinto Mountain fault suggest extremely low fault activity rates.



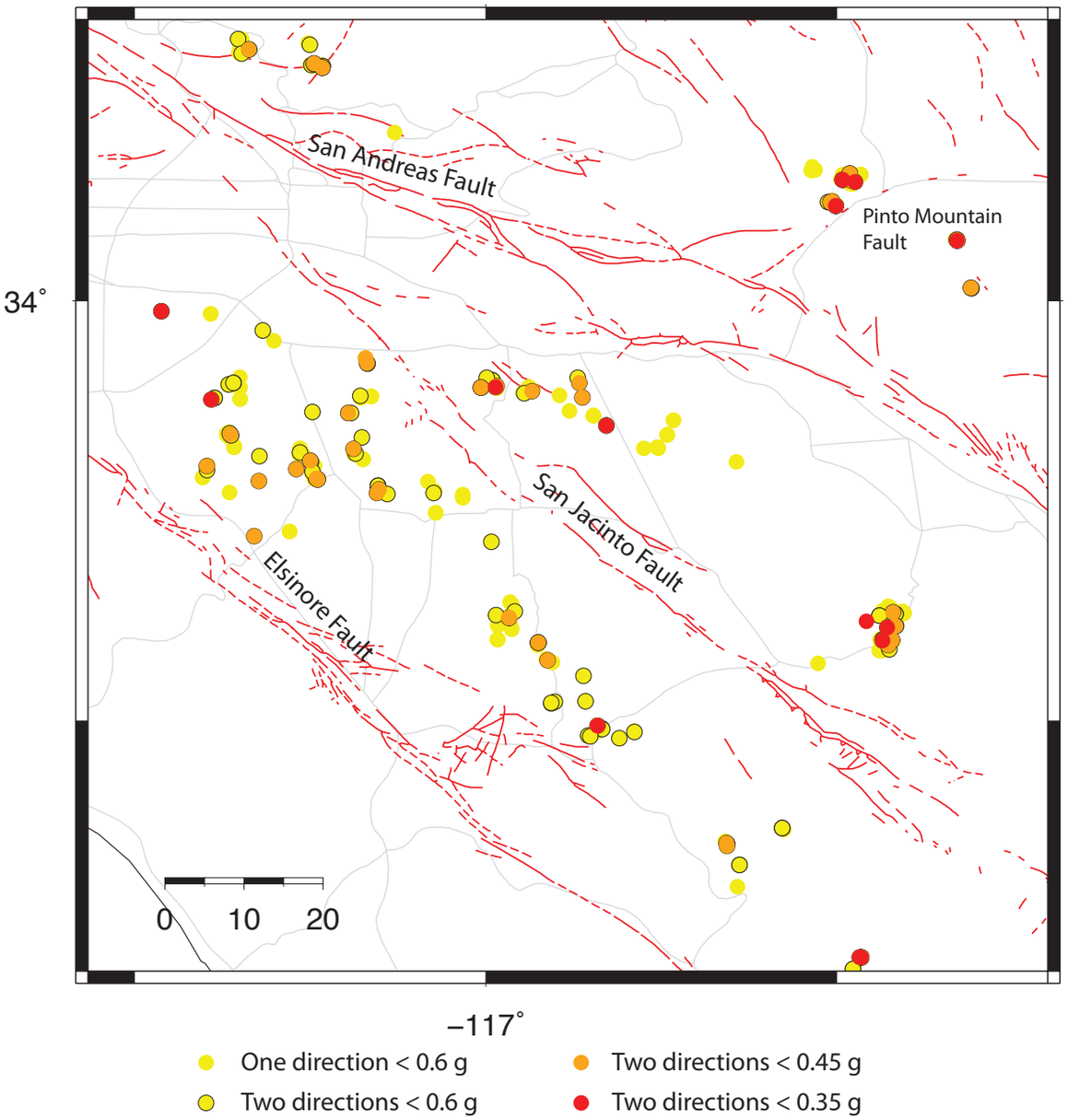


All rock sizes

R<0.8 m

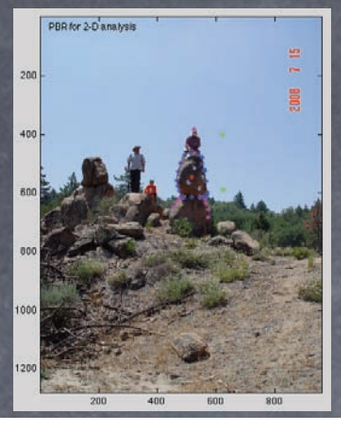
Data show some “texture” for frequency resolution.

Conclusions

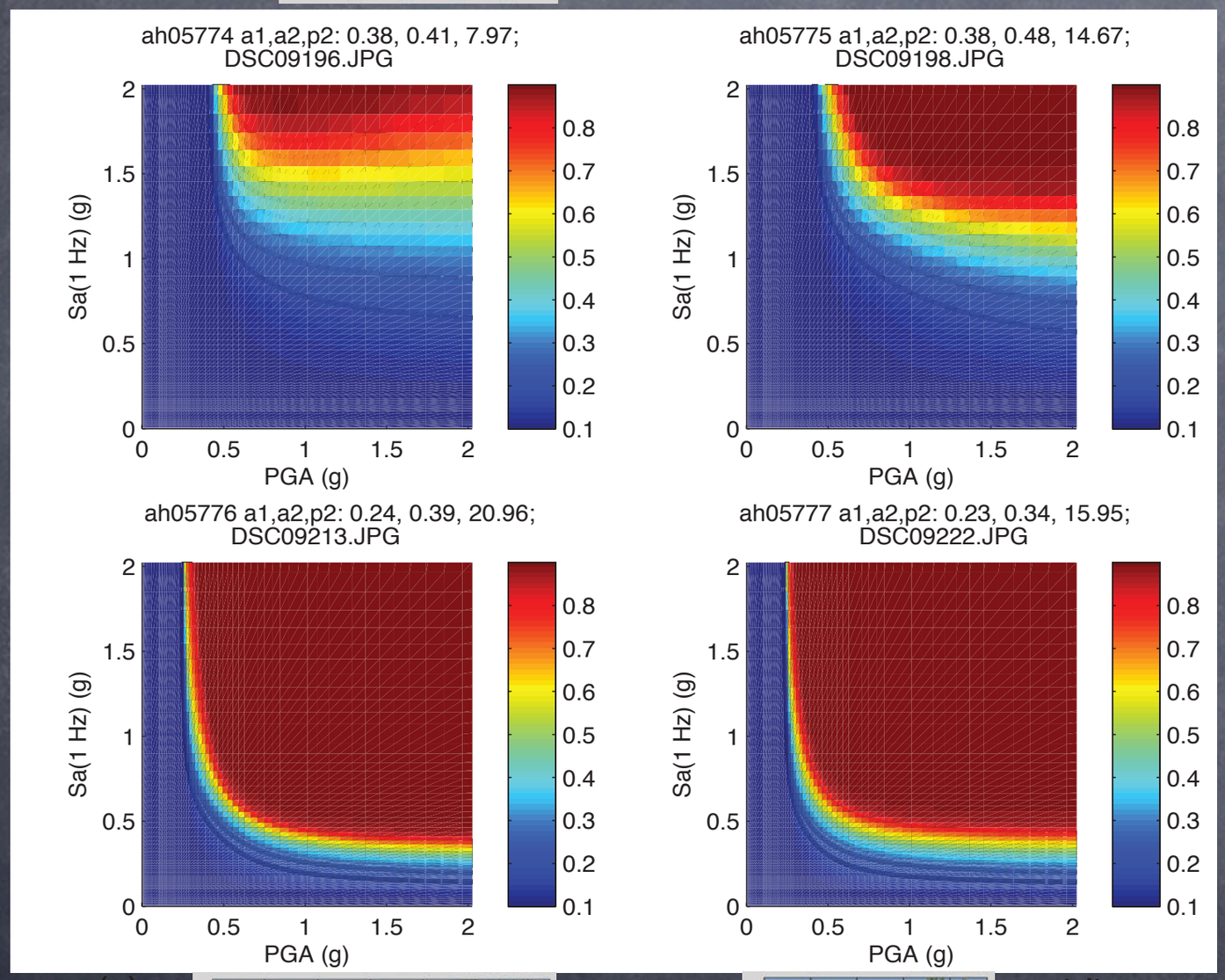


- Ground motion constraints from PBRs are coming into focus.
- Data appear to resolve some frequency dependence.
- Ground accelerations appear limited to ~0.6 g at 1-5 kyr return times in large areas of Southern California.
- Detailed study is recommended if individual points in hazard space are being investigated.

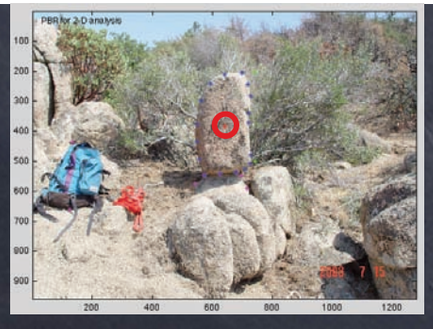
(a)



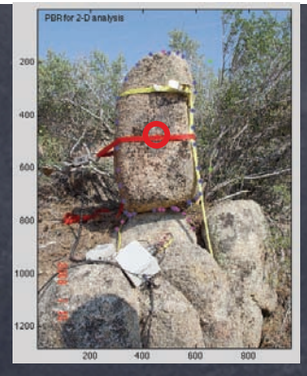
(b)



(c)

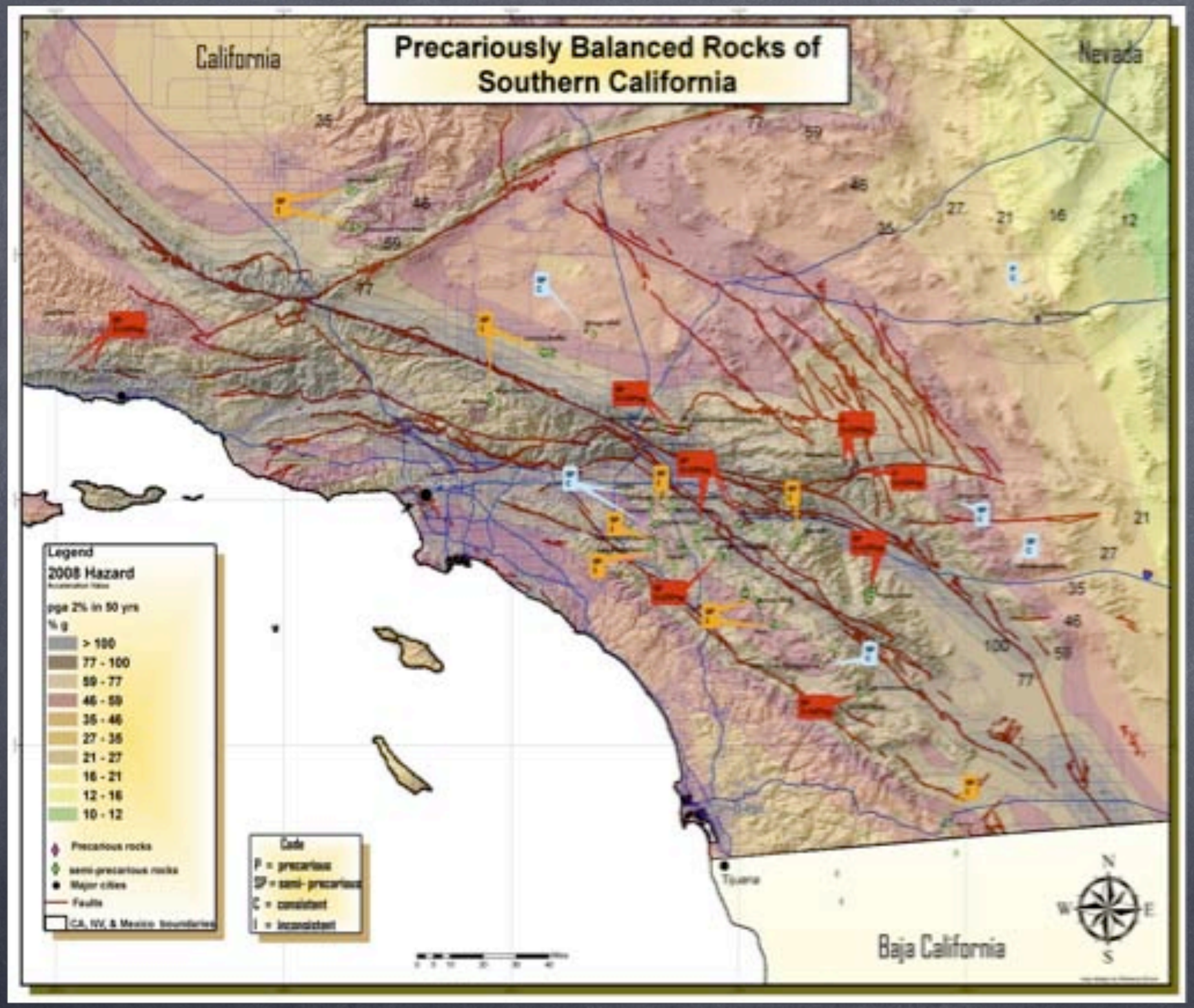


(d)



Example vector fragilities on CyberShake rocks using alphas from 2-D analyses.

Center of mass from 2-D analysis circled. (c) and (d) are repeated analyses using different images.



The state of the PBR map a year ago.

Inconsistencies suggested between PBR estimated fragilities and the 2008 NSH Map