

Faults Near DCPD : Sources of Uncertainty

Jeanne Hardebeck
USGS, Menlo Park, CA

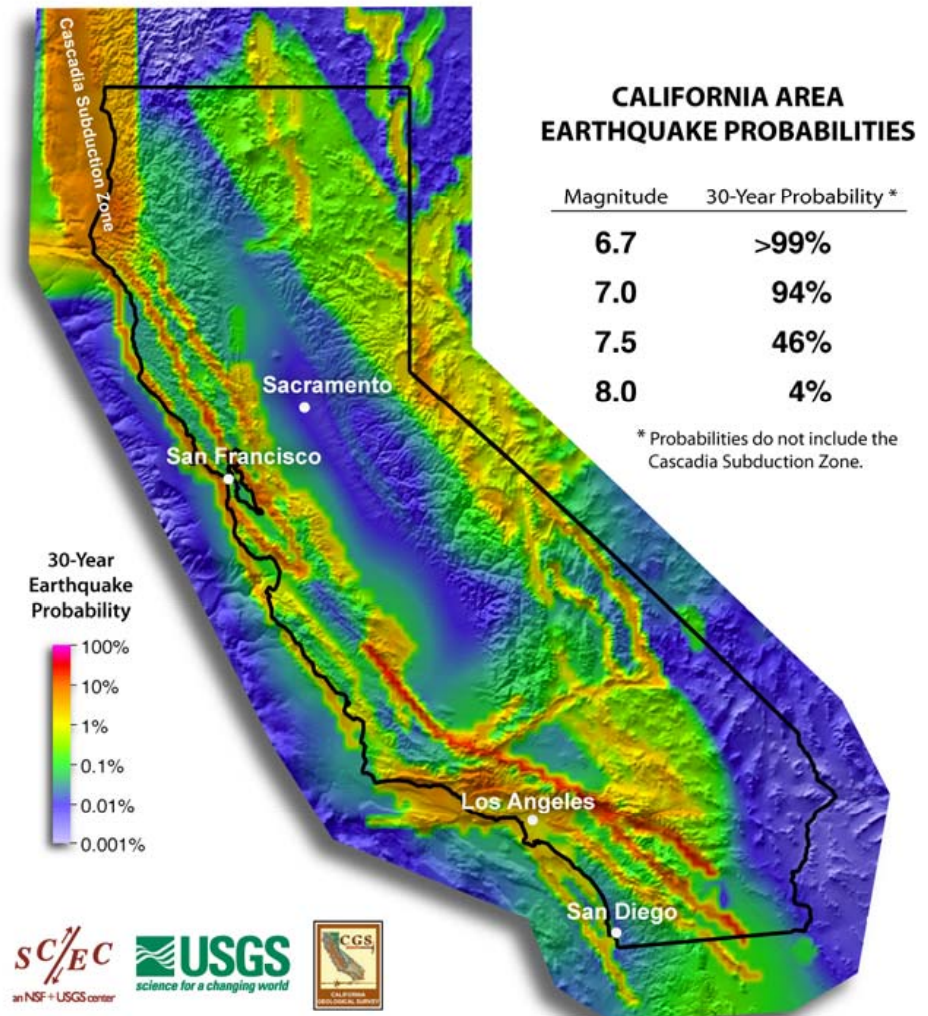
Fault Information Needed for Probabilistic Seismic Hazard Assessment:

(1) Fault Geometry

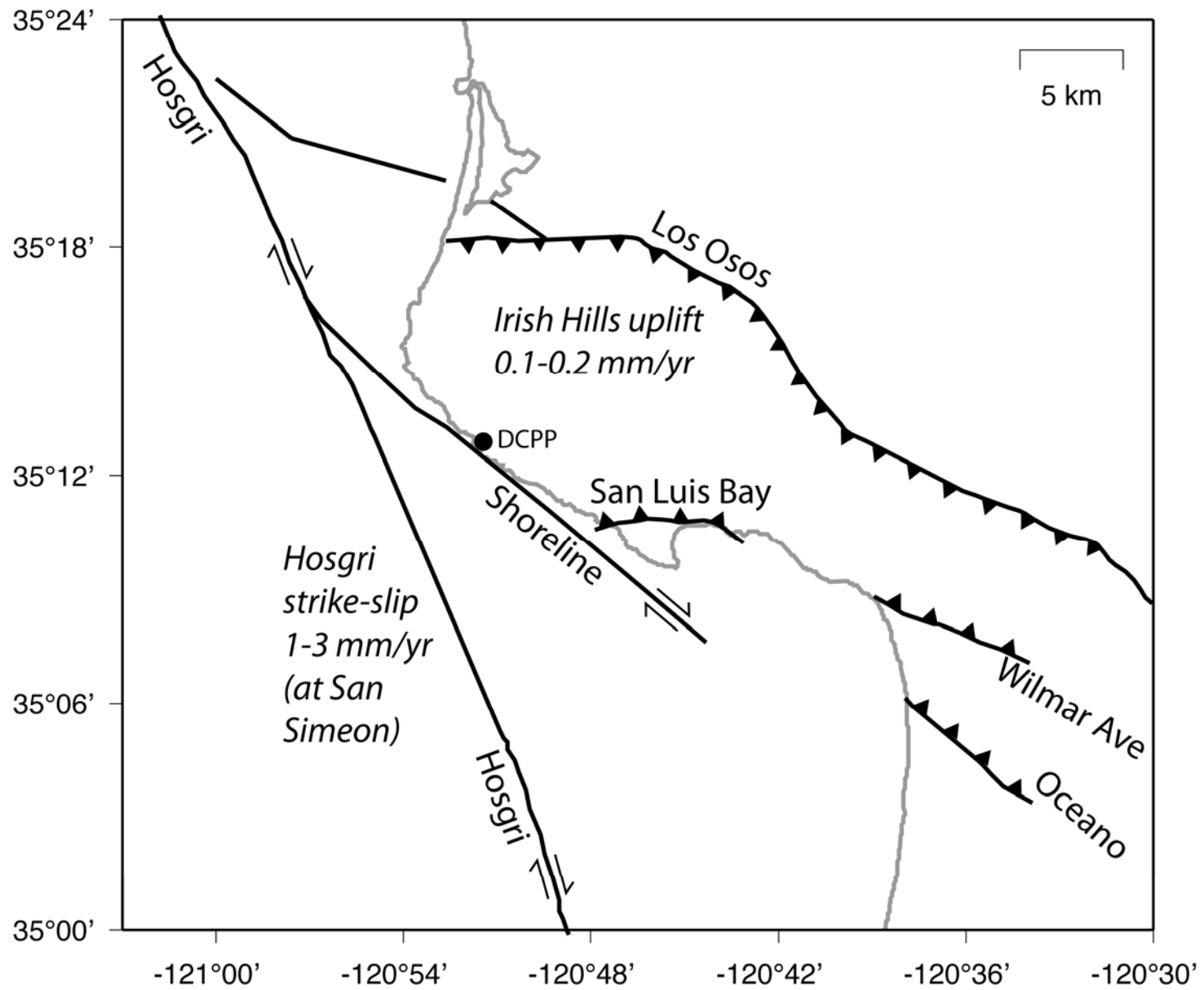
- Location
- Strike, Dip, Rake
- Length
- Connection to other faults

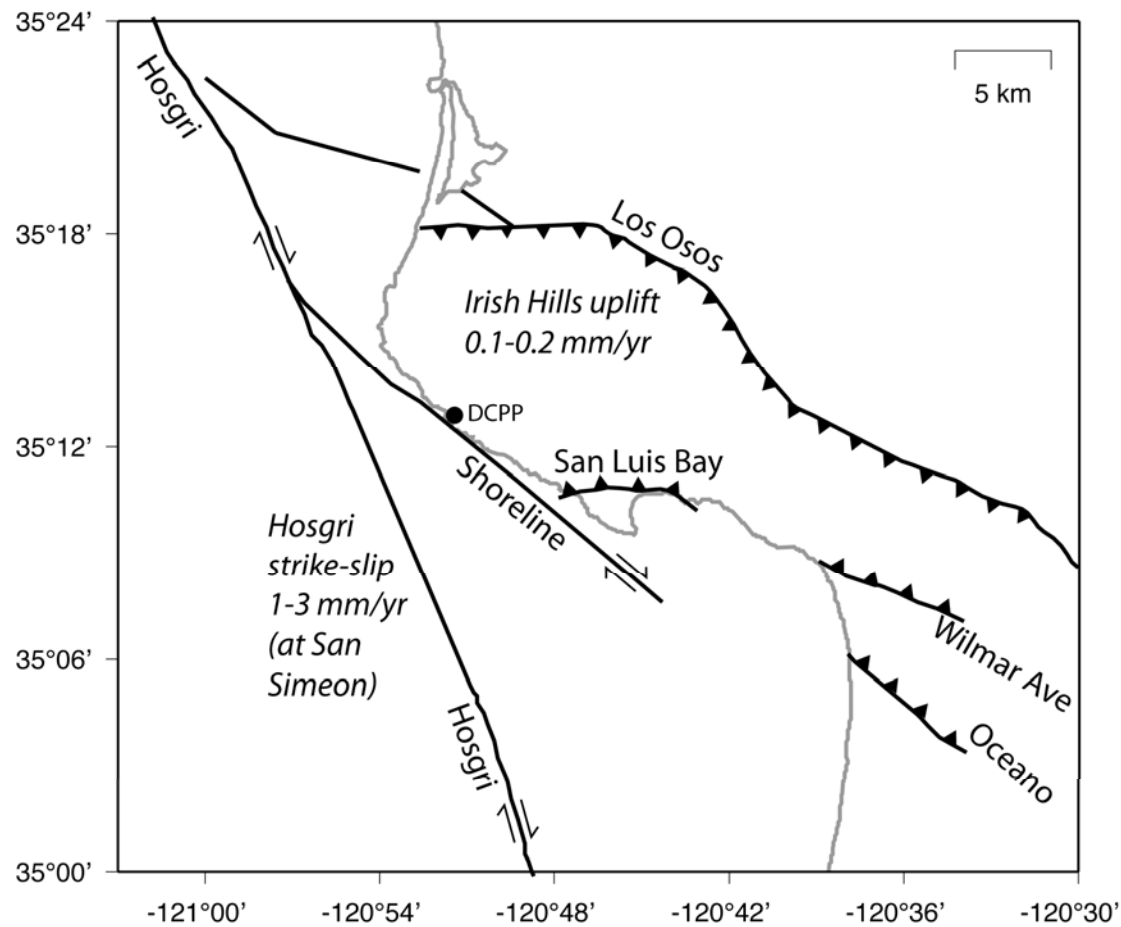
(2) Fault Slip Rate

- Offset geological features
- Past large earthquakes
- Geodesy (GPS, InSAR)



Known Faults Relevant to DCPD Seismic Hazard.

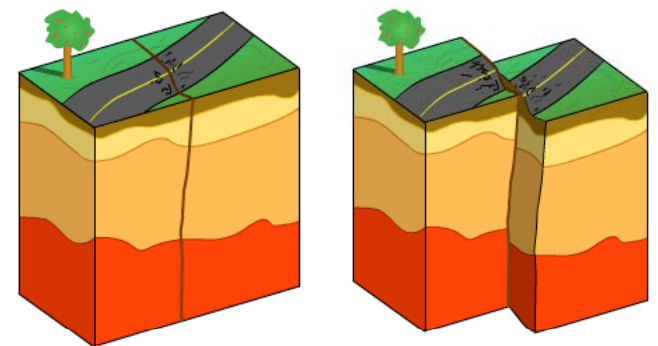




Strike-slip fault system:

Hosgri Fault

Shoreline Fault

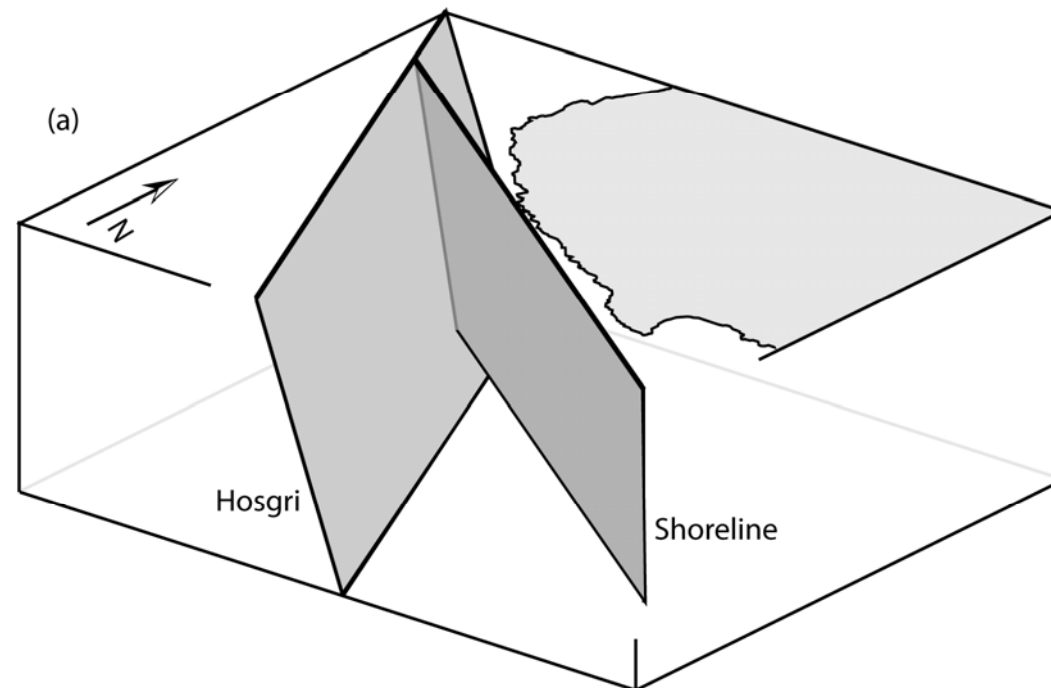


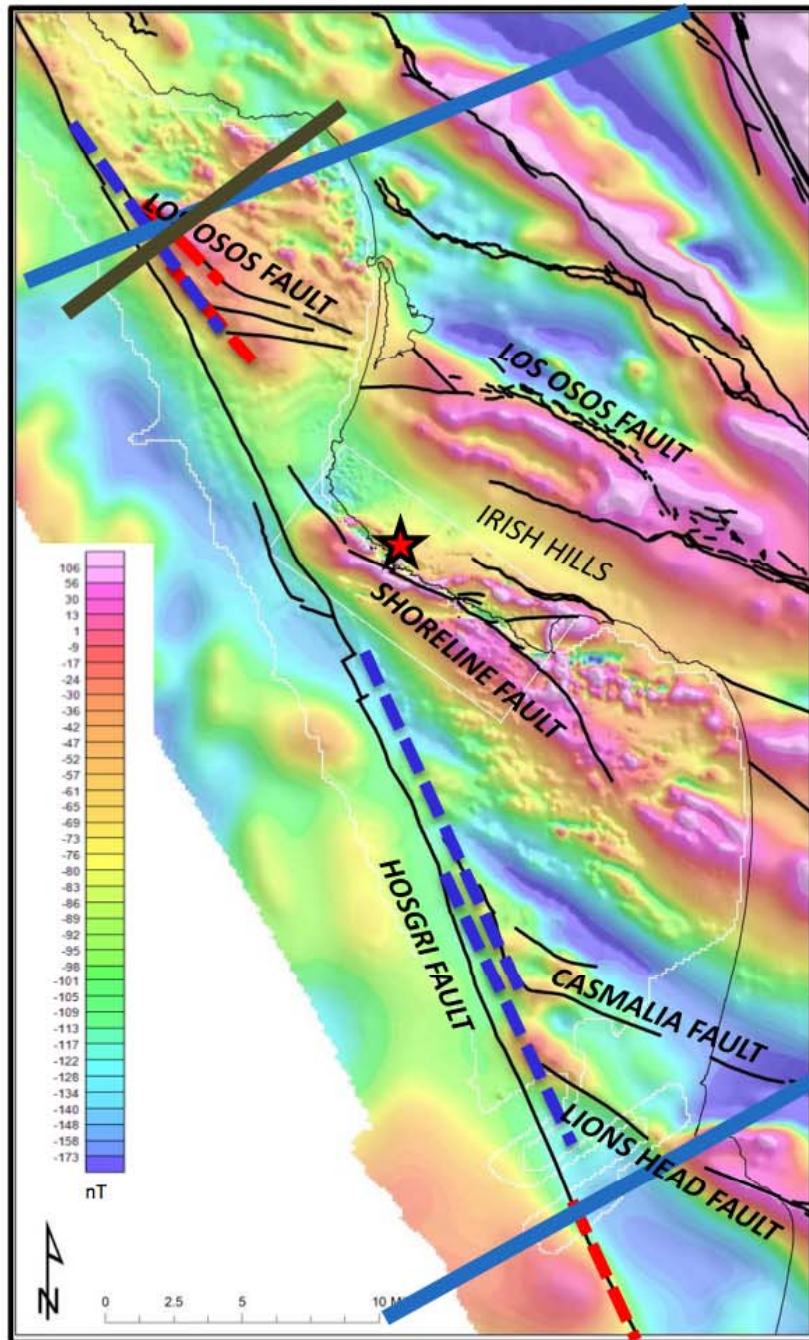
Geometry:

- Hosgri and Shoreline Faults both near-vertical, strike-slip motion.
- Hosgri and Shoreline Faults appear to join at earthquake depths, plausible they could rupture together.
- Southern end of Shoreline Fault unknown, connection to other faults to the south unknown.

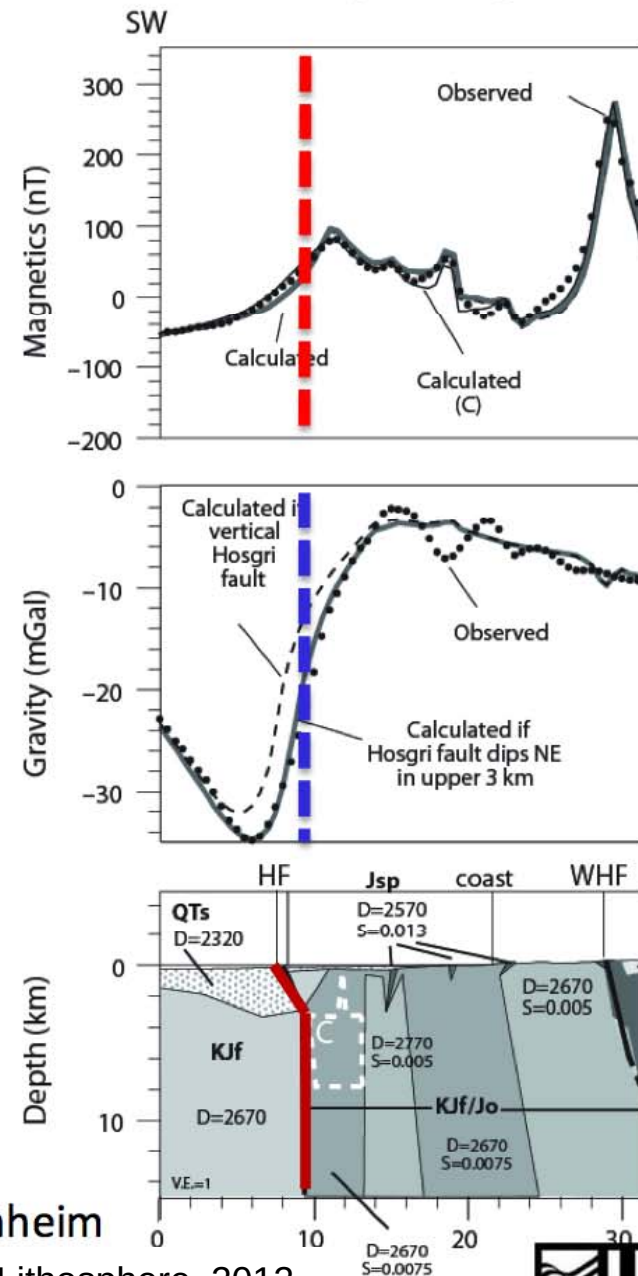
Slip Rate:

- Hosgri slip rate of 1-3 mm/yr from geologic observations near San Simeon.
- Shoreline slip rate poorly constrained.



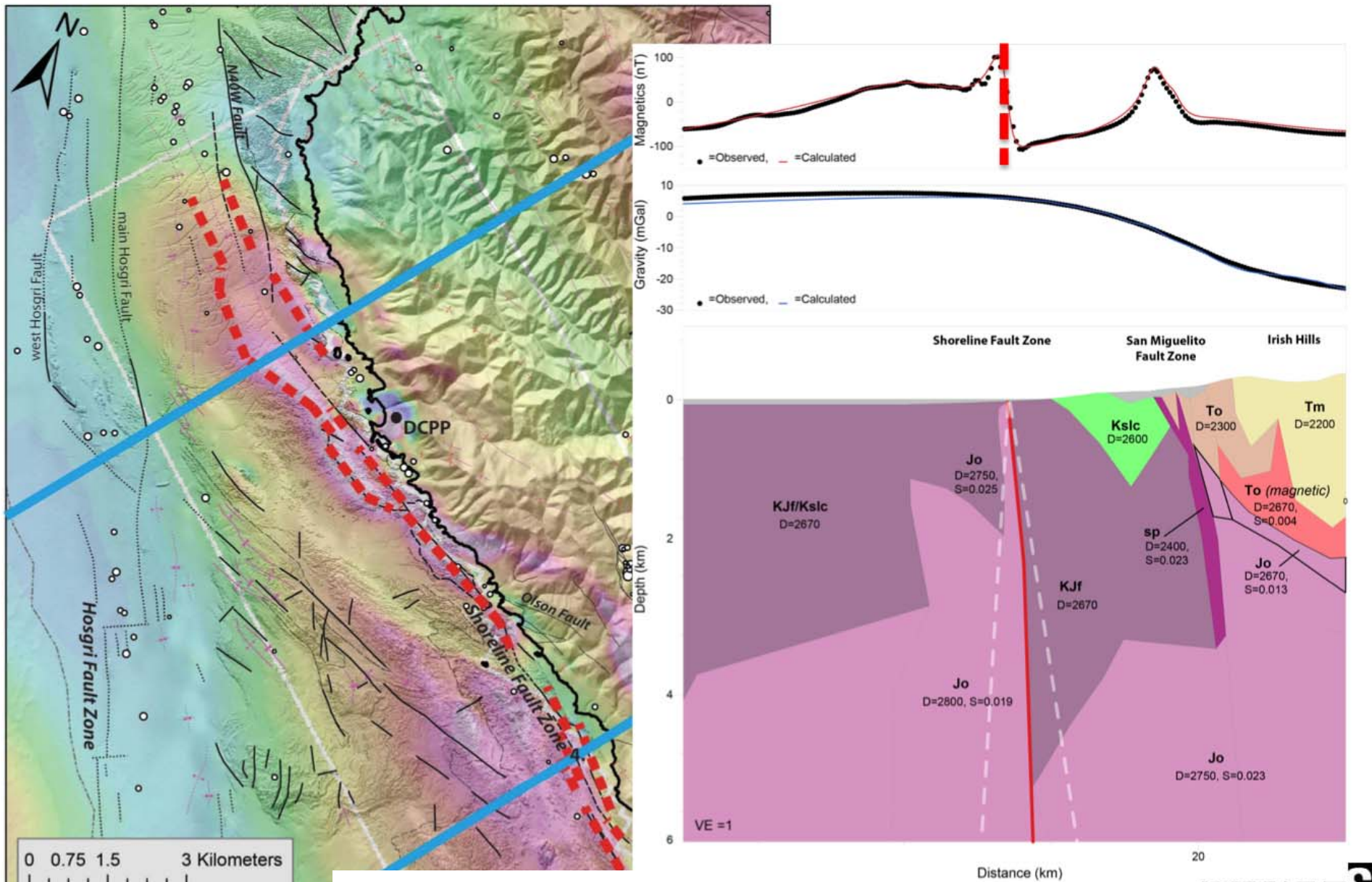


HOSGRI FAULT MODELS(V. Langenheim)



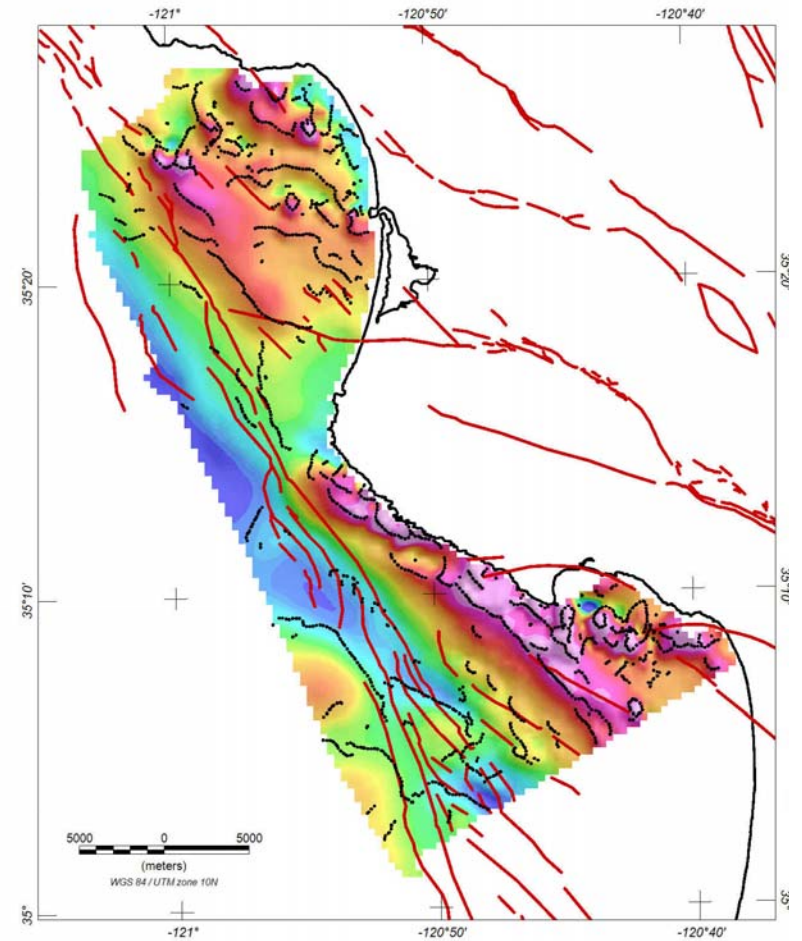
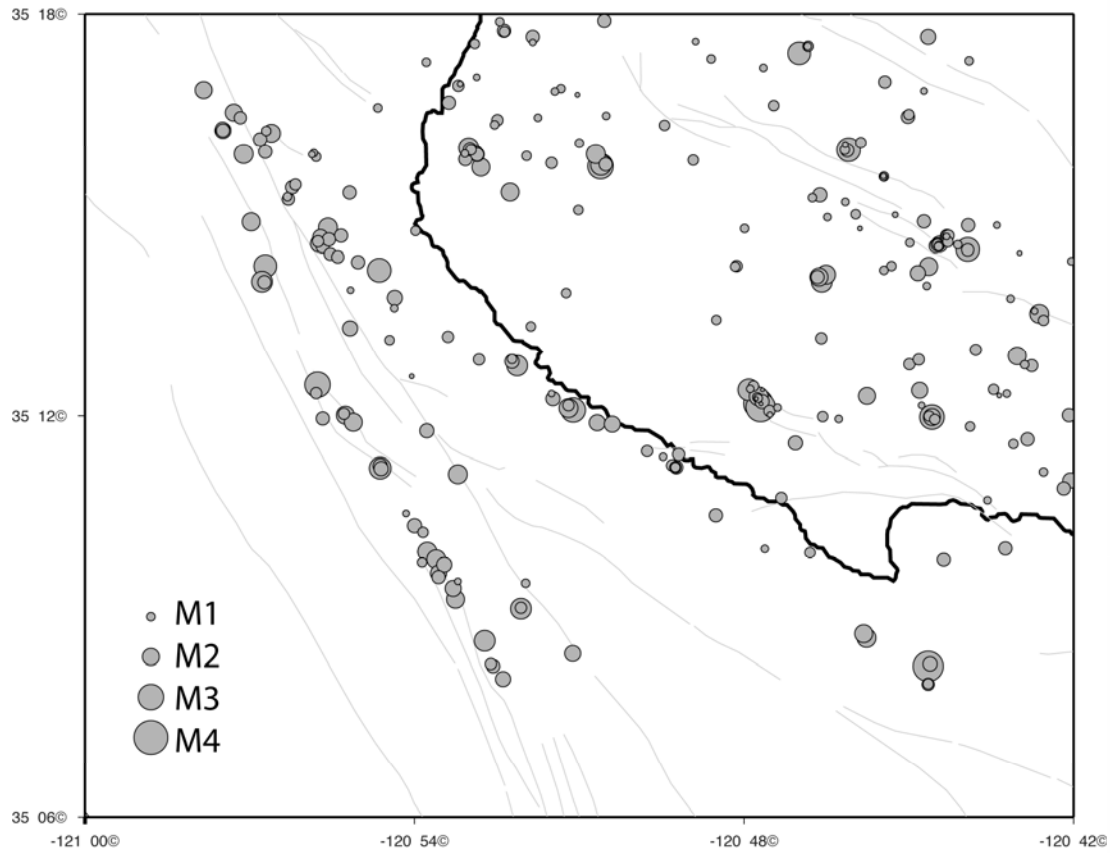
Langenheim
et al., Lithosphere, 2012

SHORELINE FAULT ZONE



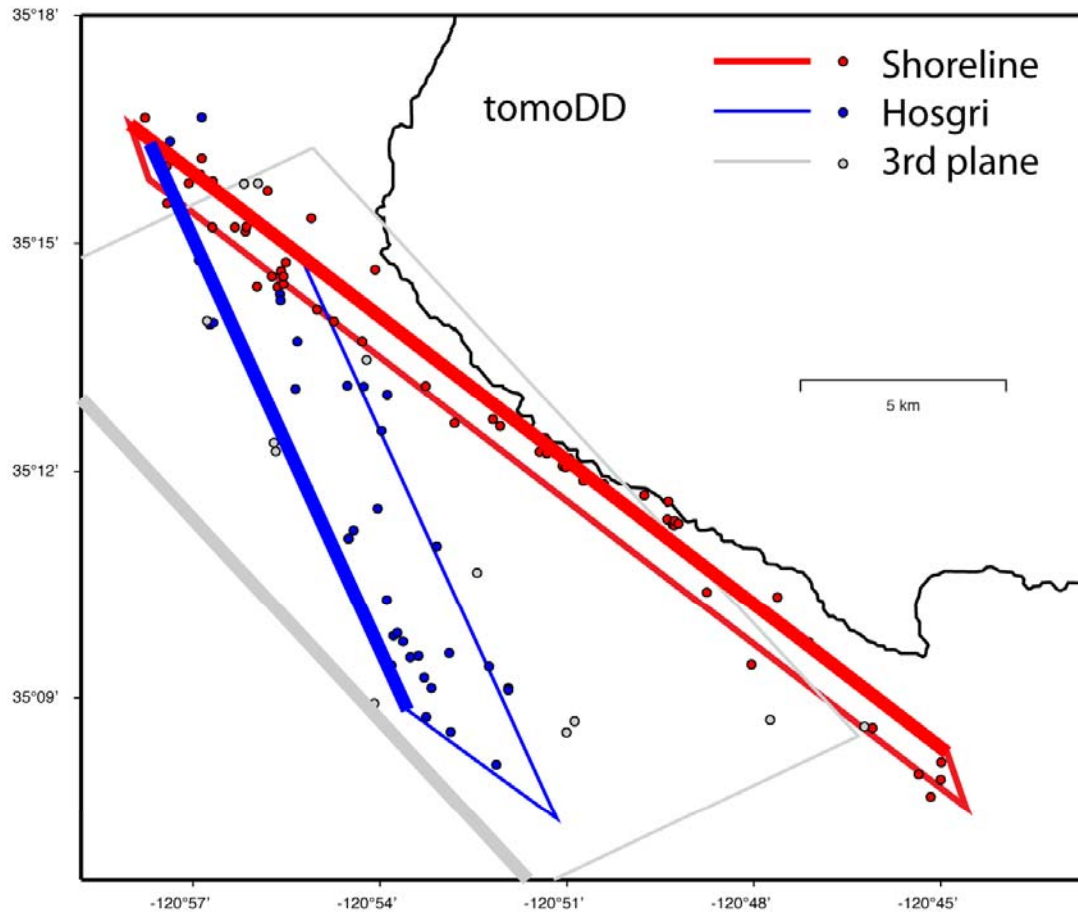
From J. Watt, SSHAC SSC Workshop 2

Southern End of Shoreline Fault?



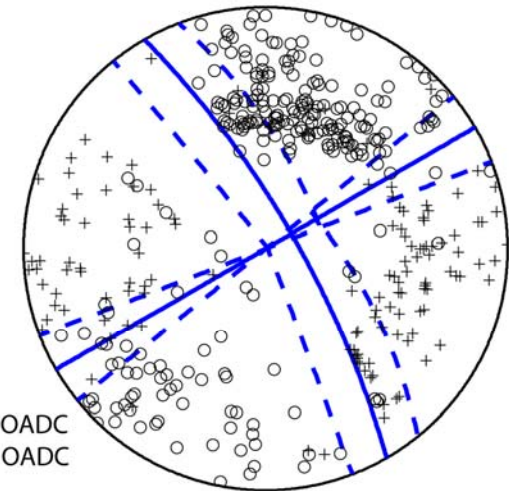
From J. Watt,
USGS.

Fault Geometry from Small Earthquakes

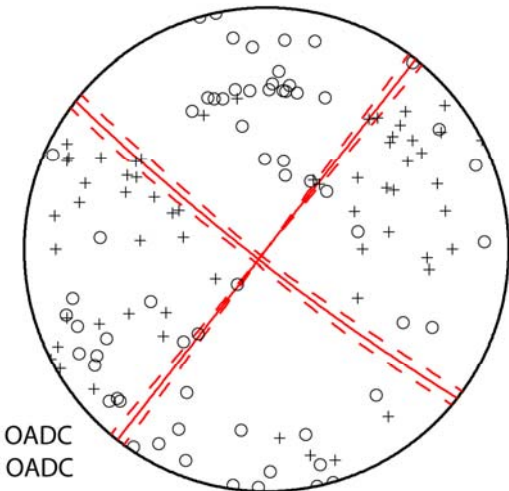


From Hardebeck, BSSA, 2013.

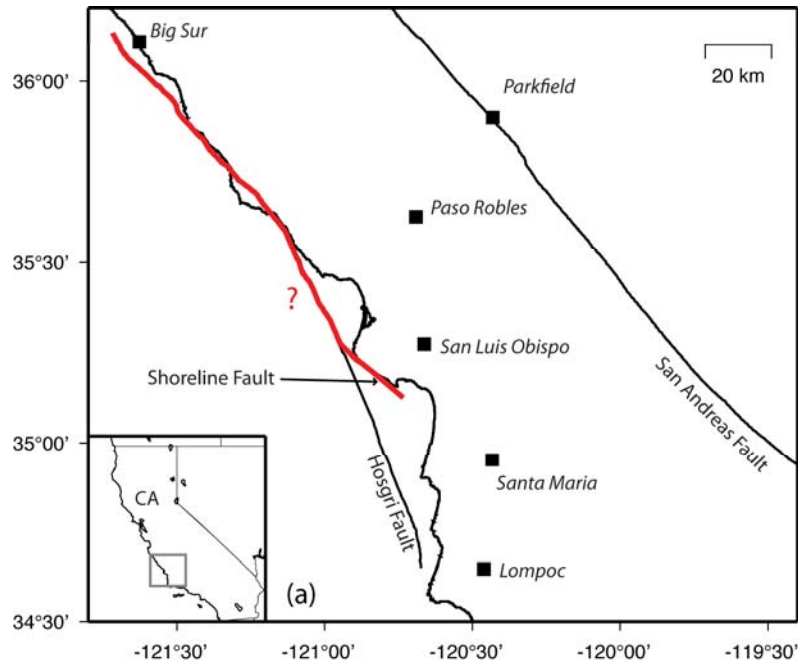
Hosgri (tomoDD)



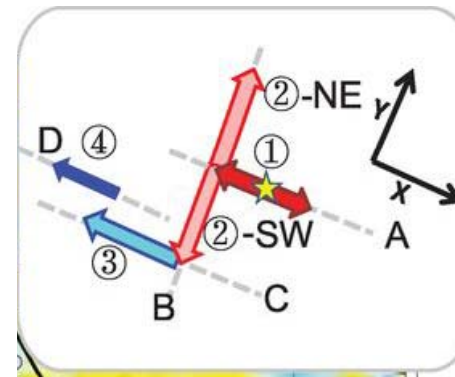
Shoreline (tomoDD)



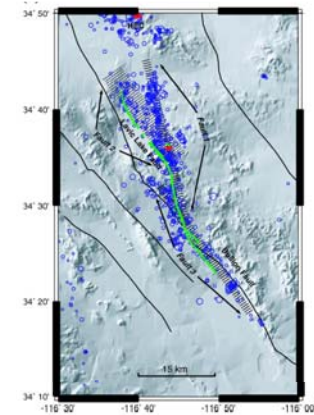
Multi-Fault Earthquakes.



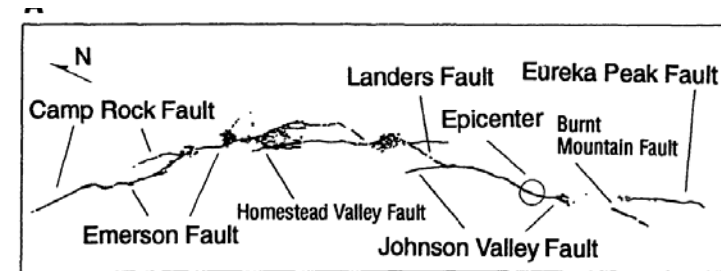
From J. Hardebeck,
SSHAC SSC Workshop 2



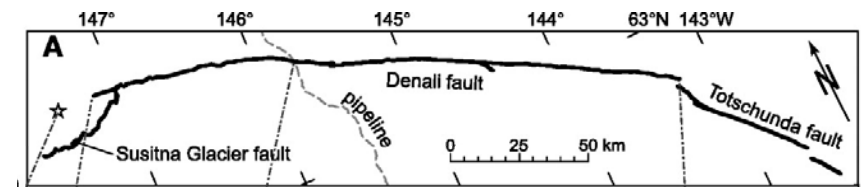
2012 Sumatra



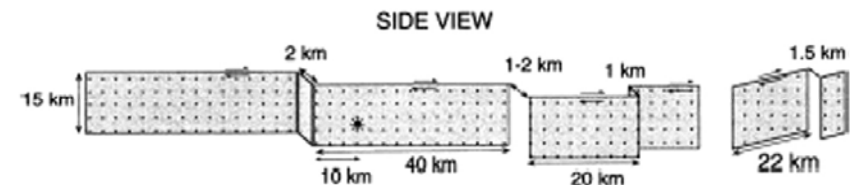
1999 California



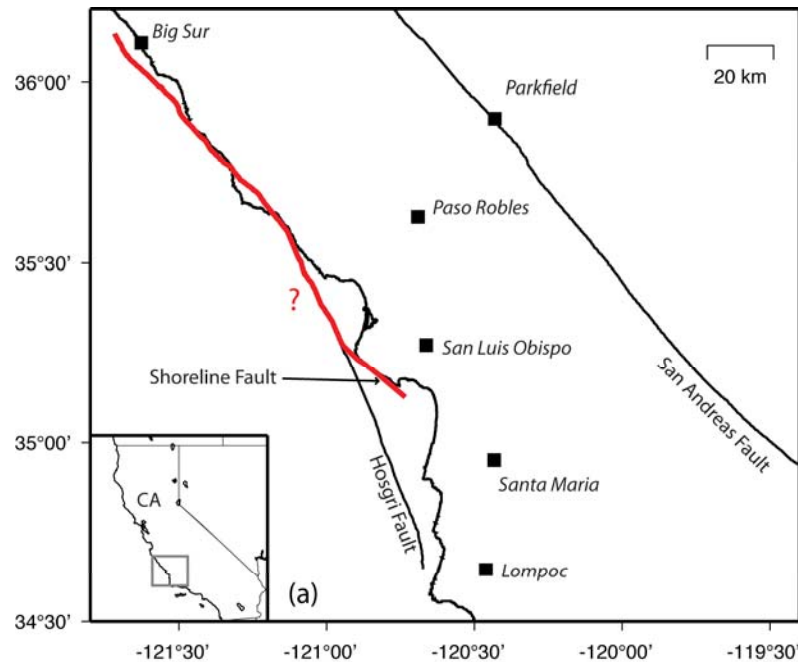
1992 California



2002 Alaska



1999 Turkey

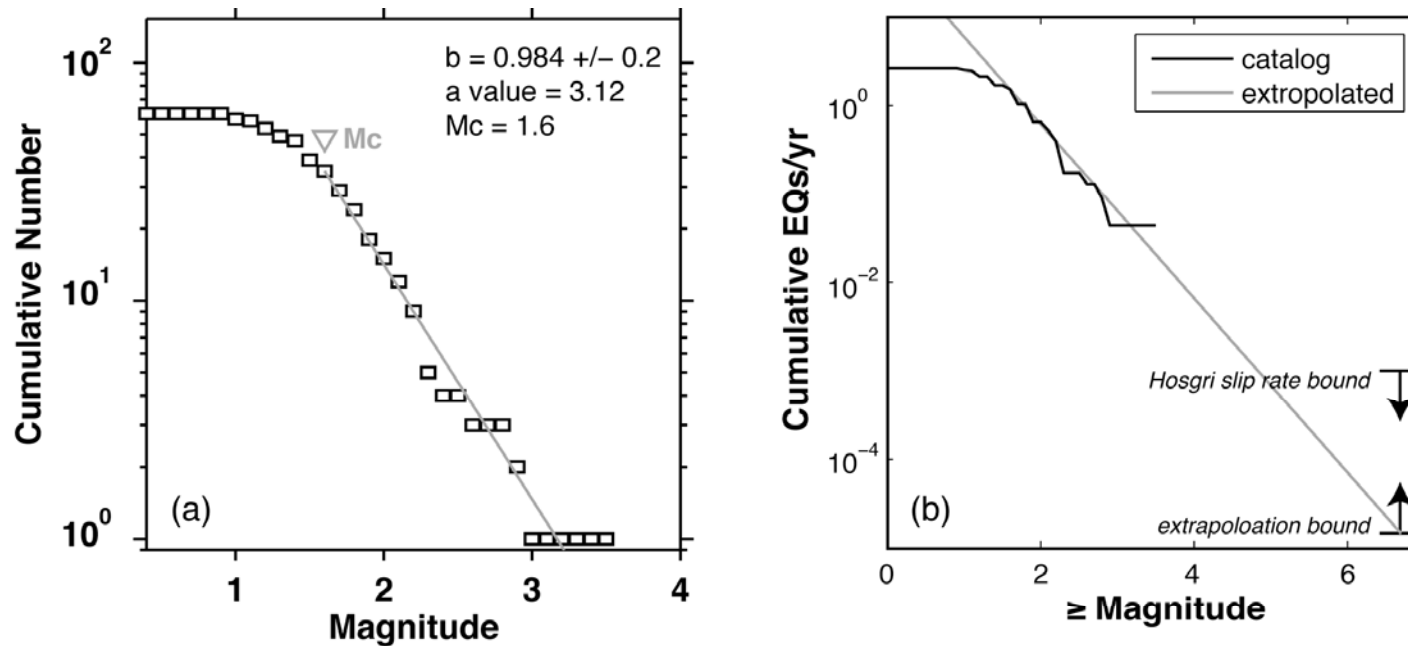


Estimated Maximum Magnitude Earthquake:

- Shoreline defined by seismicity:
 - $M_{\max} = 6.7$.
- Shoreline extended south to coast:
 - $M_{\max} = 6.8$.
- Hosgri, Lompoc to Big Sur:
 - $M_{\max} = 7.5$.
- Shoreline + Hosgri (pictured):
 - $M_{\max} = 7.2$.

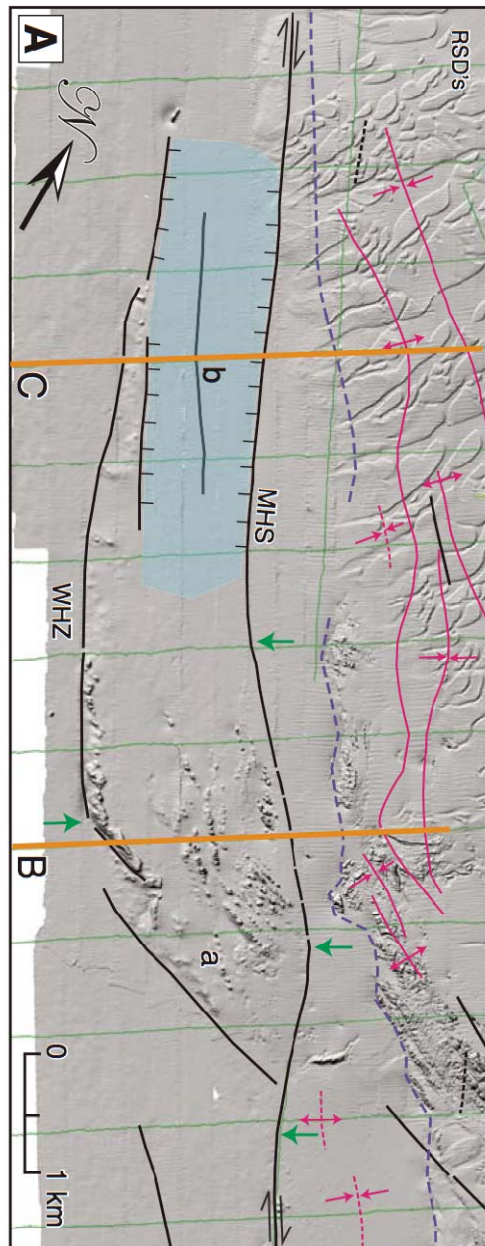
From Hardebeck, BSSA, 2013.

Weak bounds on Shoreline slip rate from small earthquakes.

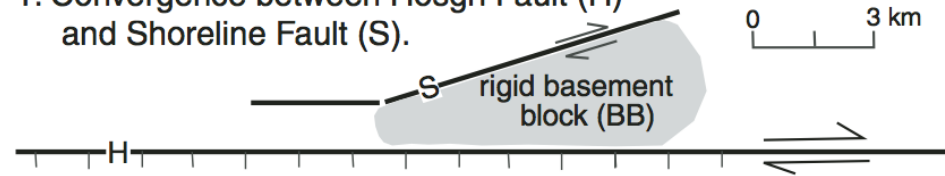


- Lower bound from extrapolation to $M_{\max}=6.7$.
- Upper bound assuming slip rate less than Hosgri.
- Slip rate: 0.04 mm/yr - 3 mm/yr.
- Recurrence time of M6.7 earthquakes: 1,000 yr - 67,000 yr.

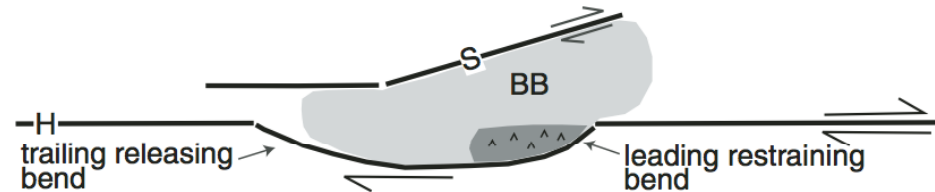
From Hardebeck, BSSA, 2013.



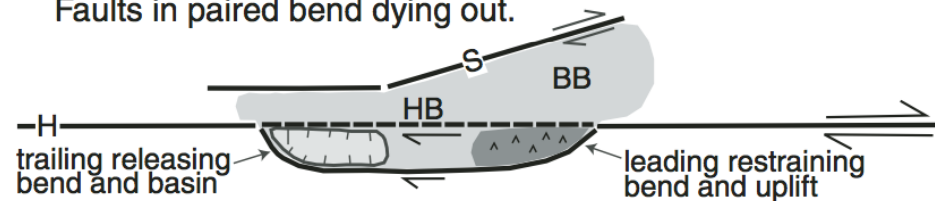
1. Convergence between Hosgri Fault (H) and Shoreline Fault (S).



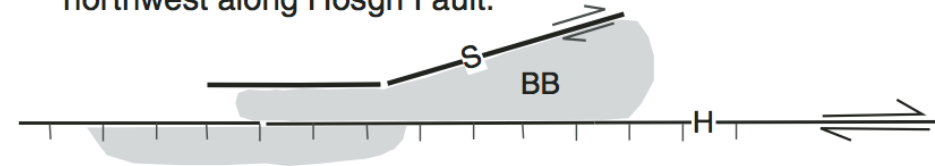
2. Basement block "indents" Hosgri Fault, forming "paired bend."



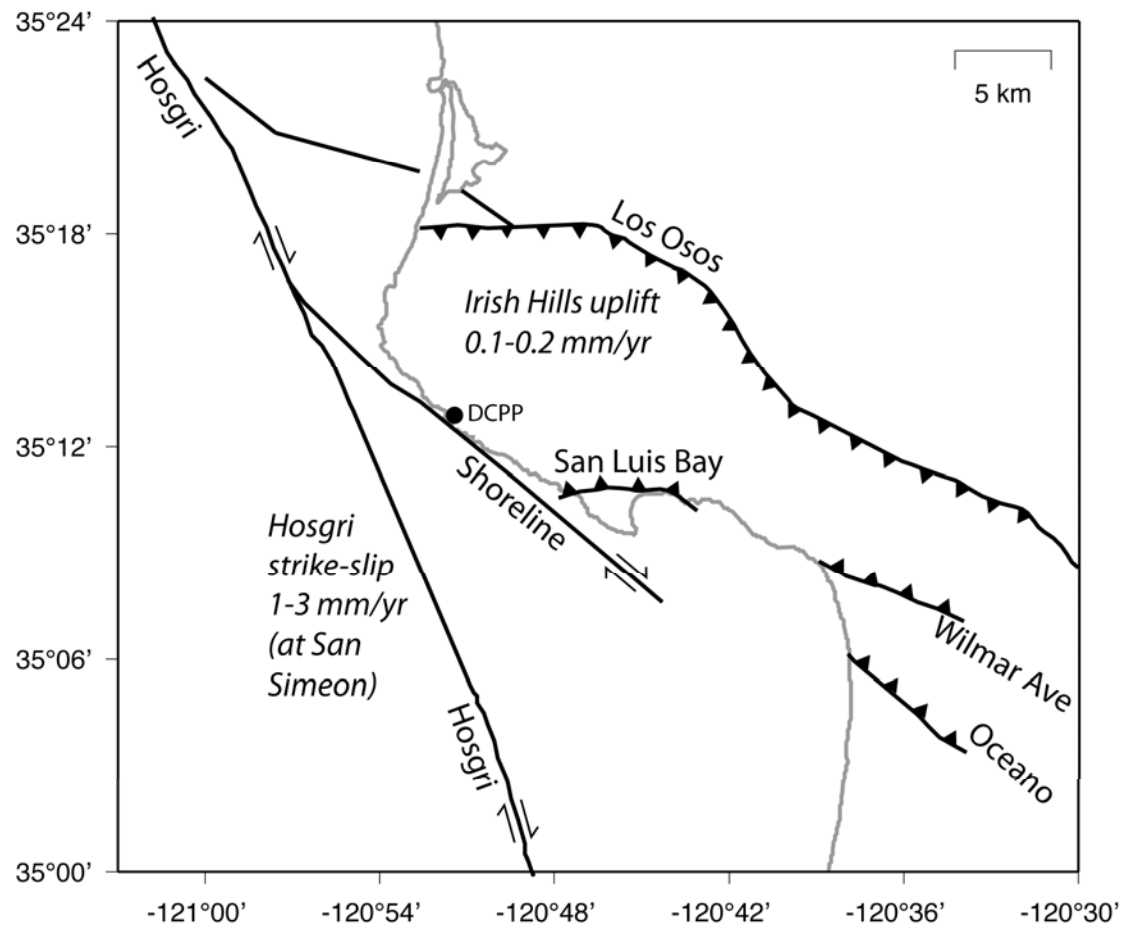
3. Hosgri "bypass" fault (HB) reactivates along original Hosgri trend. Faults in paired bend dying out.



4. "Captured" basement slice is downdropped, buried and translated northwest along Hosgri Fault.



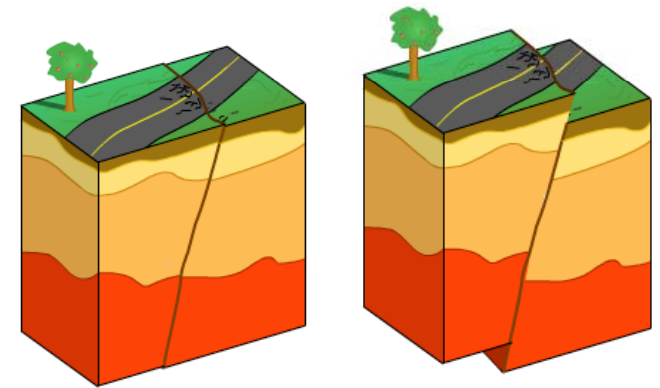
From Johnson and Watt, Geosphere, 2012.



Reverse fault system:

Uplift of Irish Hills:

- Los Osos Fault
- San Luis Bay Fault
- Others?

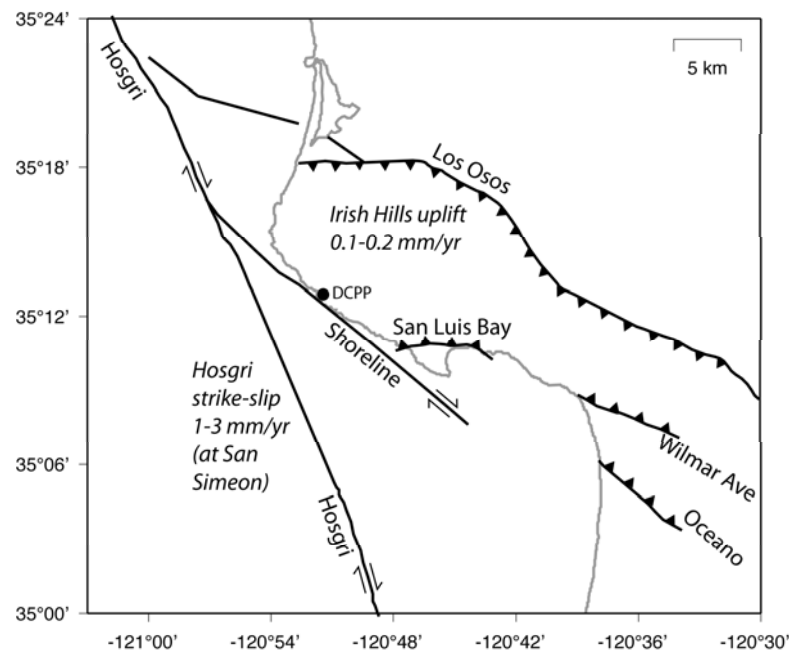


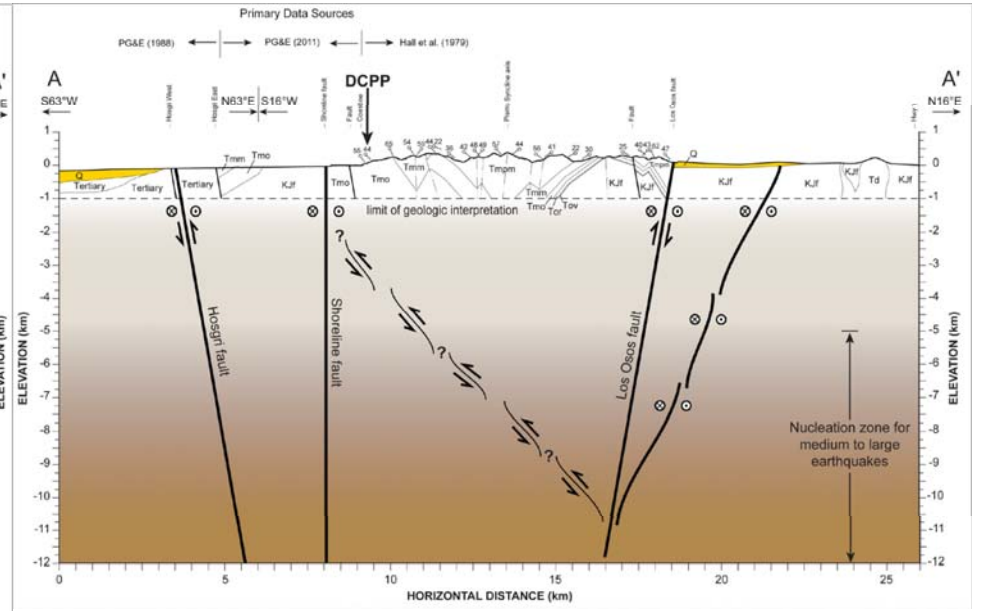
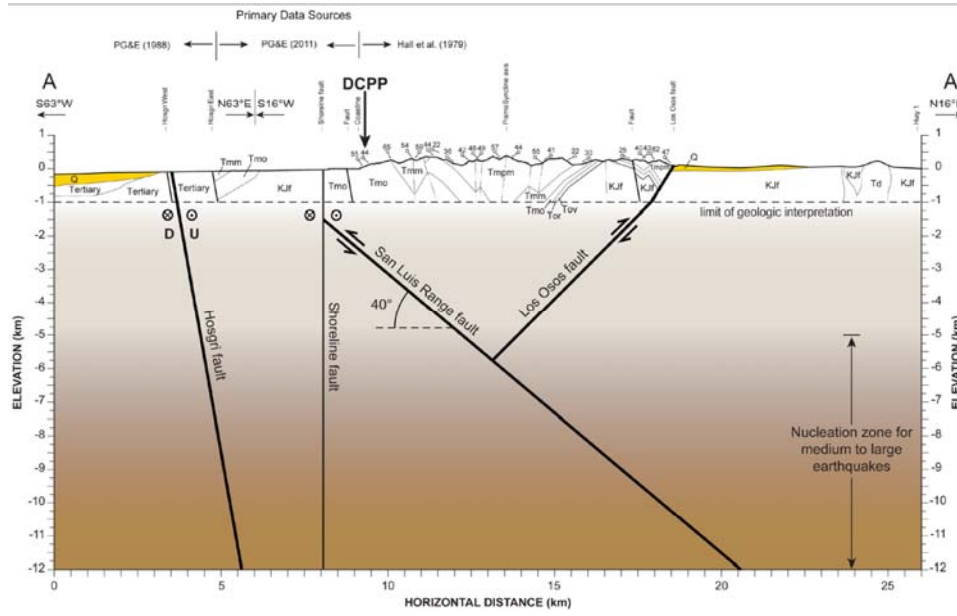
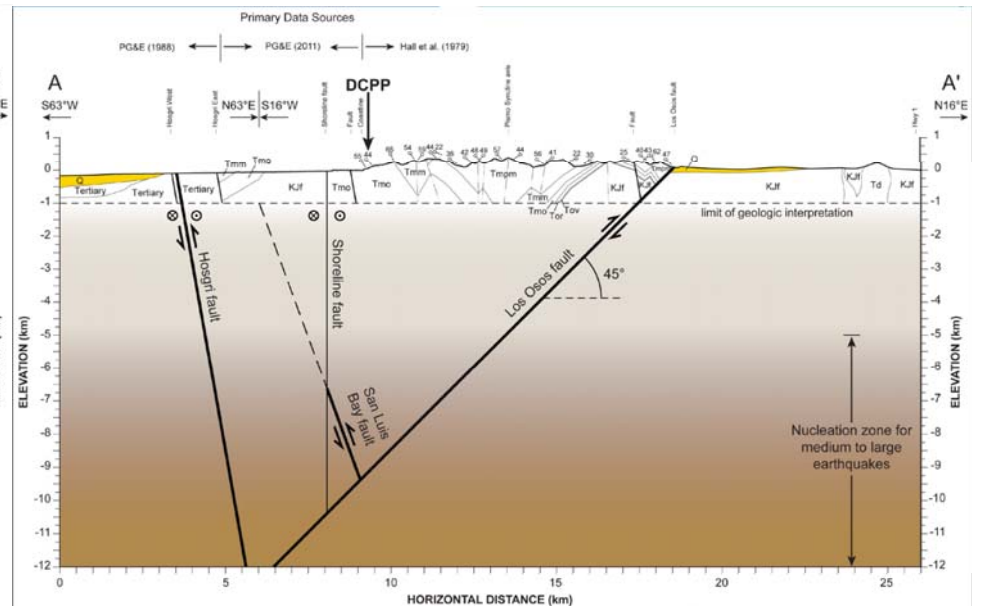
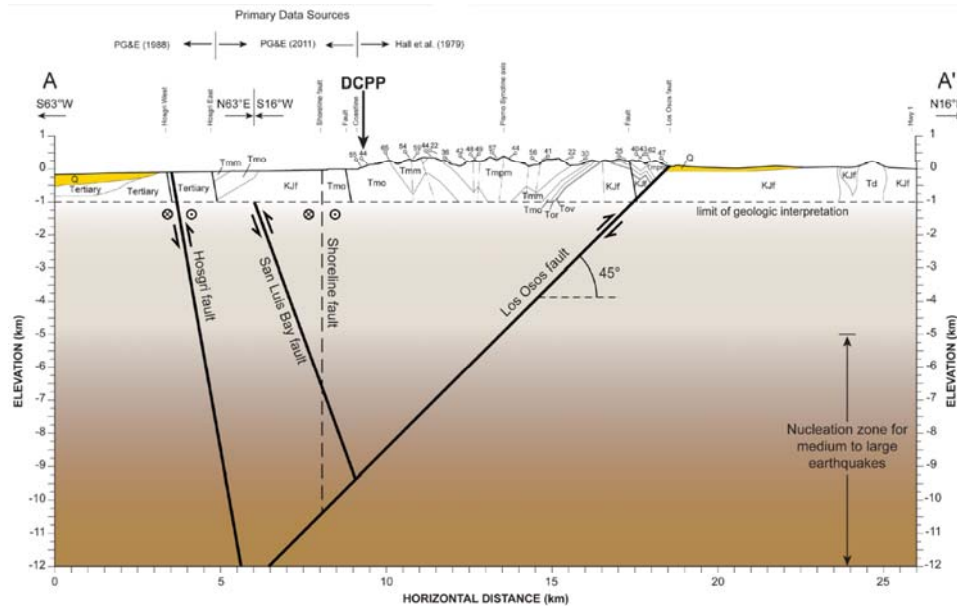
Geometry:

- Geometry of Los Osos and other faults of the Irish Hills poorly constrained at earthquake depths.
- Not clear what structures accommodate the uplift of the Irish Hills on the southwestern side.

Slip Rate:

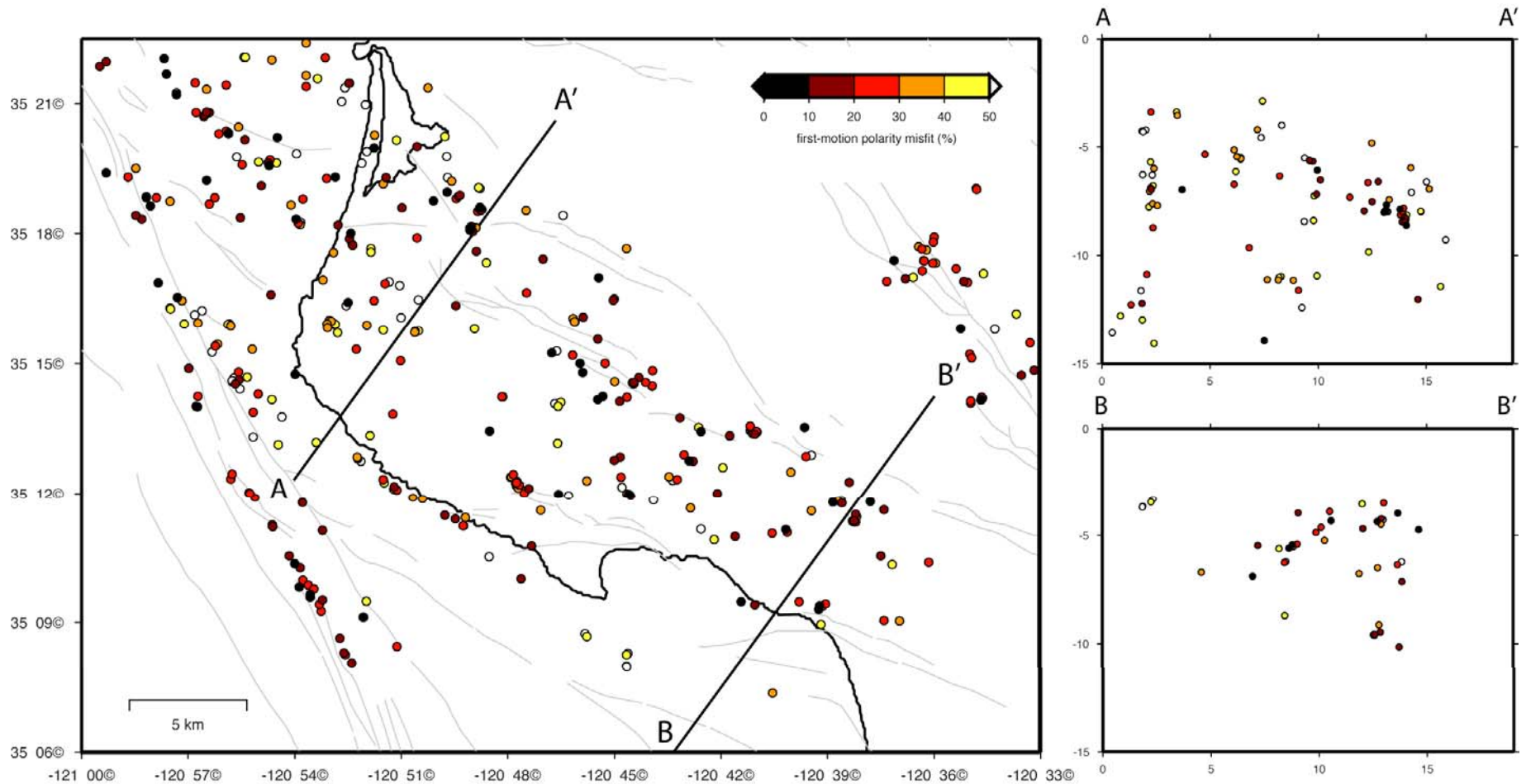
- Uplift rate of 0.1-0.2 mm/yr from geologic observations in Irish Hills.
- Slip rate of faults follows from uplift rate, depends primarily on dip.





From W. Lettis SSHAC SSC Workshop 2

Fault Geometry Poorly Constrained by Small Earthquakes



From J. Hardebeck, SSHAC SSC Workshop 2

Major Sources of Uncertainty & Possible Further Work:

1. Fault geometry beneath the Irish Hills:
 - Imaging – seismic imaging, gravity, magnetics.
 - Geology – further study of known faults.
 - Improved interpretation of small earthquakes.
2. Slip rate of Shoreline Fault:
 - Search for datable offset geological features – shallow (low energy) seismic imaging, high-resolution bathymetry.
 - Ocean-bottom GPS (expensive, slow.)
3. Southern end of Shoreline Fault, connection to other faults:
 - Imaging south of known fault – seismic imaging, high-resolution bathymetry, gravity, magnetics.

