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Mechanical Models of the Southern San Andreas Fault

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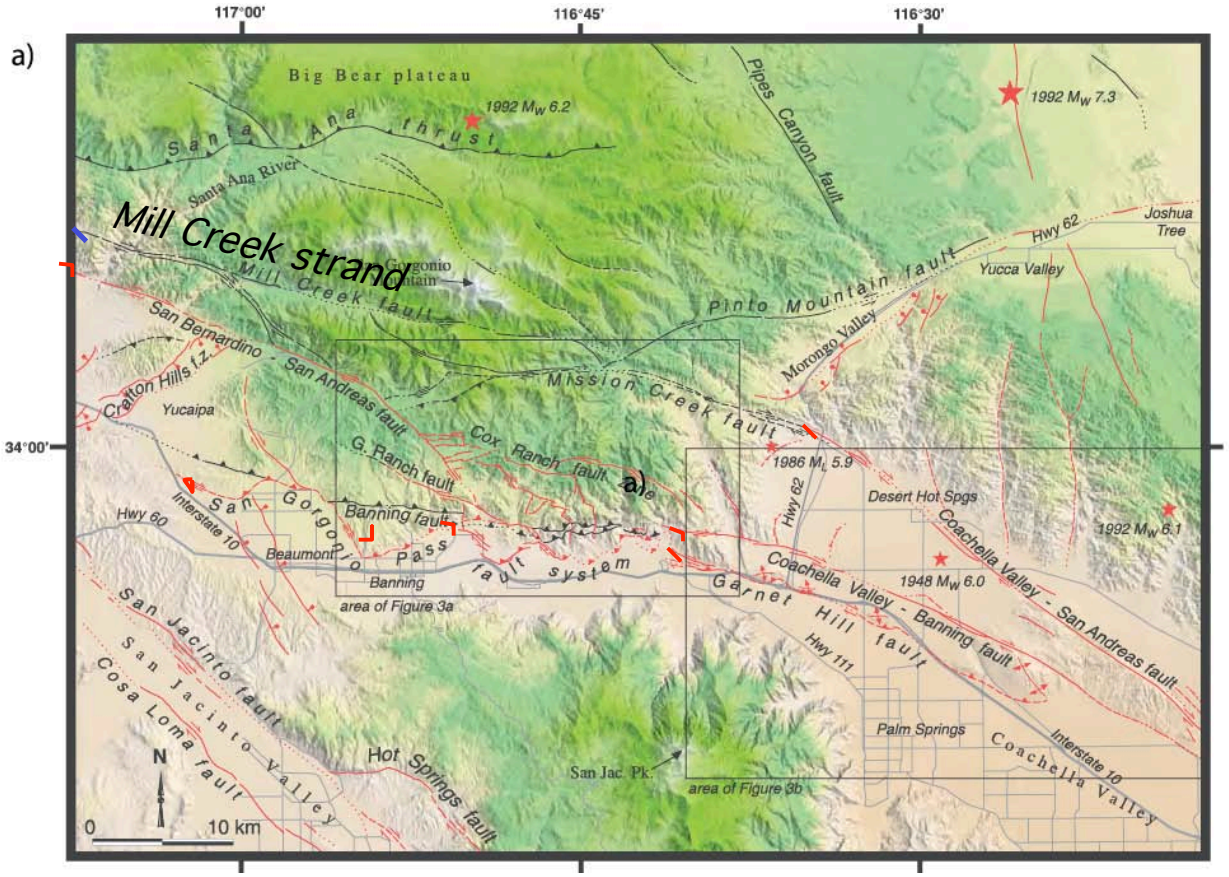
SAF Models!

- Forward Mechanical Models
  - BEM: *e.g. Du & Aydin (1996); Cooke & Dair (2011), Herbert & Cooke (in press)*
  - FEM: *e.g. Bird & Kong (2004), Smith & Sandwell (2003); Li & Liu (2006)*
- Inversions for slip rates
  - GPS: *Bennett et al (1996); Meade and Hager, 2005; Johnson et al. (2007); Spinler et al. (2010); Loveless and Meade 2011)*
  - GPS and focal mechanisms: *Becker et al. (2005)*
  - InSar & GPS: *Fialko (2006)*
- Inversions for stress
  - *Parsons (2006)*

Active fault geometry through the San Gorgonio Pass



95 ka soils are not offset by the Mill Creek strand of the San Andreas Fault (Kendrick et al., 2011 SCEC mtg.)

Active geometry, Garnet Hill – San Gorgonio Pass Thrust (SGPT), highlighted in red

From the award winning paper, Yule & Sieh, 2003

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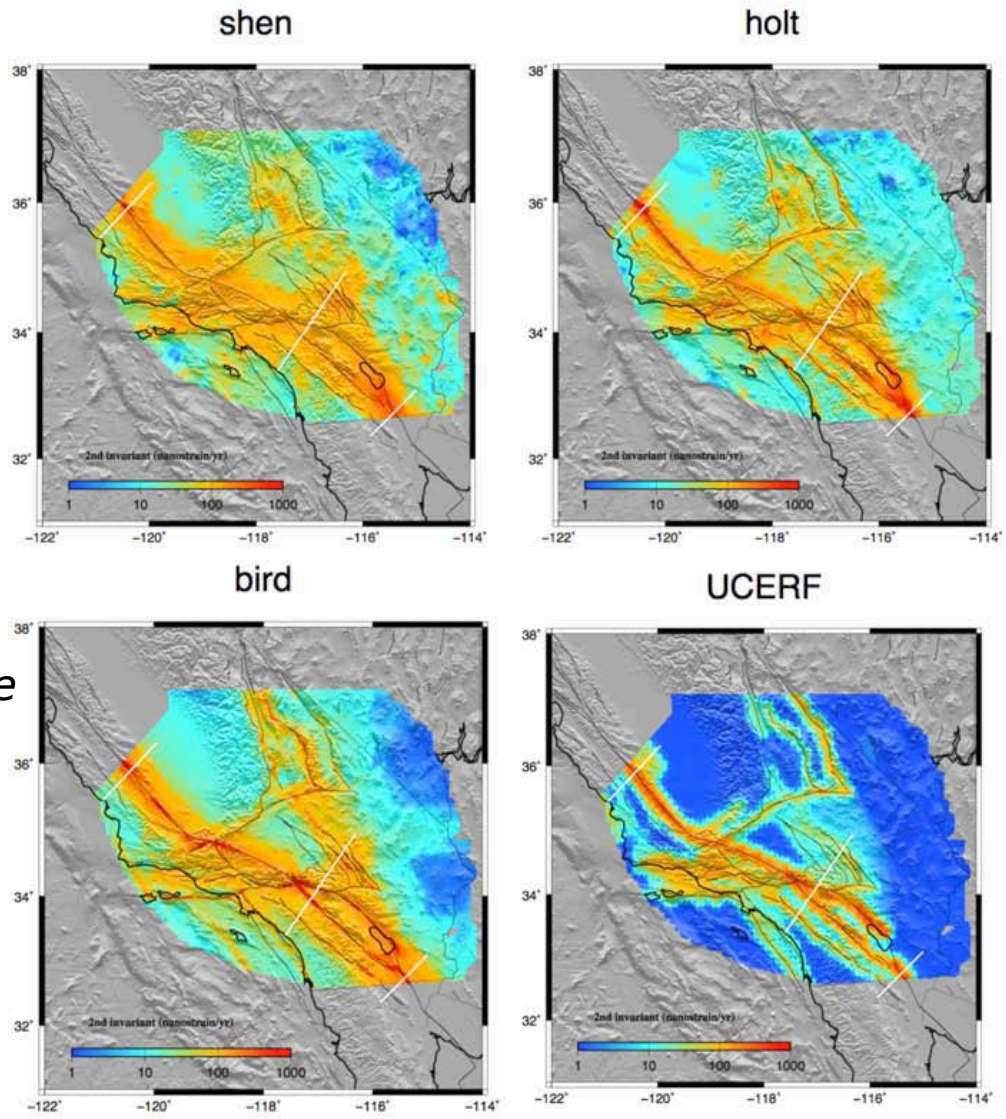
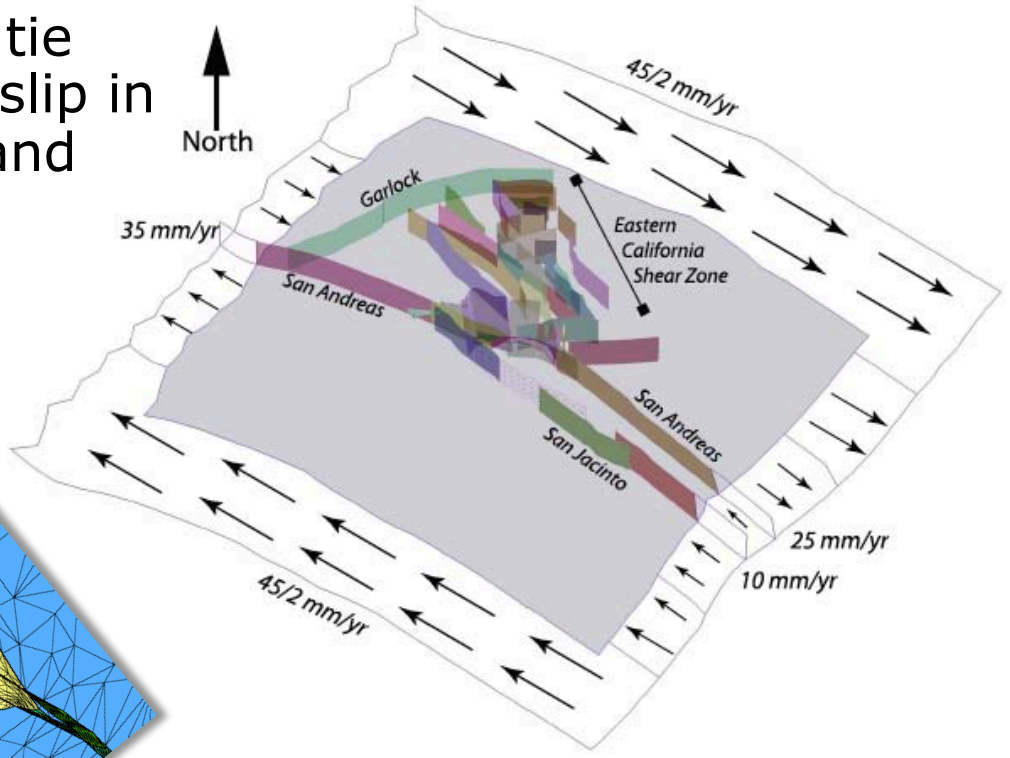
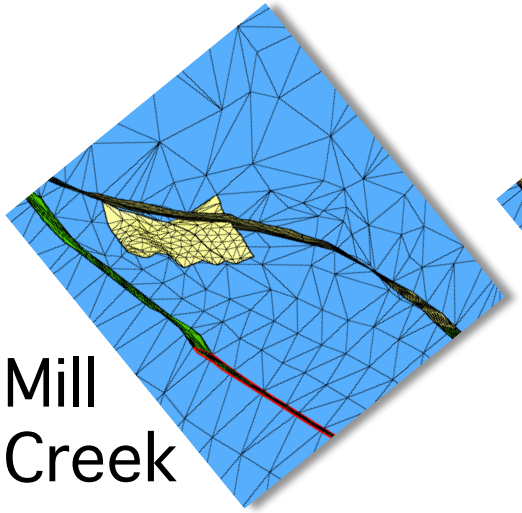


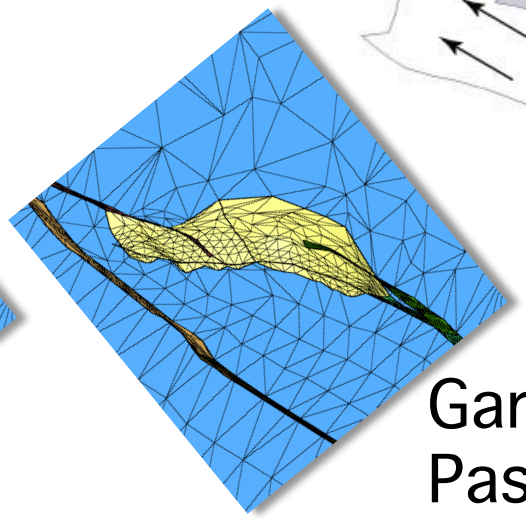
Boundary Element Method (BEM) Model Set Up

- Plate motions applied at the edges of the model.
- Faults are freely-slipping and tie into horizontal detachment – slip in response to tectonic loading and interaction with other faults
- Faults defined with triangular elements ~ 4km diameter
- 63 faults





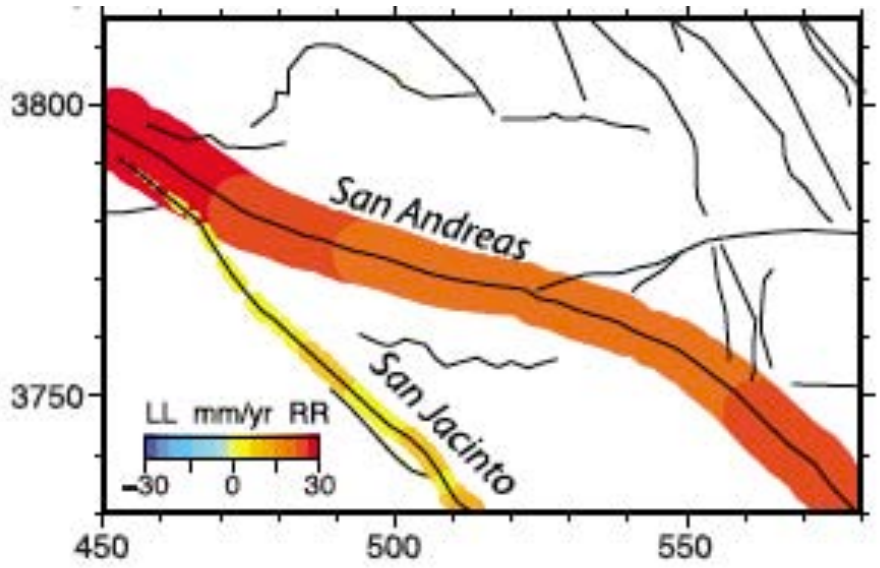
Mill Creek



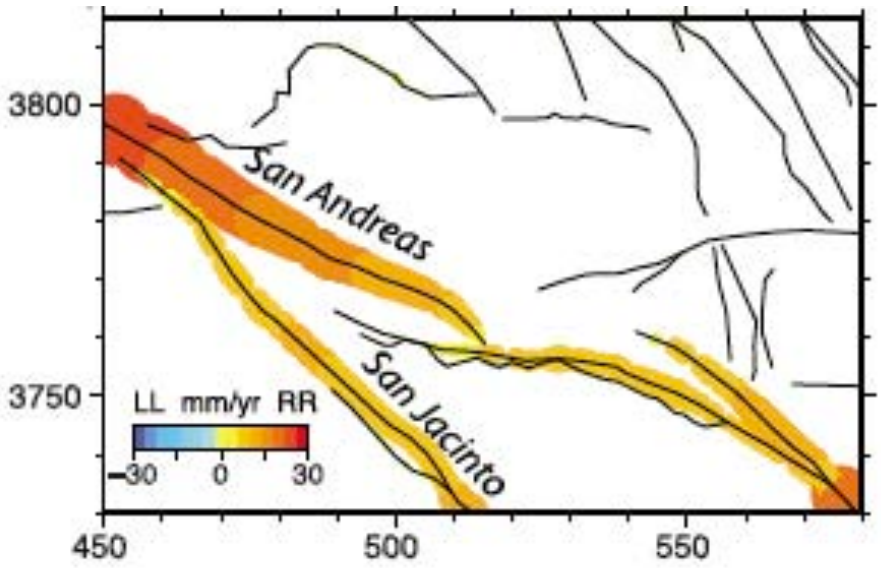
Garnet Hill - San Gorgonio Pass Thrust (SGPT)

Slip Rates

Mill Creek



Garnet Hill - SGPT



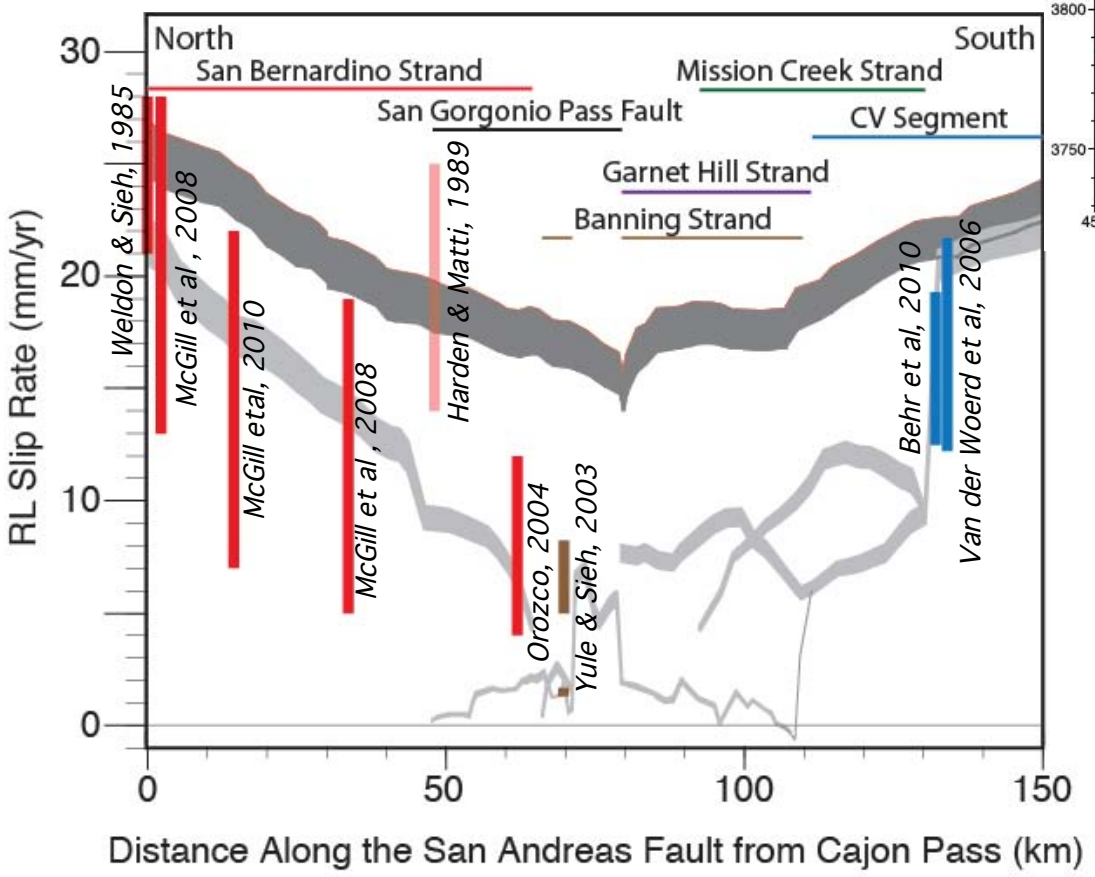
- Mill creek geometry may overestimate SAF strike slip by as much as 300%

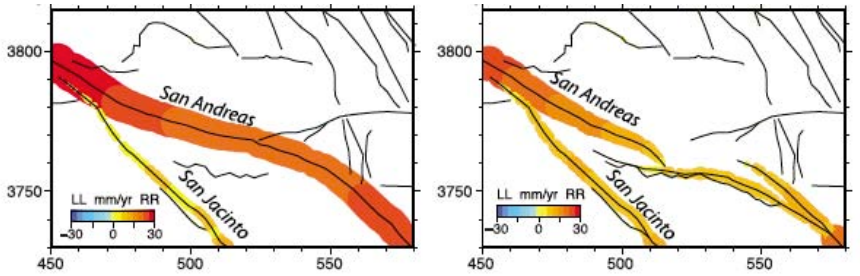
Increasing slip on the SAF results in decreases slip on the San Jacinto though they are not hard linked at Cajon Pass

Co-dependent a la Bennett et al., 2004

From: Cooke and Dair, 2011 JGR

Strike-Slip rates along the SAF through the San Gorgonio Pass





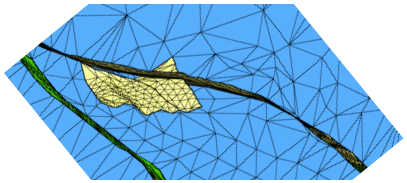
- The Mill Creek model does not match strike-slip rates along the San Bernardino strand of the SAF

Mill Creek

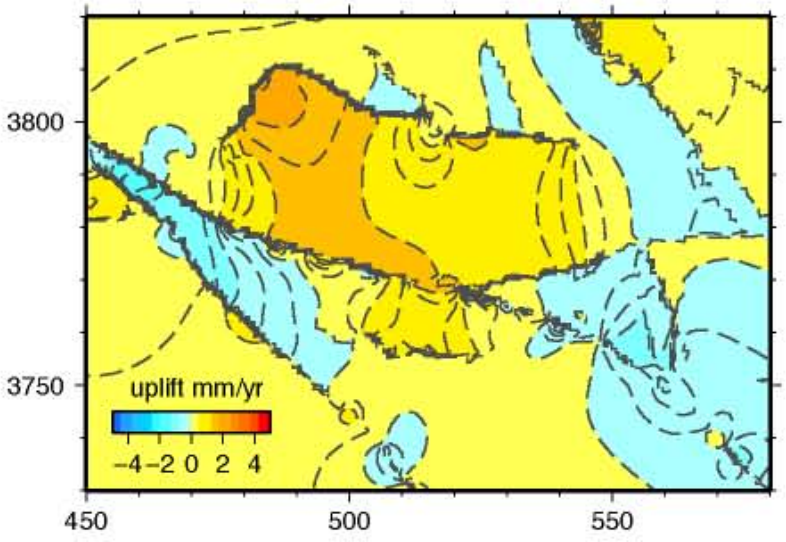
Garnet Hill - SGPT

From: Cooke and Dair, 2011 JGR; Herbert and Cooke, in press

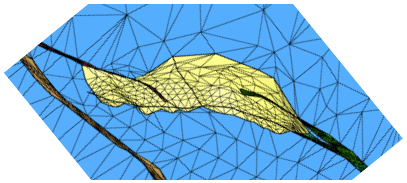
Sensitivity of uplift to fault geometry



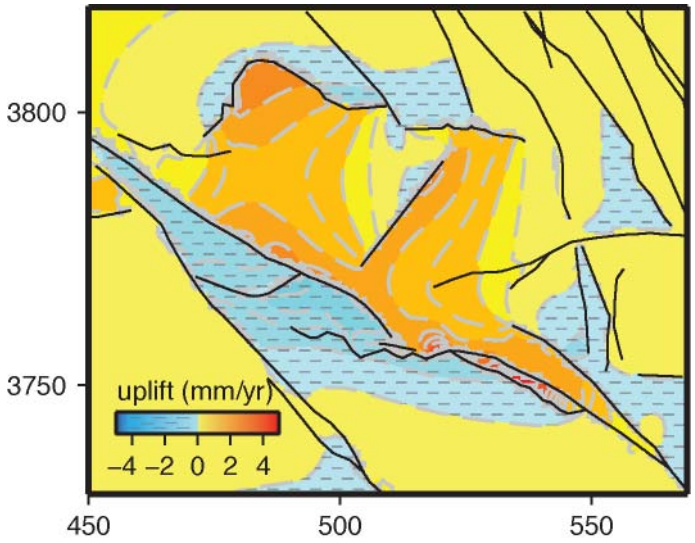
Mill Creek



From: Cooke and Dair, 2011 JGR



Garnet Hill - SGPT

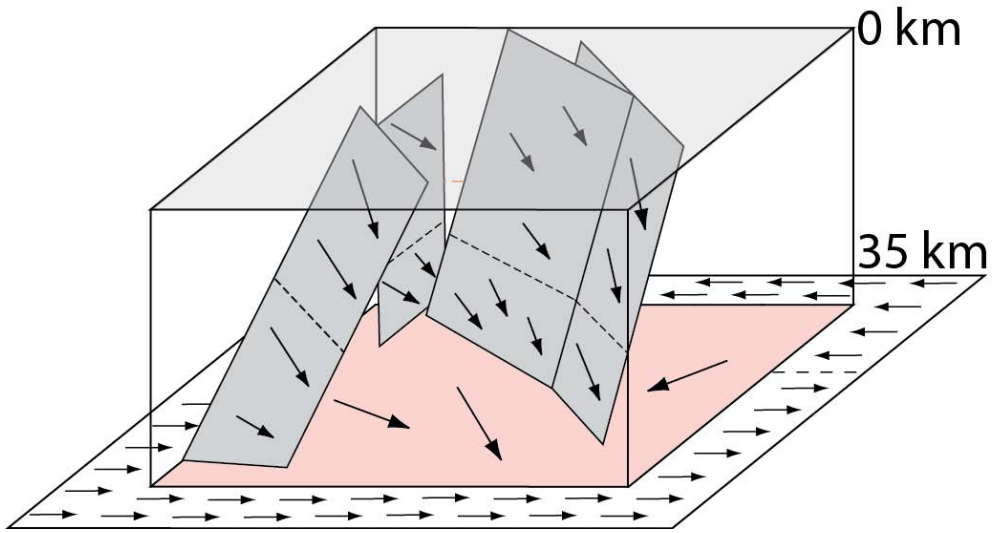


From: Herbert and Cooke, 2012 BSSA

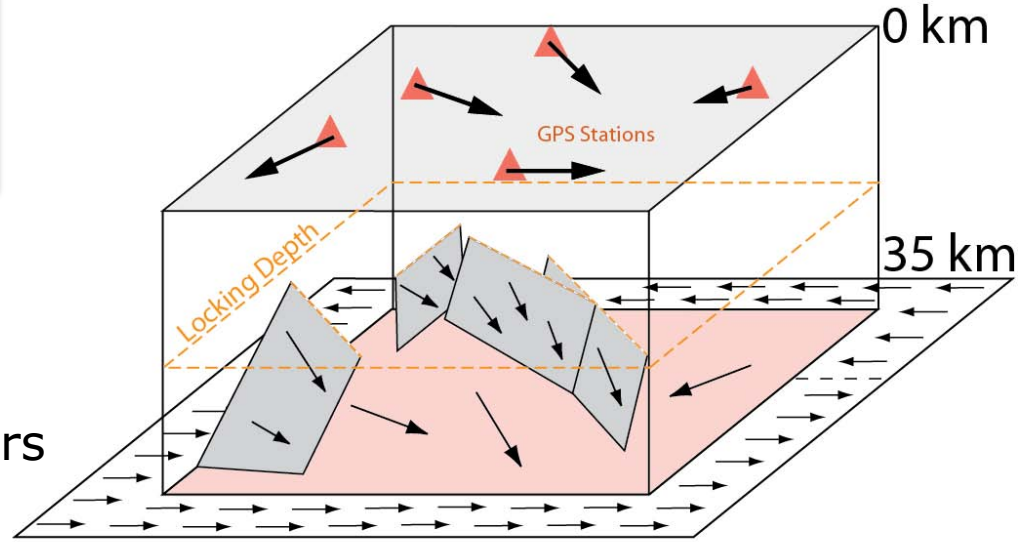
Uplift with isostatic correction

Interseismic Model

- Back slip approach
  - Slip from geologic time-scale model applied below locking depth

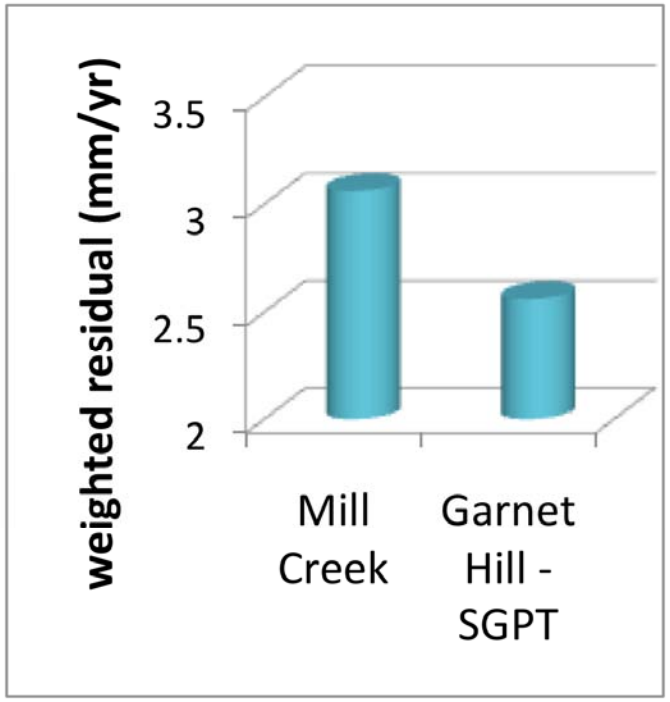


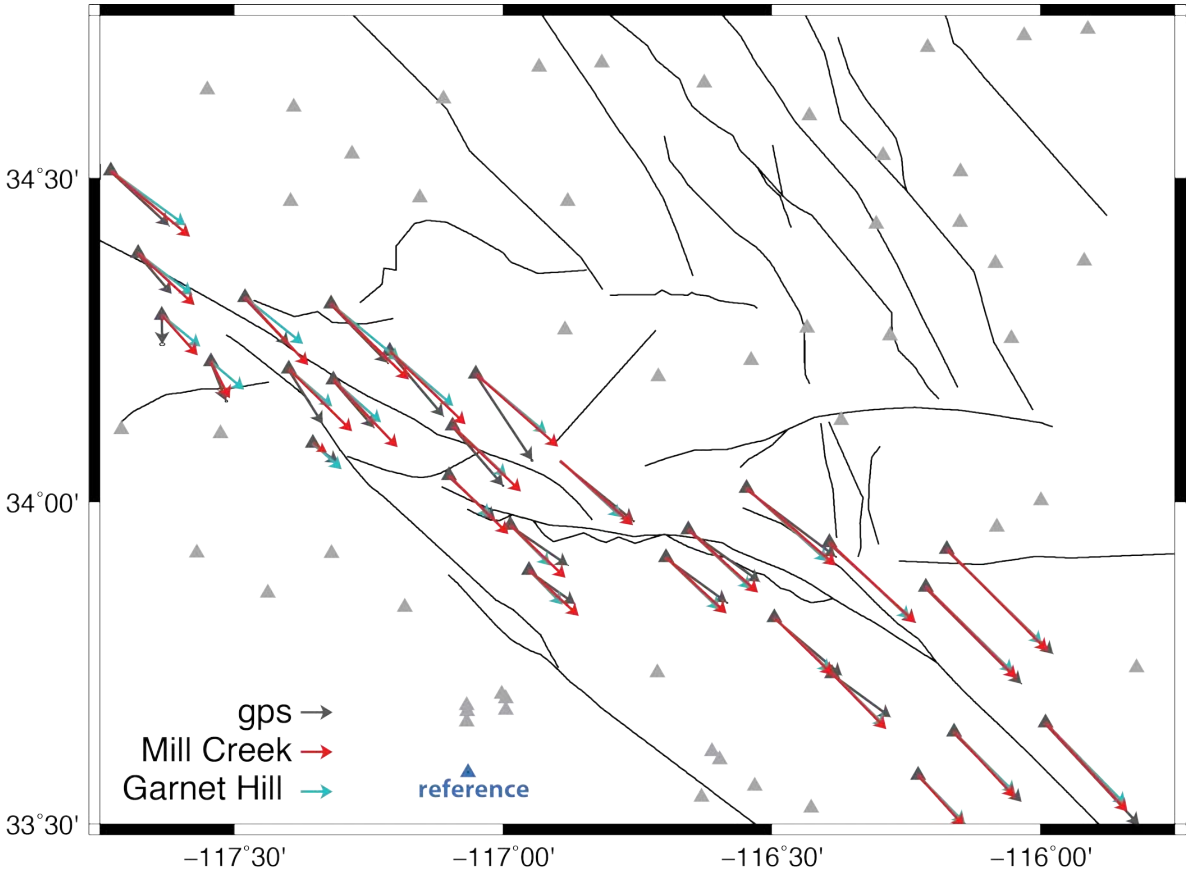
- GPS data processing
  - Seismic offset removed
  - Annual and semi-annual signals
  - Post-seismic – up to 5 years following hector mine
  - Principal component analysis



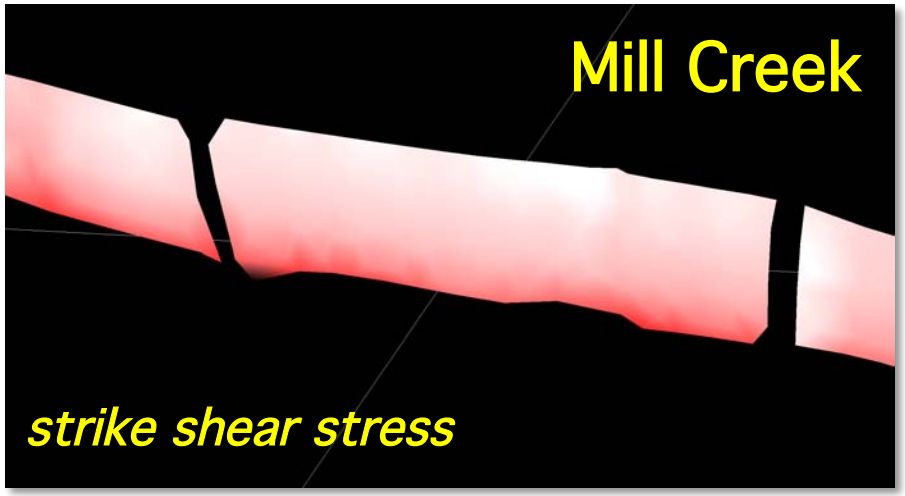
Interseismic GPS Velocities

- Garnet Hill-SGPT model better matches GPS station velocities.





Stressing Rate



Conclusions

- **Data Gaps: Holocene slip rates on Banning & Garnet Hill**

- **Mill Creek strand of the SAF produces different slip rates, interseismic deformation field and stressing rates than the Garnet Hill strand and SGPT**
- **Slip rates and GPS station velocities are better matched with the Garnet Hill/SGPT active system**

- **Discussion: Will these differences impact the nature of earthquake rupture through the region?**

Photo along the abandoned Mill Creek strand of the SAF