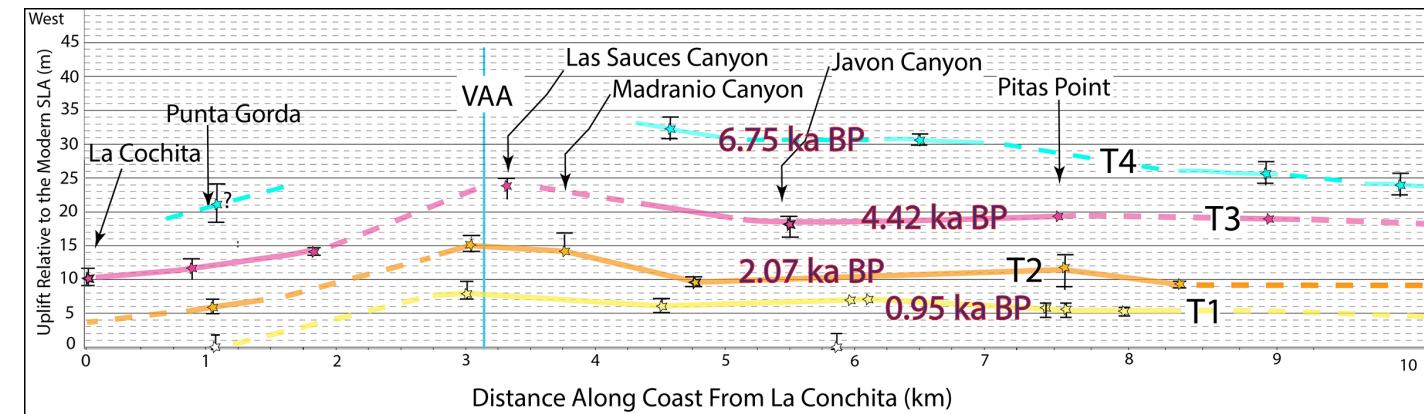


# *The Ventura Special Fault Study Area:*

*Assessing the potential for large, multi-segment thrust fault earthquakes  
and their hazard implications*

## Motivation

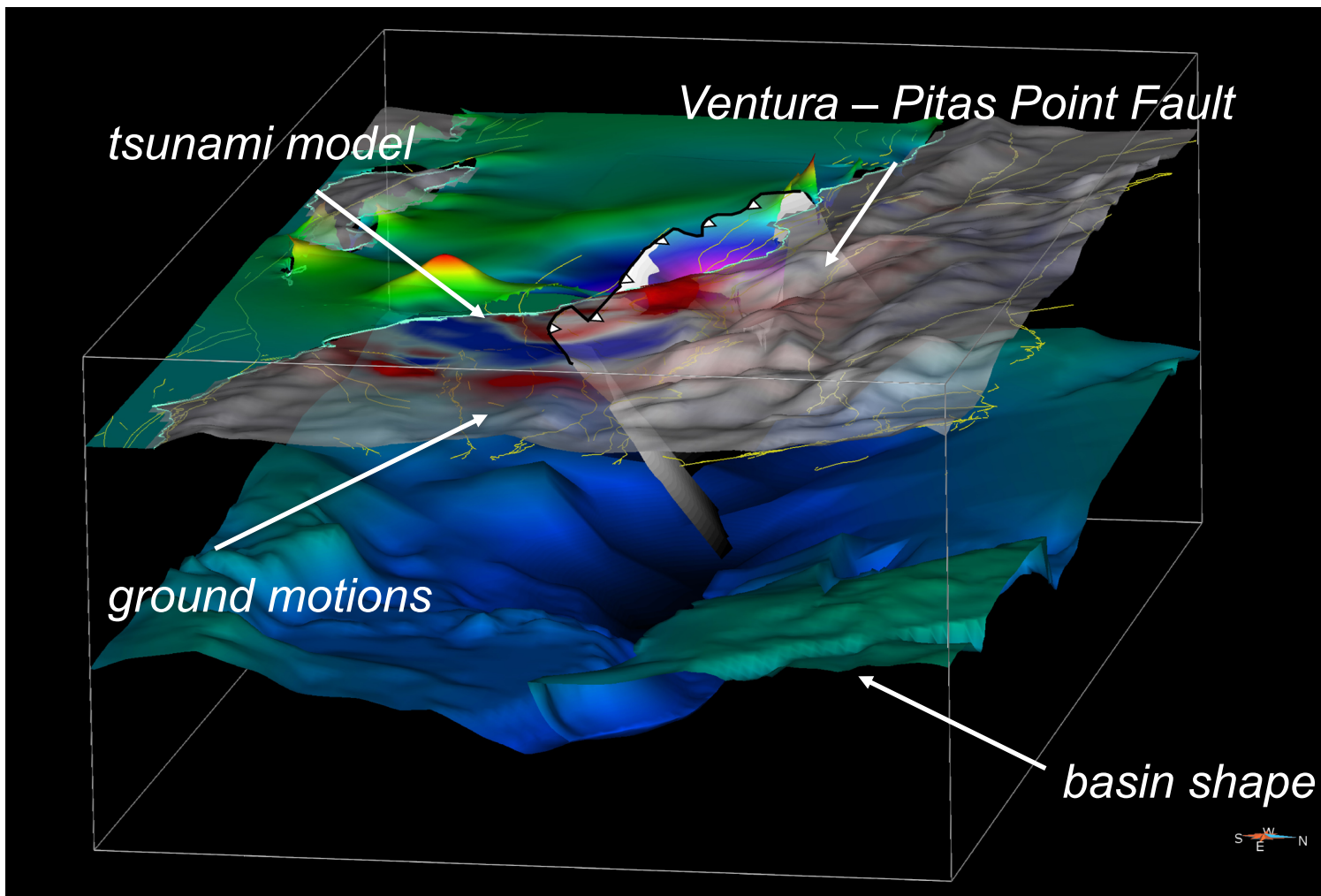
Recognition of large (8-11 m ) coastal uplift events over crest of Ventura Avenue anticline on hanging wall of Pitas Point thrust fault



Large Holocene fold scarp associated with the Ventura fault – the onshore continuation of the Pitas Point fault

Offshore seismic data support ongoing rapid shortening

Onshore geologic and geodetic data that document rapid late Quaternary convergence



# A Bit of History

- The Ventura Ave. anticline has long been recognized
  - Our understanding of the underlying structure has changed
- (a) Cross-section from Yeats (1982) and Huftile and Yeats (1995)
  - Ventura fault is an aseismic bending moment fault
- (b) Cross-section from Hubbard et al. (2014) based on Sarna-Wojcicki and Yerkes (1982)
  - Ventura fault is a major seismogenic structure (~M8 EQ's)

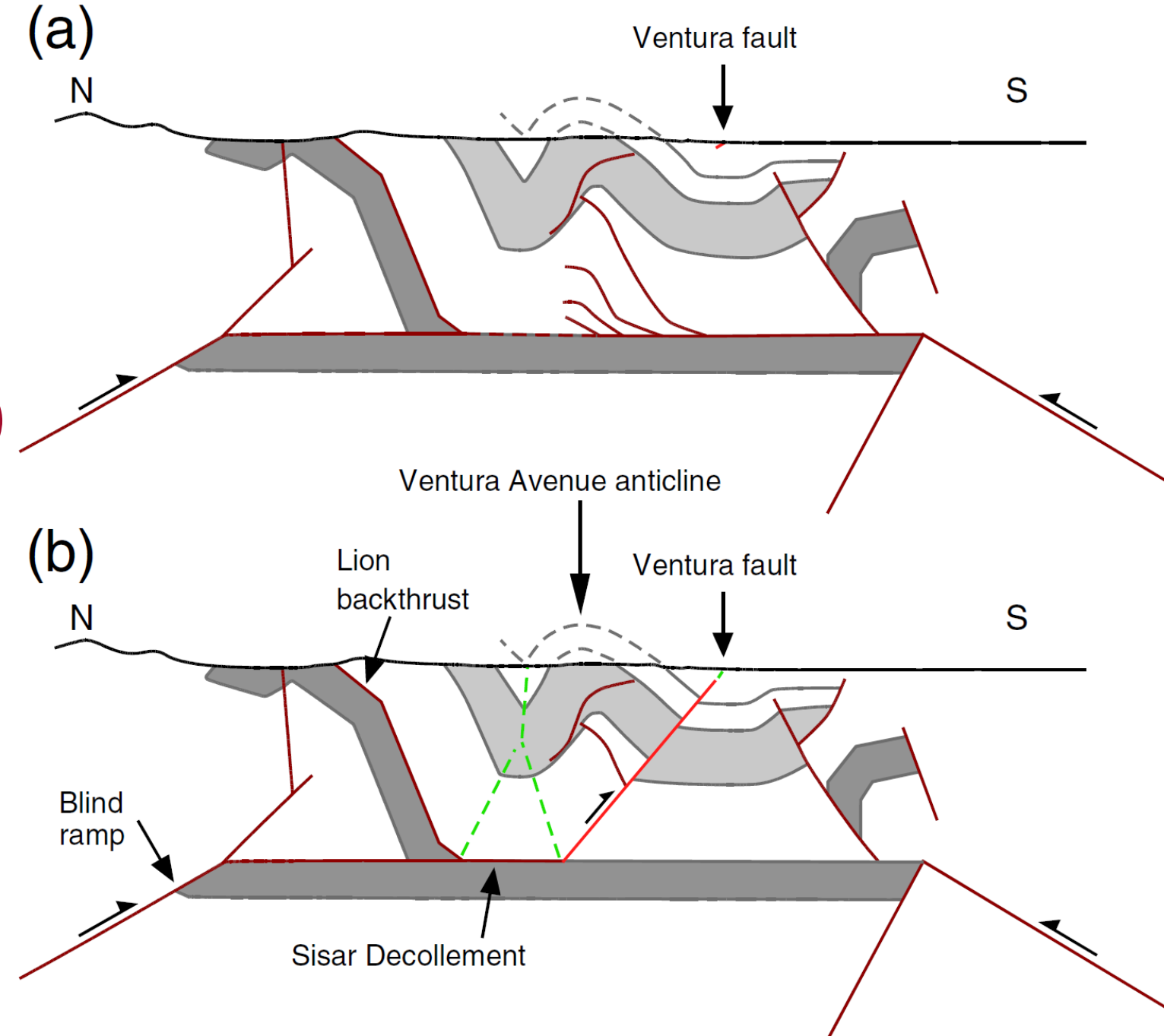
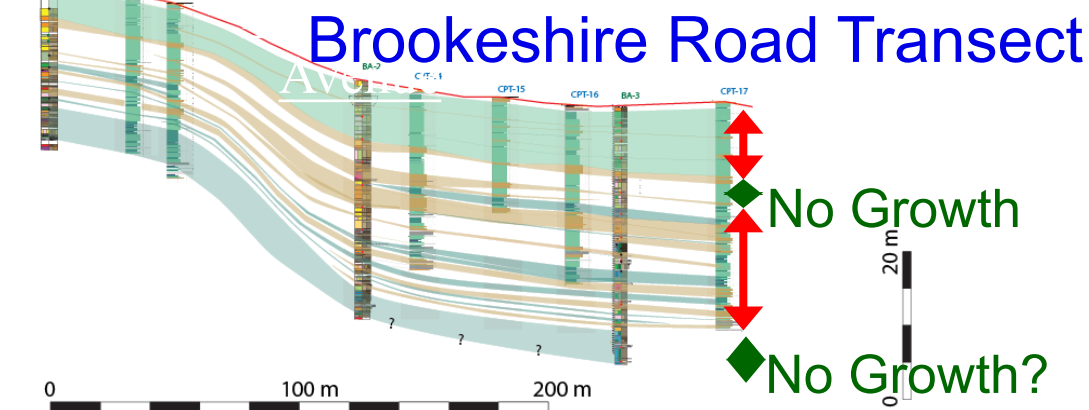
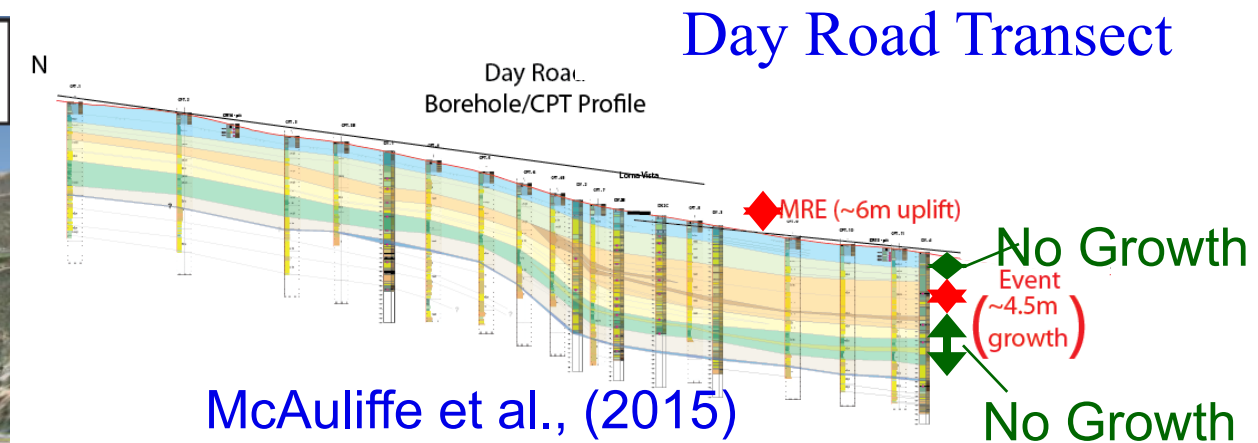
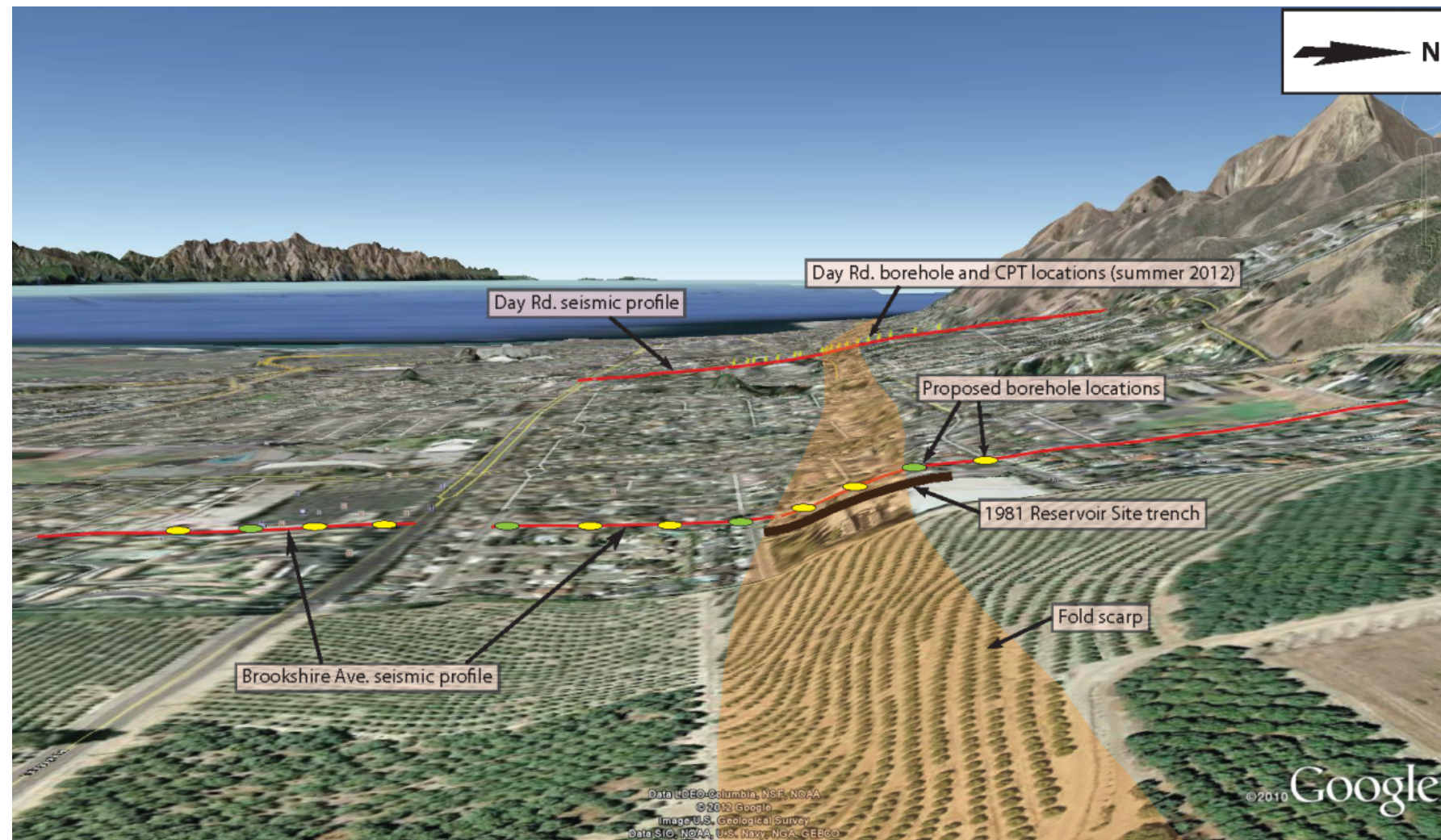


Figure From Hubbard et al. (2014)



# Ventura F. Paleoseismology Supports Large Slip Events

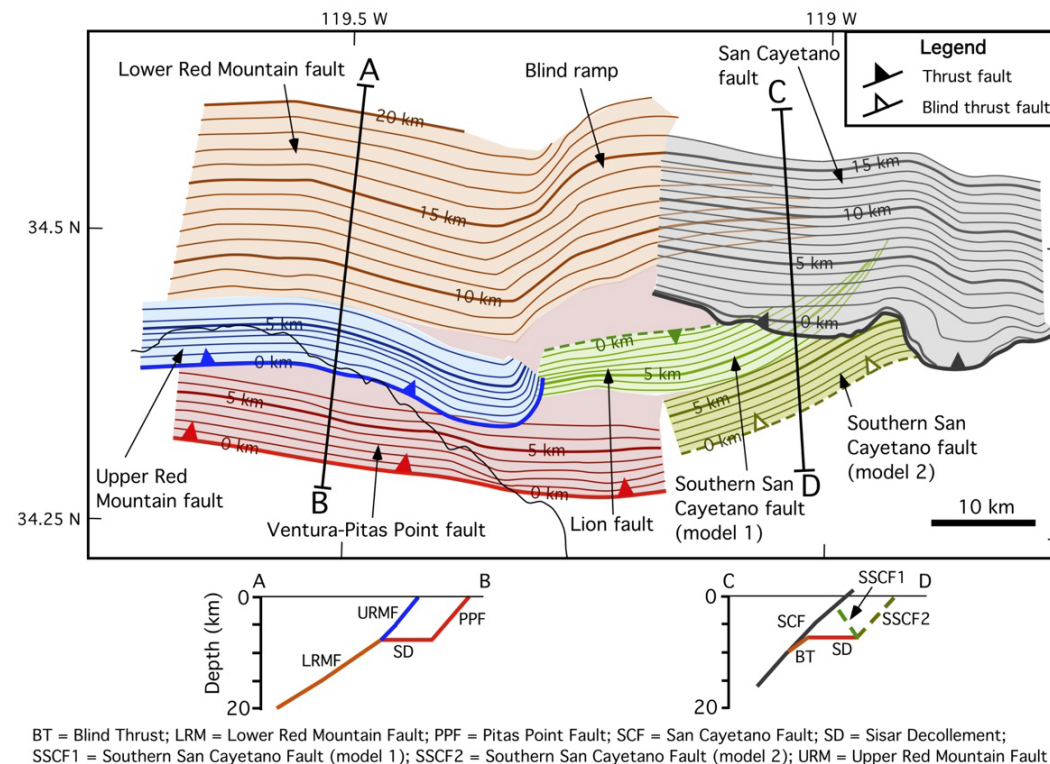
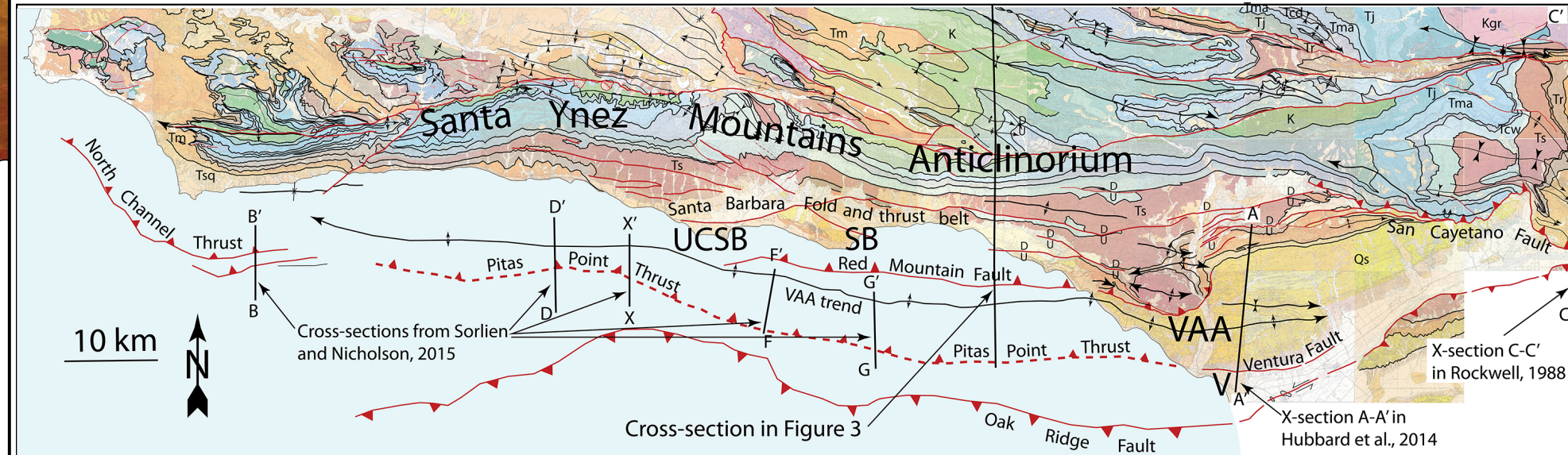
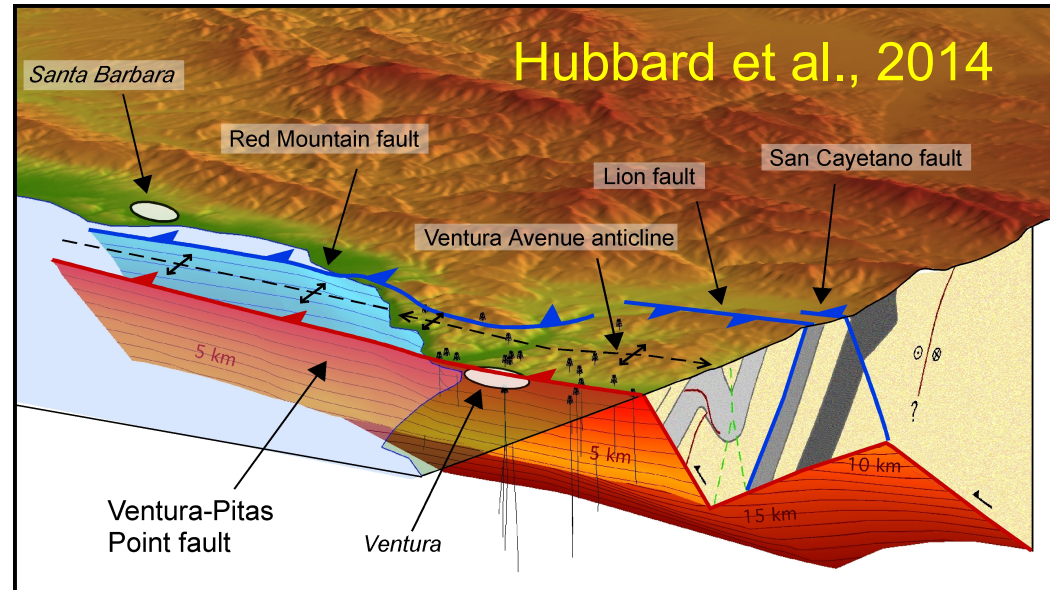


MRE is 700-900 years BP, based on Post-IRIRSL dating. – some discrepancy with coastal terrace dates based on C14 dating

Penultimate event between 3 and 5 ka, consistent with 3<sup>rd</sup> emergent terrace; missing events?

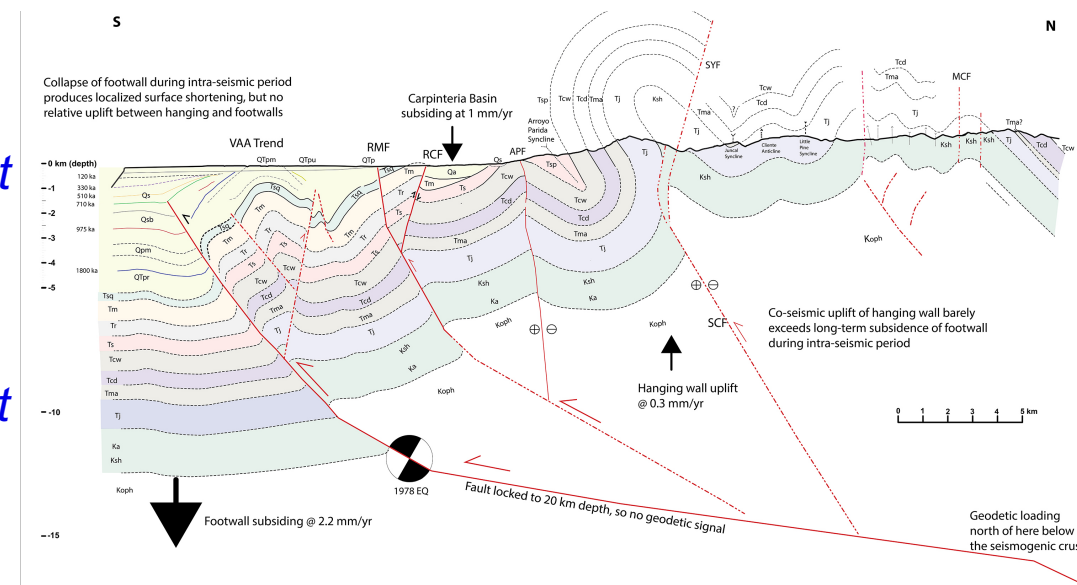


# Linkage of large thrust faults



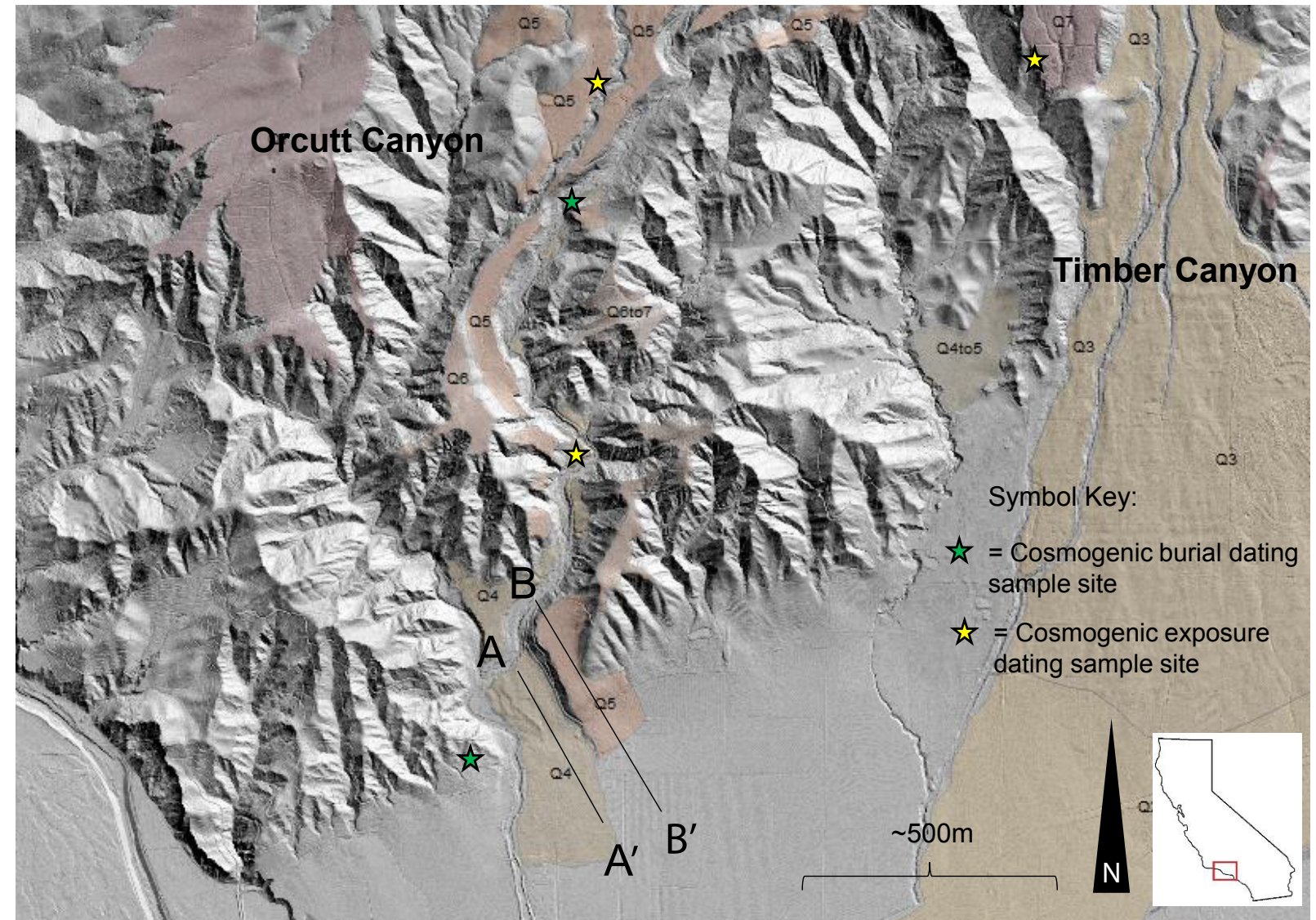
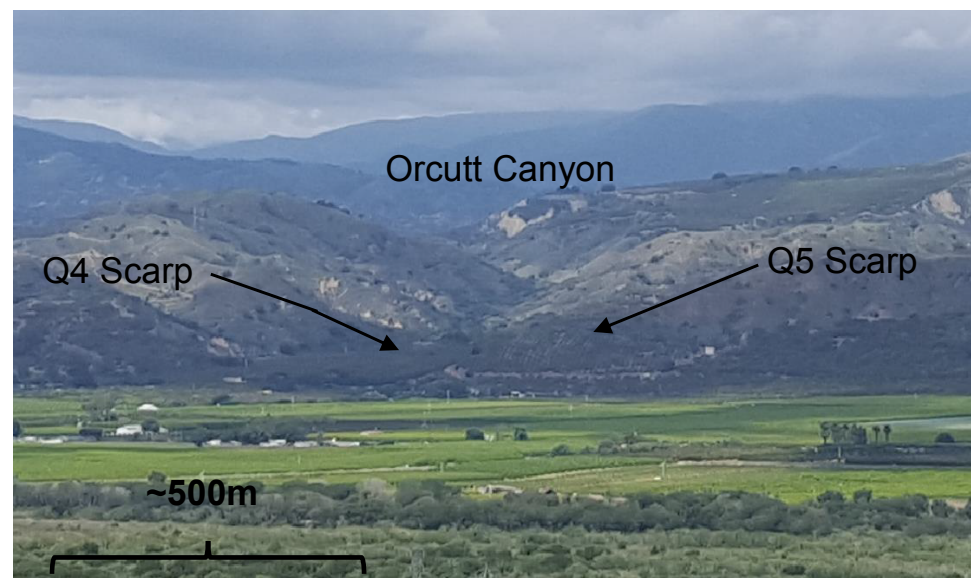
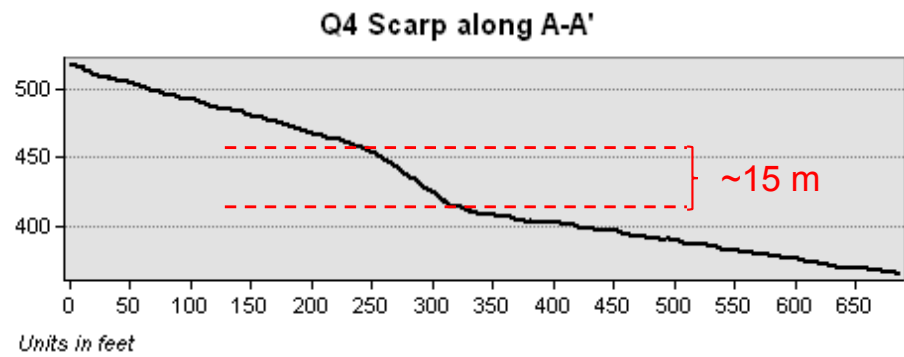
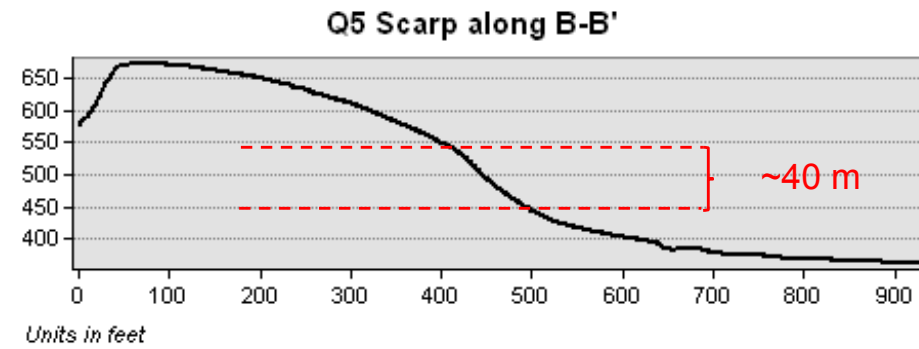
Subsurface structural analysis suggests that the Ventura fault represents a direct linkage between some of the largest, highest slip rate thrust faults in the Transverse Ranges, including the Pitas Point fault (right) and San Cayetano fault (below), which may enable multi-segment ruptures.

Surface structure implies potential linkage extending for 180 km



Levy et al., in progress





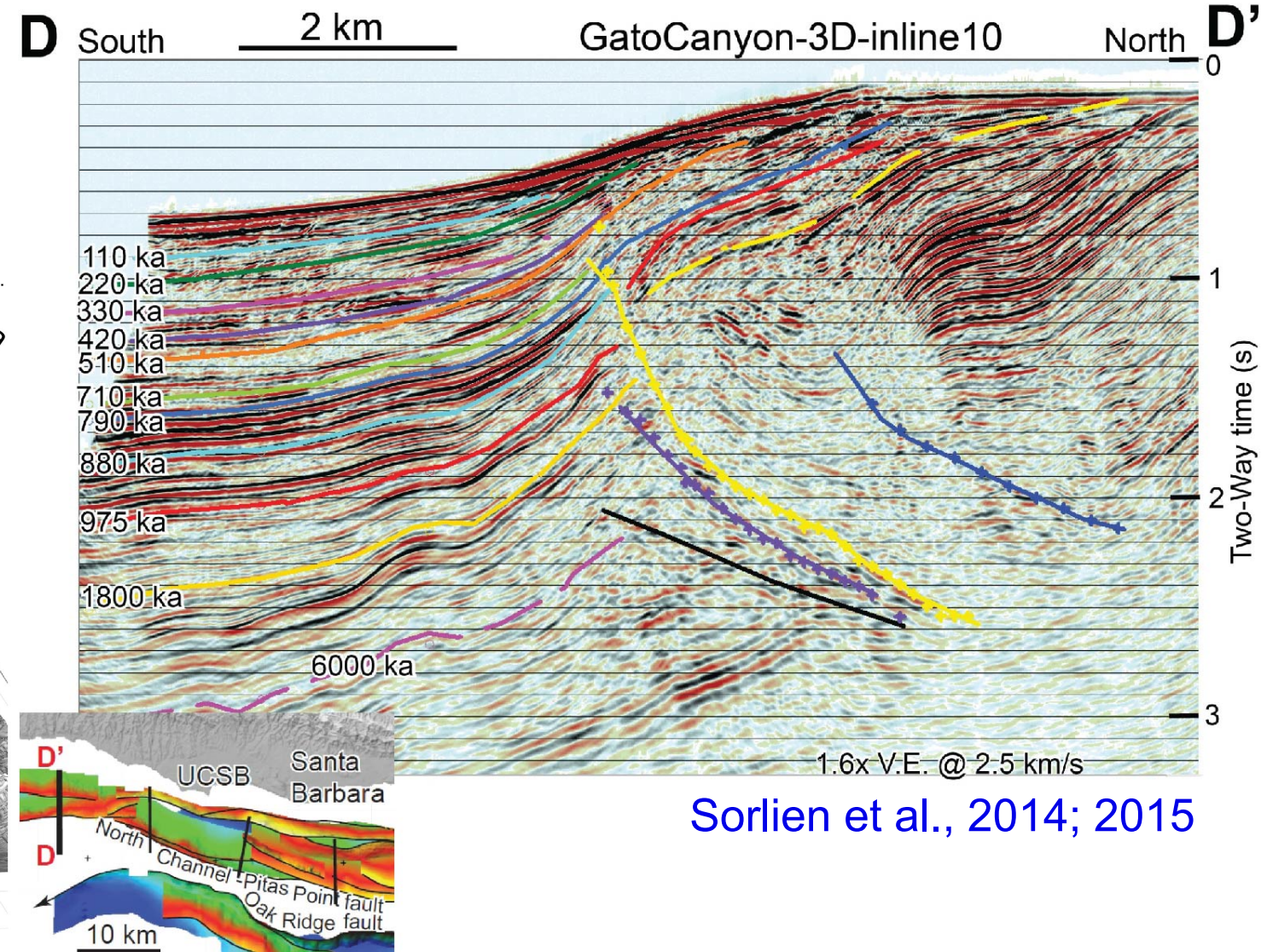
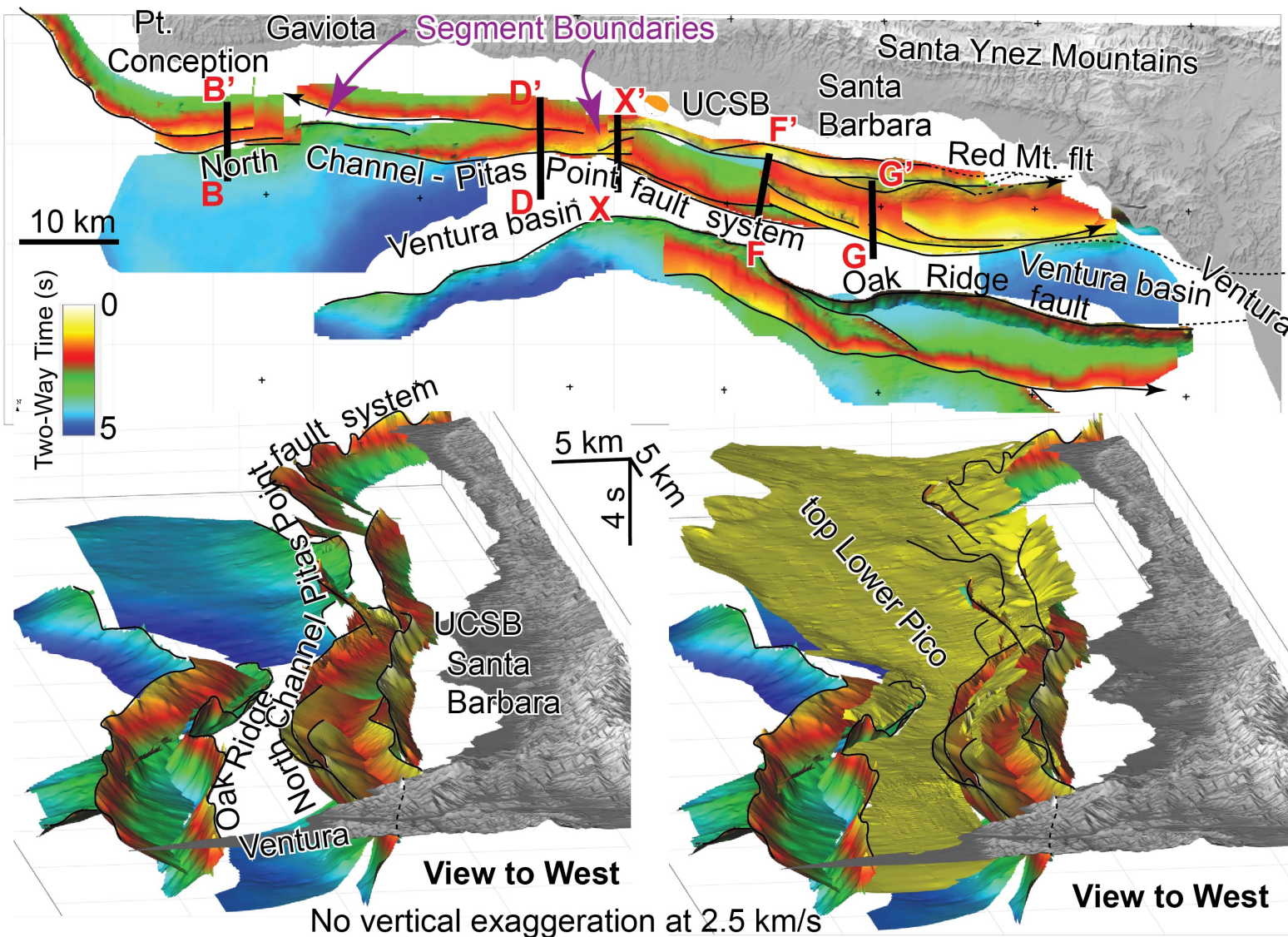
**Top Right:** Hill shade image of the mouth of Orcutt Canyon. The shaded areas are uplifted fan surfaces or river terraces which have been adapted from Rockwell (1988) or mapped from field observations. The lines A-A' and B-B' are the lines of the two topographic profiles in the top left.

**Top Left:** Topographic profiles along the lines A-A' and B-B' highlighting scarps in the Q4 and Q5 surfaces at the mouth of Orcutt Canyon.

**Bottom Left:** Photo looking north across the Santa Clara River Valley at the mouth of Orcutt Canyon. The Q4 scarp is on the eastern mouth of the canyon and the Q5 scarp on the west side.



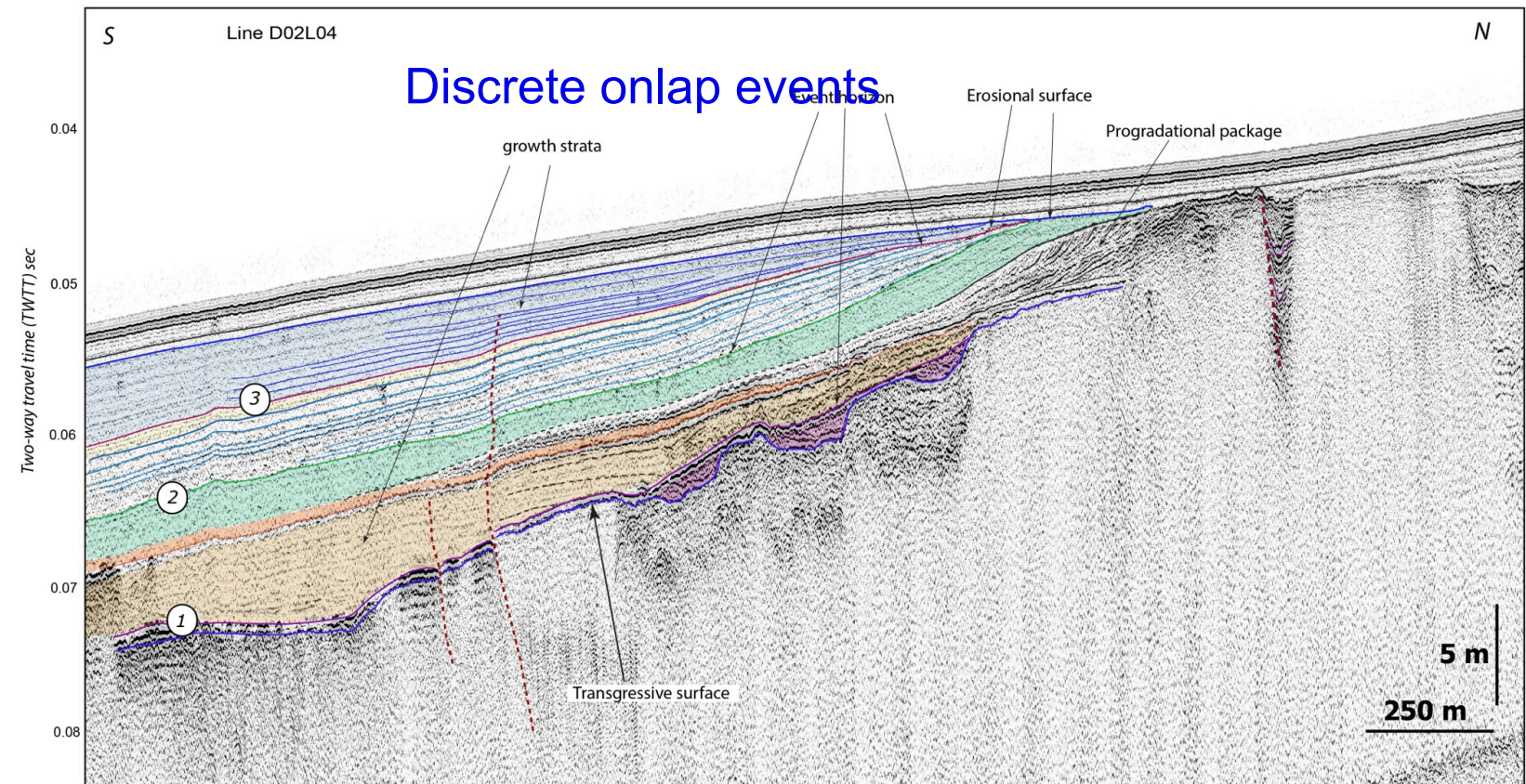
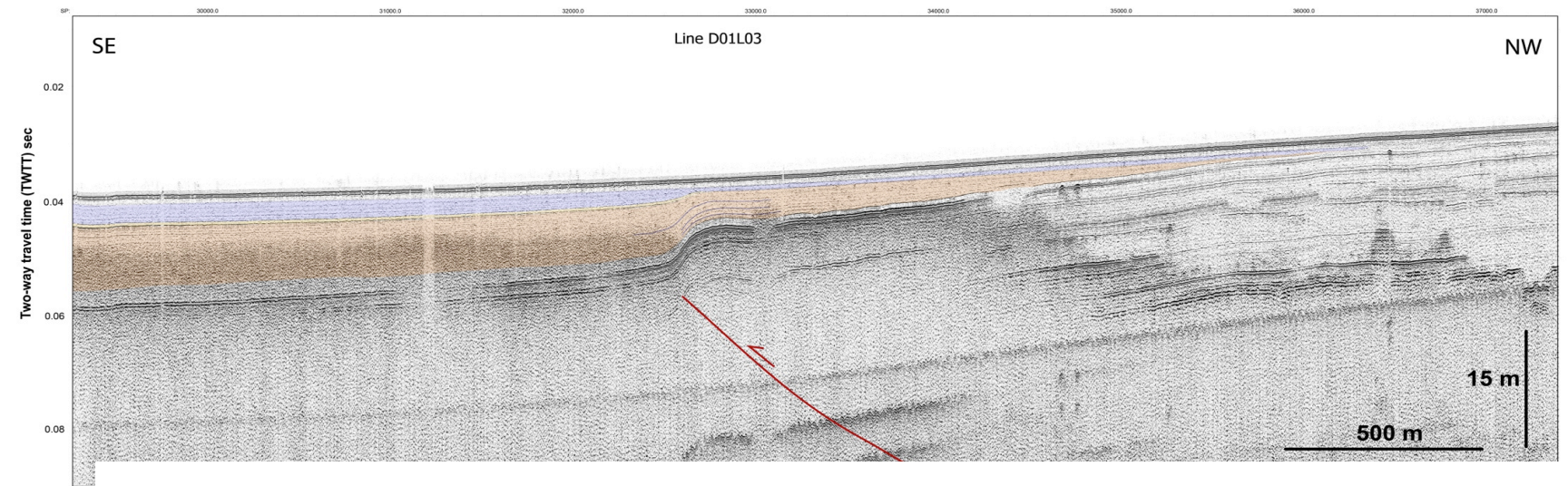
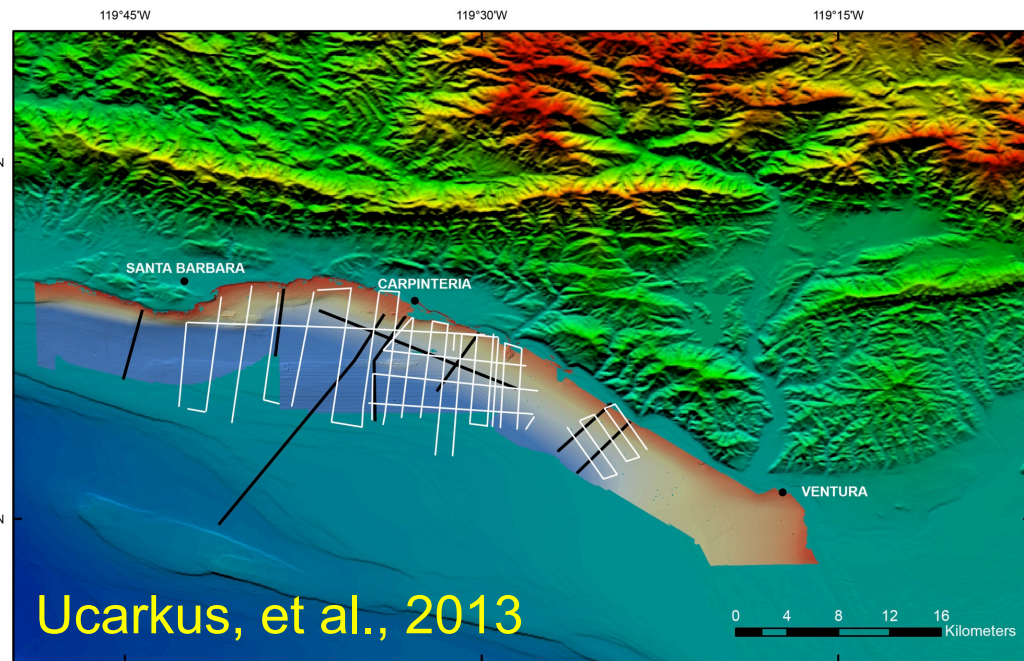
# Investigating the offshore extent of the fault system



Sorlien et al., 2014; 2015



# Offshore Chirp Data Shows Multiple Late Holocene Folding Episodes

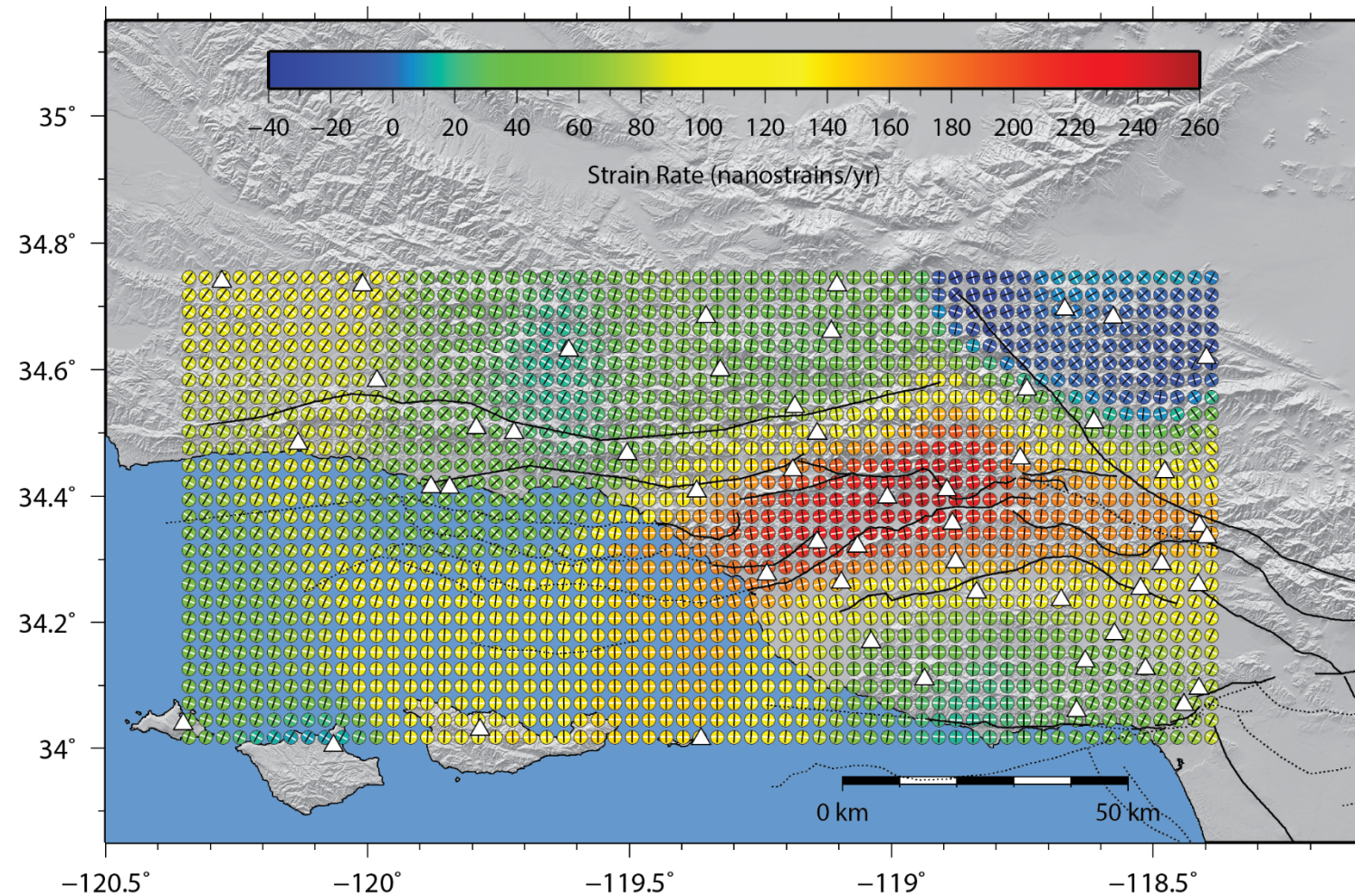


❖ ~240 km-long very high-resolution (decimeter) CHIRP seismic reflection data from offshore Santa Barbara in the west to Ventura in the east.

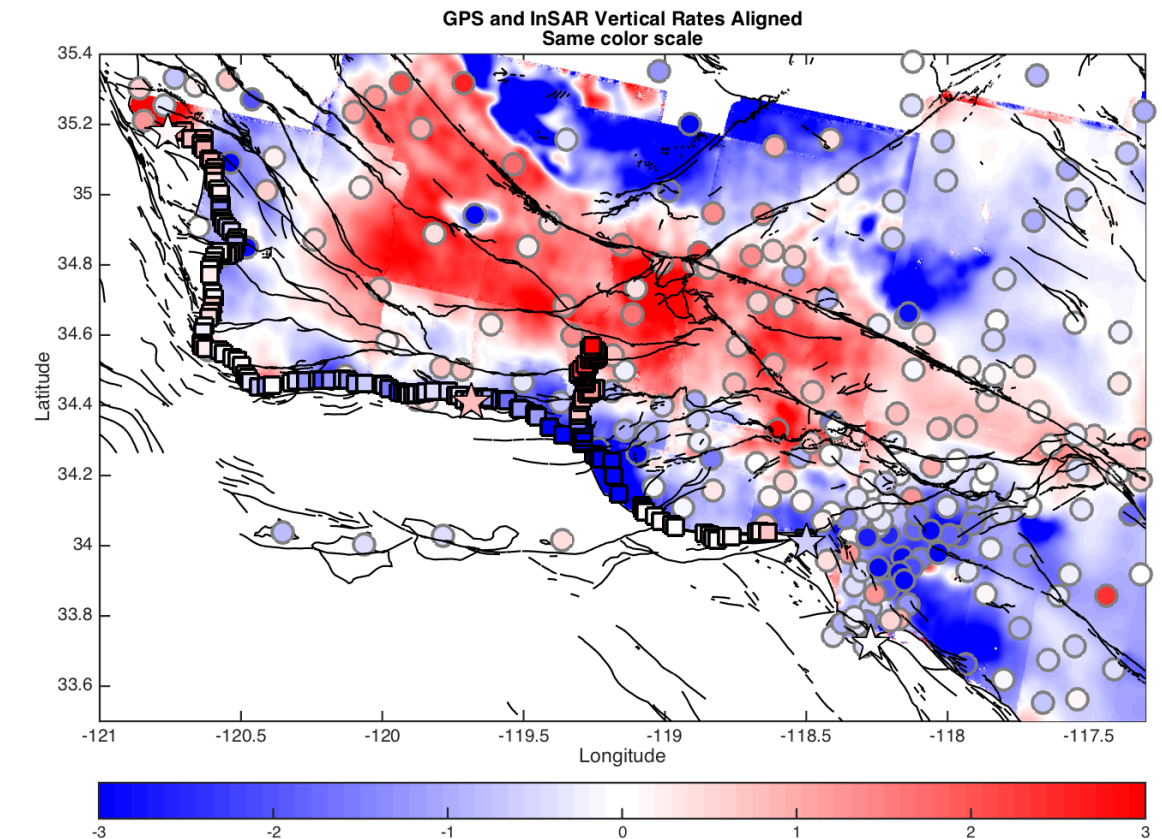
❖ High-Resolution Mini-Sparker Seismic-Reflection Data From the Southern California Continental Shelf—Gaviota to Mugu Canyon by USGS, Sliter et al. 2008.



# Vertical Rates and Geodetic Contraction Rates



Principal contraction rates from smoothed inversion of PBO GPS velocities. Shortening is localized in the Ventura basin Marshall et al. (2013, JGR)



- Vertical rates constrained by repeated leveling, tide gauges, InSAR, and GPS
- Rates from terrestrial techniques and InSAR are aligned with the space-based GPS rate field. Burgette et al. in prep.



# *Major Questions*

- **Geology**
  - What are the earthquake histories and slip rates of the regional faults?
- **Near Surface Geophysics/Crustal Structure/Seismology**
  - What are the subsurface fault geometries, and how are they linked?
  - What does the current EQ activity tell us?
- **Geodesy and Fault Modeling**
  - Is interseismic contraction related to faulting or basin subsidence?
  - Are there significant vertical motions in the geodetic observations?
  - Are we correctly modeling strain accumulation?
- **Dynamic Rupture Modeling/Tsunamis**
  - What is the tsunami potential from the regional faults?



# *Pre-Meeting Workshop – SCEC Annual Meeting 2016*

To bring together the most up to date and significant results and attempt to form a consensus view of the Ventura fault system and its associated hazards

## Today's General Program

- **Session 1: Geology, Paleoseismology, Tectonic Geomorphology**
- **Session 2: Crustal Structure, Near Surface Geophysics, Seismology**
- **Session 3: Geodesy and Fault Modeling**
- **Session 4: Dynamic Rupture and Tsunamis**
- **Session 5: What's Next? Future Research Directions**