Growth History of Ventura Avenue Anticline, Ventura Basin, CA

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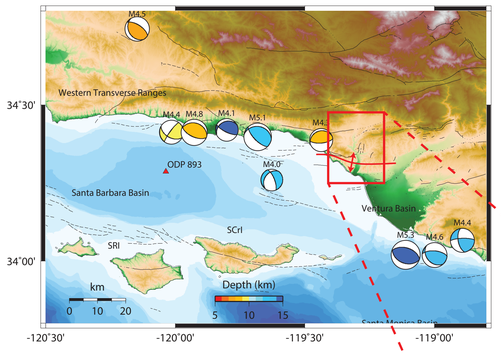
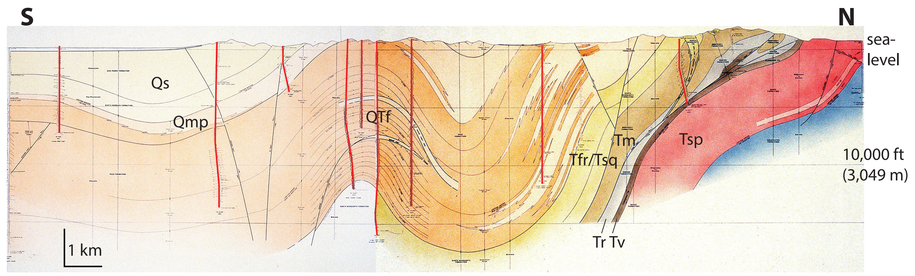
Motivation

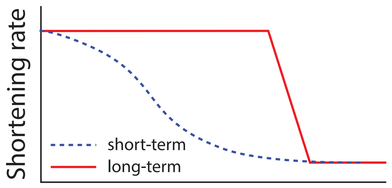
The Ventura Avenue anticline hosts one of the fastest-uplifting structures in southern California. However, assessing its seismic potential has been a long-standing challenge due to first-order disagreements over the subsurface structure of the system. In particular, it requires estimating long-term deformation rates and the relative contribution of seismic and aseismic processes in the Ventura basin.

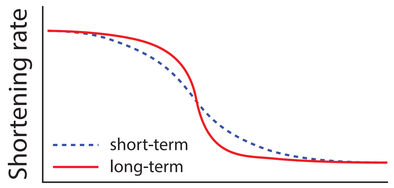


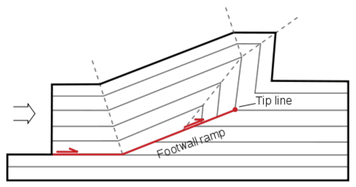


Vertical structure cross-section across the Ventura Avenue anticline (Hopps et al, 1992). Red lines show well control.

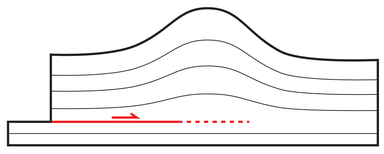
Models







Fault-propagation fold



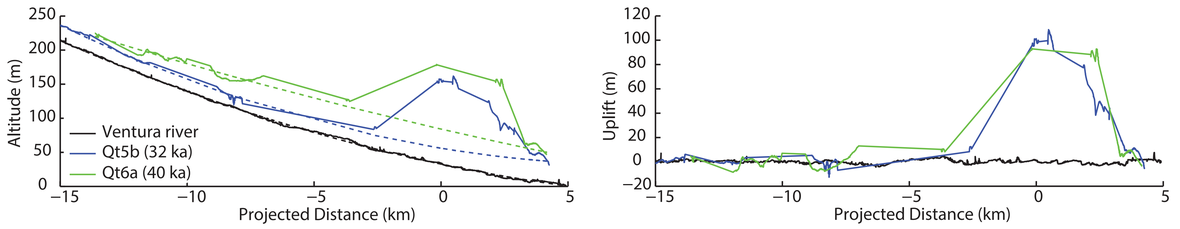
Detachment fold

Two proposed models for the Ventura Avenue anticline: fault-propagation fold model that Ventura fault extend to seismogenic depth beneath the anticline (Hubbard et al., 2013); and detachment fold model that the Ventura fault is a shallow fault that extends only about 300 m in depth (Yeats et al., 1988).

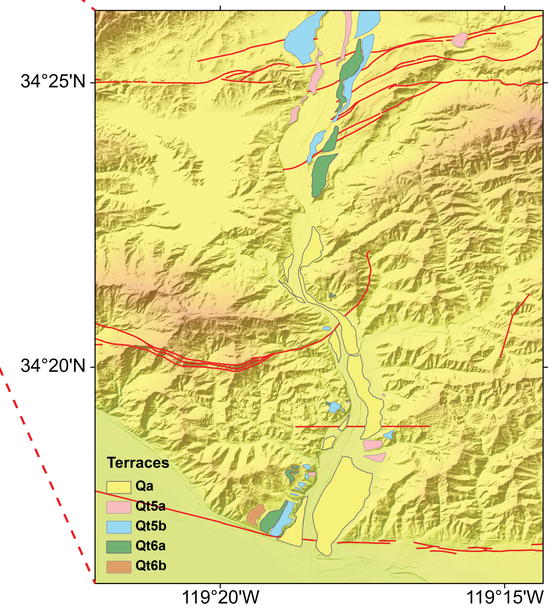
Conclusions

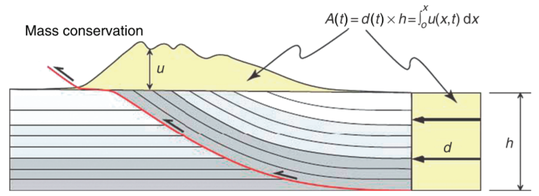
1) The fluvial terraces yield a shortening rate of 2.1 mm/yr across the Ventura Avenue anticline.
2) GPS data measures shortening rates of 8-10 mm/yr across the Ventura basin.
3) A kinematic model of the Ventura Avenue anticline will be developed on the basis of structure cross-sections.

Fluvial terraces

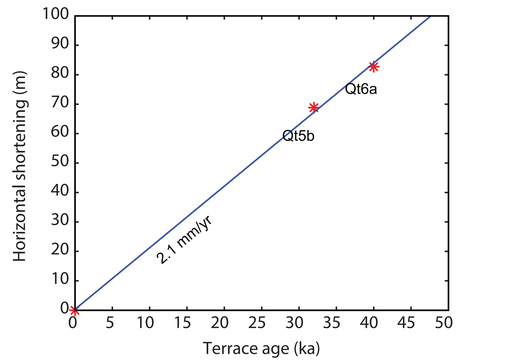


Ventura fluvial terraces and river profiles projected on a N10E trend. The terrace altitudes are extracted from 10 m DEM data. The excess area can be estimated for respective terrace.



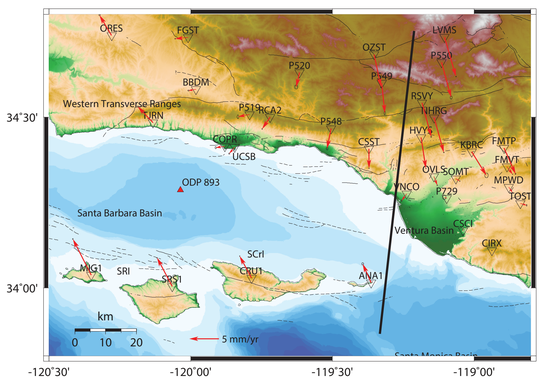


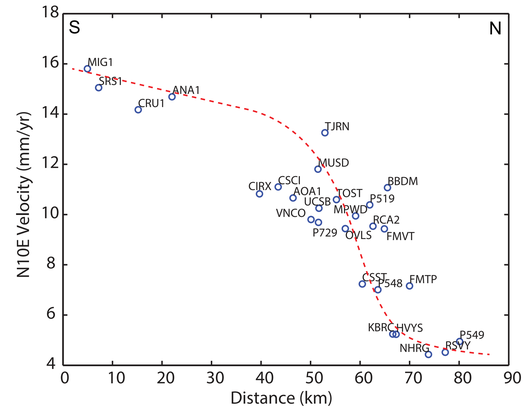
Relationship between excess area and depth to detachment (Avouac et al., 2007)



Plot of horizontal shortening deduced from the fluvial terraces along the Ventura river as a function of age of terrace abandonment. The data yield a uniform 2.1 mm/yr shotening rate over the last 40 ka. The depth to detachment is estimated to be ~7.4 km (Hubbard et al., 2013). Age control is from ^{14}C dates (Rockwell et al., 1988).

GPS data





Horizontal GPS data (blue circles) with a rough dislocation model (red curve) projected on a N10E trend. The GPS velocities are from Marshall et al. (2013).