Late Quaternary slip rates for the southern San Cayetano fault, southern California, using LiDAR and cosmogenic nuclide exposure dating

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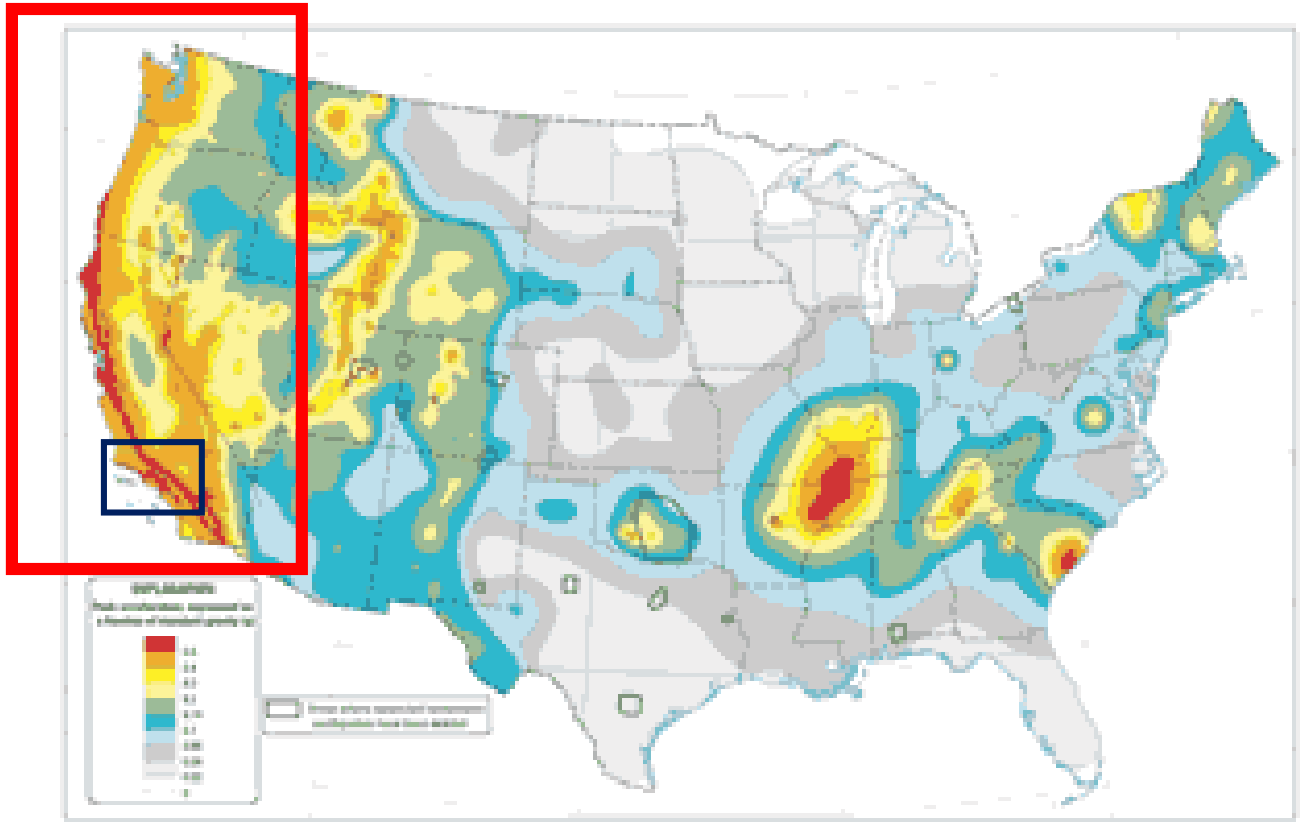
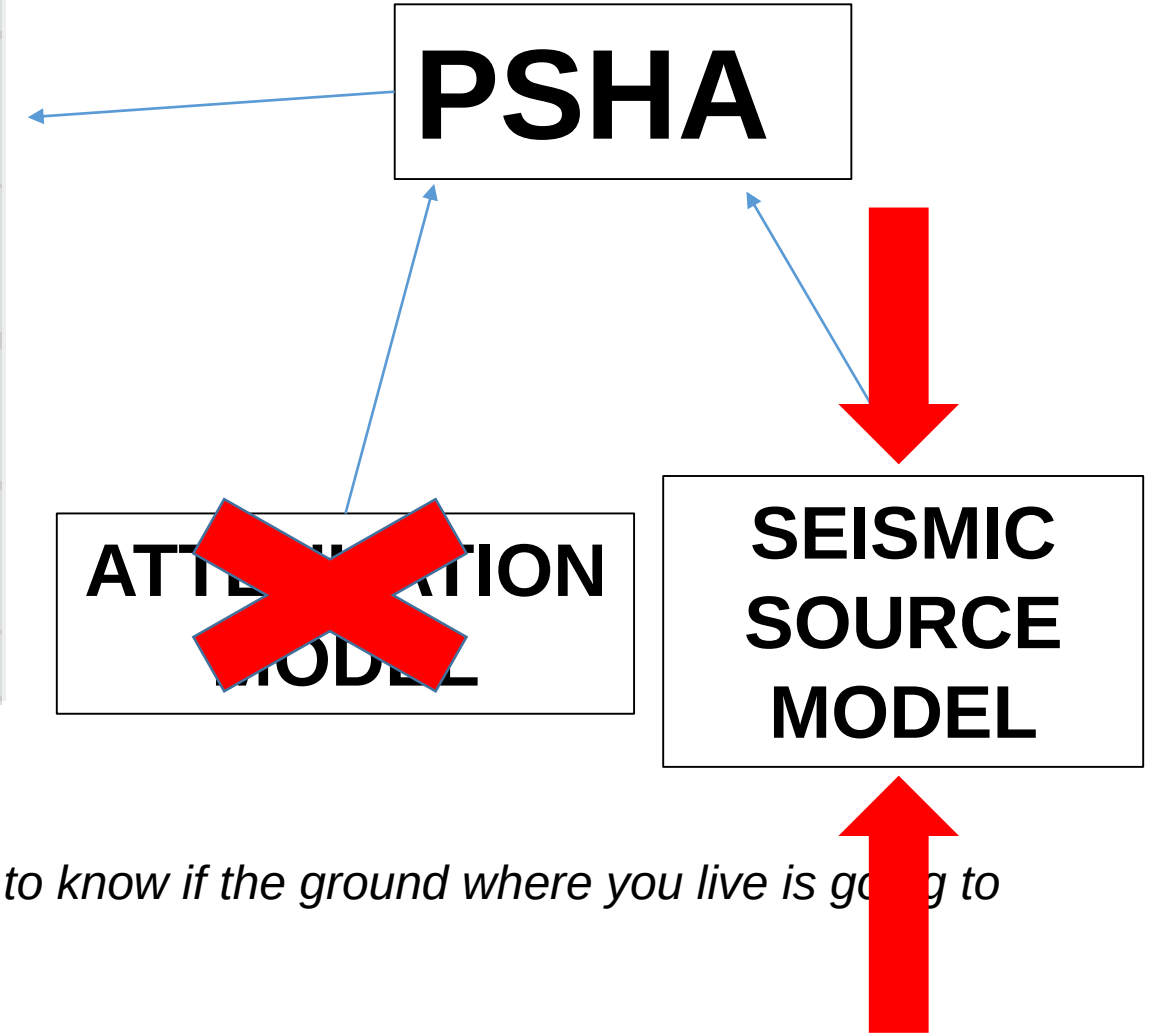
- Background & Methods
- Southern San Cayetano Fault
- Results
- Implications

Probabilistic Seismic Hazard Assessment (PSHA):



HAZARD MAPS *(source USGS)*



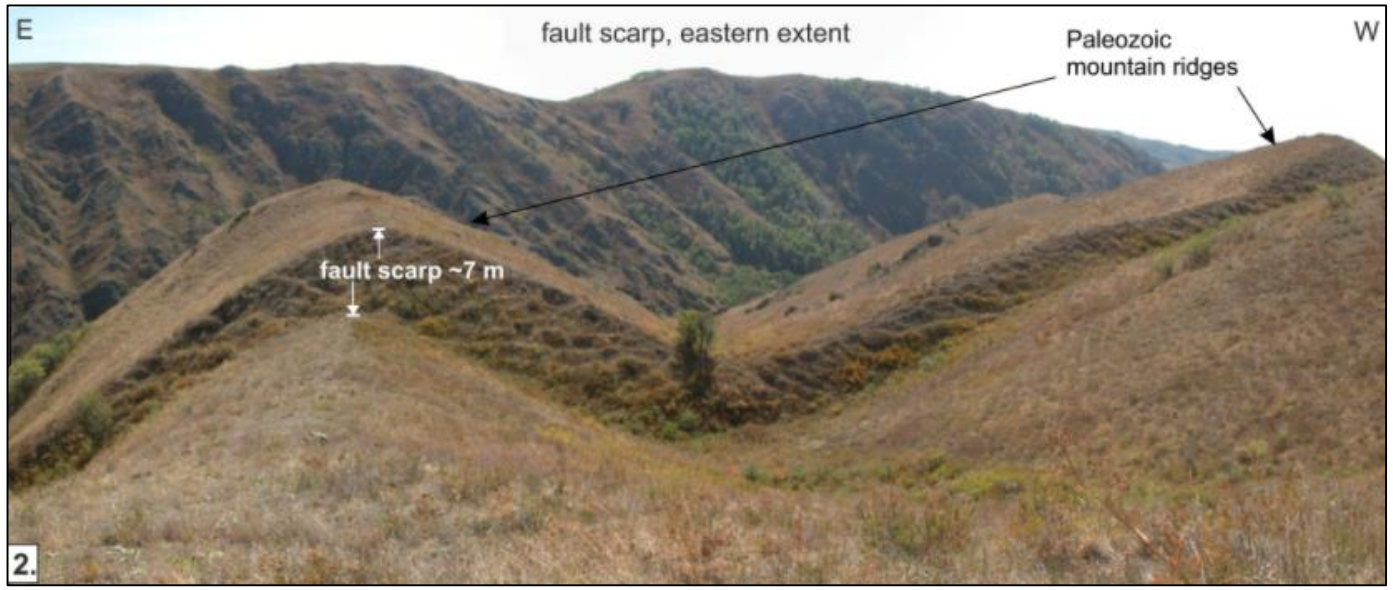
- PSHA used by governments and industry (*and also its useful to know if the ground where you live is going to start shaking with a velocity of 3g!*)

Fault Slip Rates: *How fast is a fault 'moving'?.....*

Increased slip rate = increased seismic hazard

1. Quantify offset

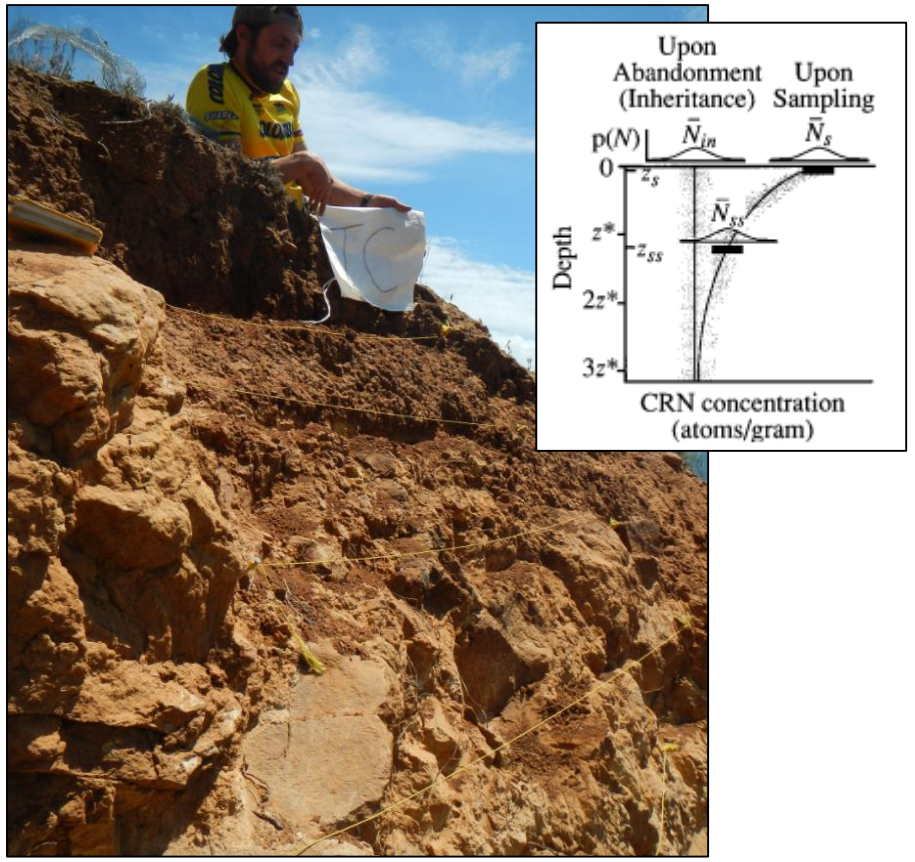
- LiDAR topographic data



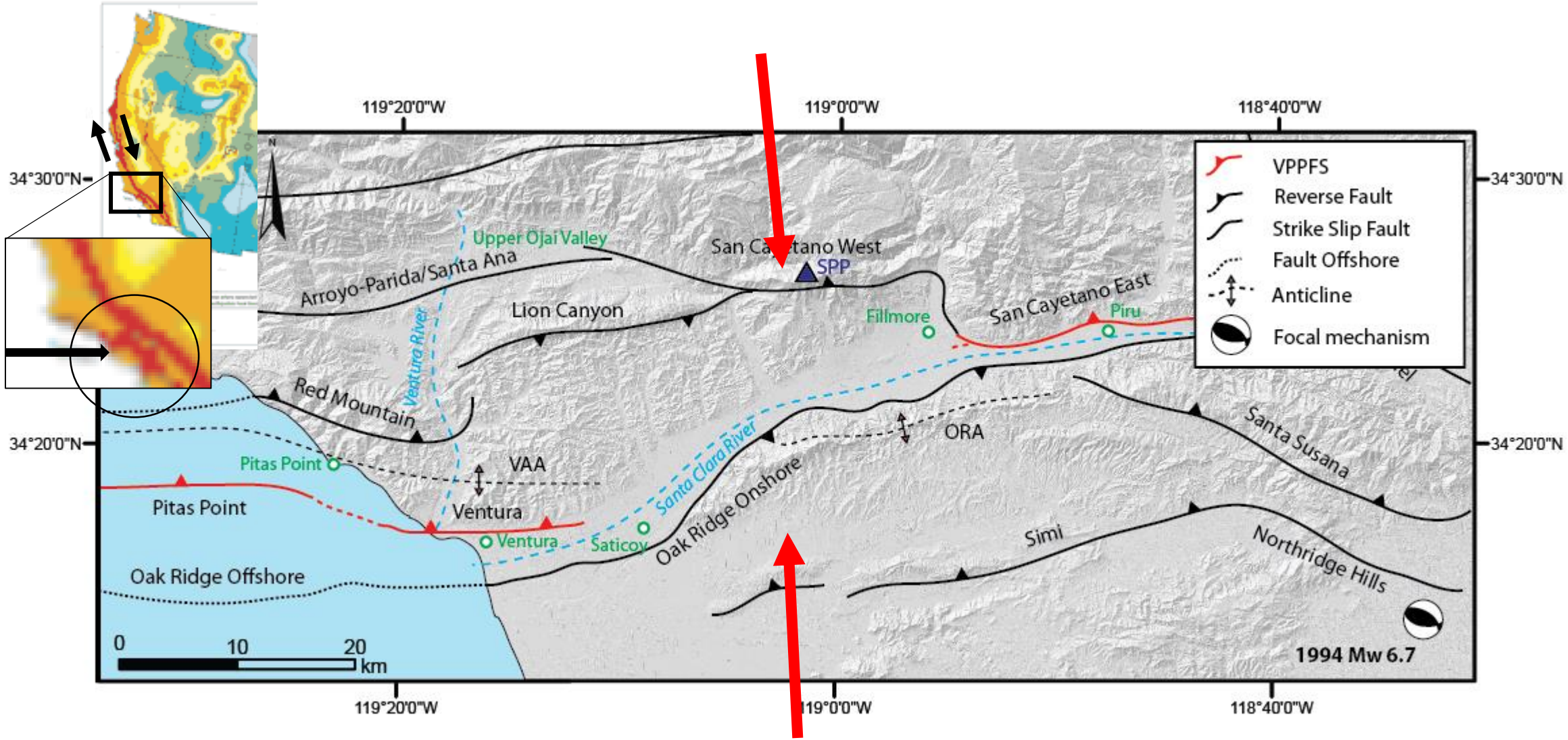
http://ewf.nerc.ac.uk/2012/10/11/moving-mountain-and-steppe-kazakhstan/

2. Apply time constraints

- Cosmogenic exposure dating
  - Depth profile



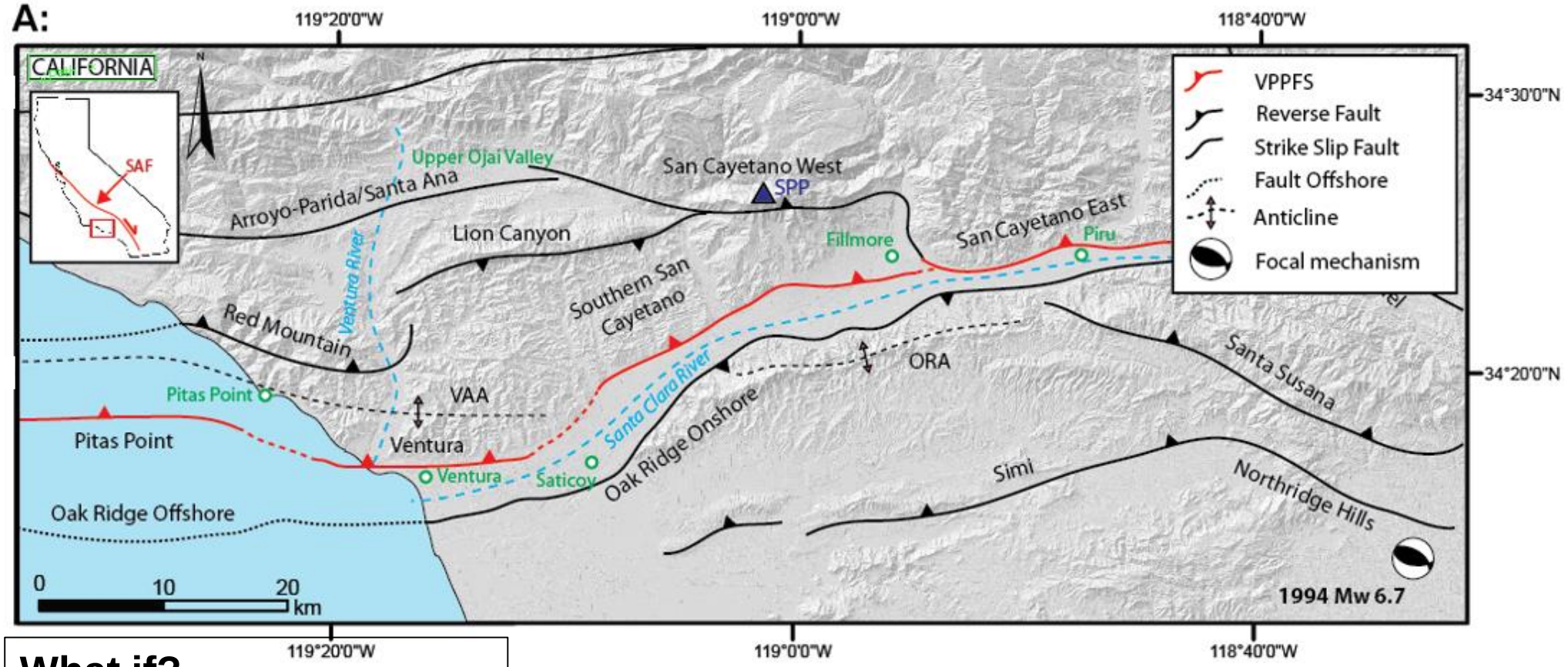
Study Area: The Ventura Basin



Study Area: The Ventura Basin

Scaling Relationships:
M = 5.0 + (1.22 x log (SRL))

LONGER FAULT = BIGGER EARTHQUAKE



25 km > Mw ~6.6

- M6: Damaging locally up to ~100 km from epicentre

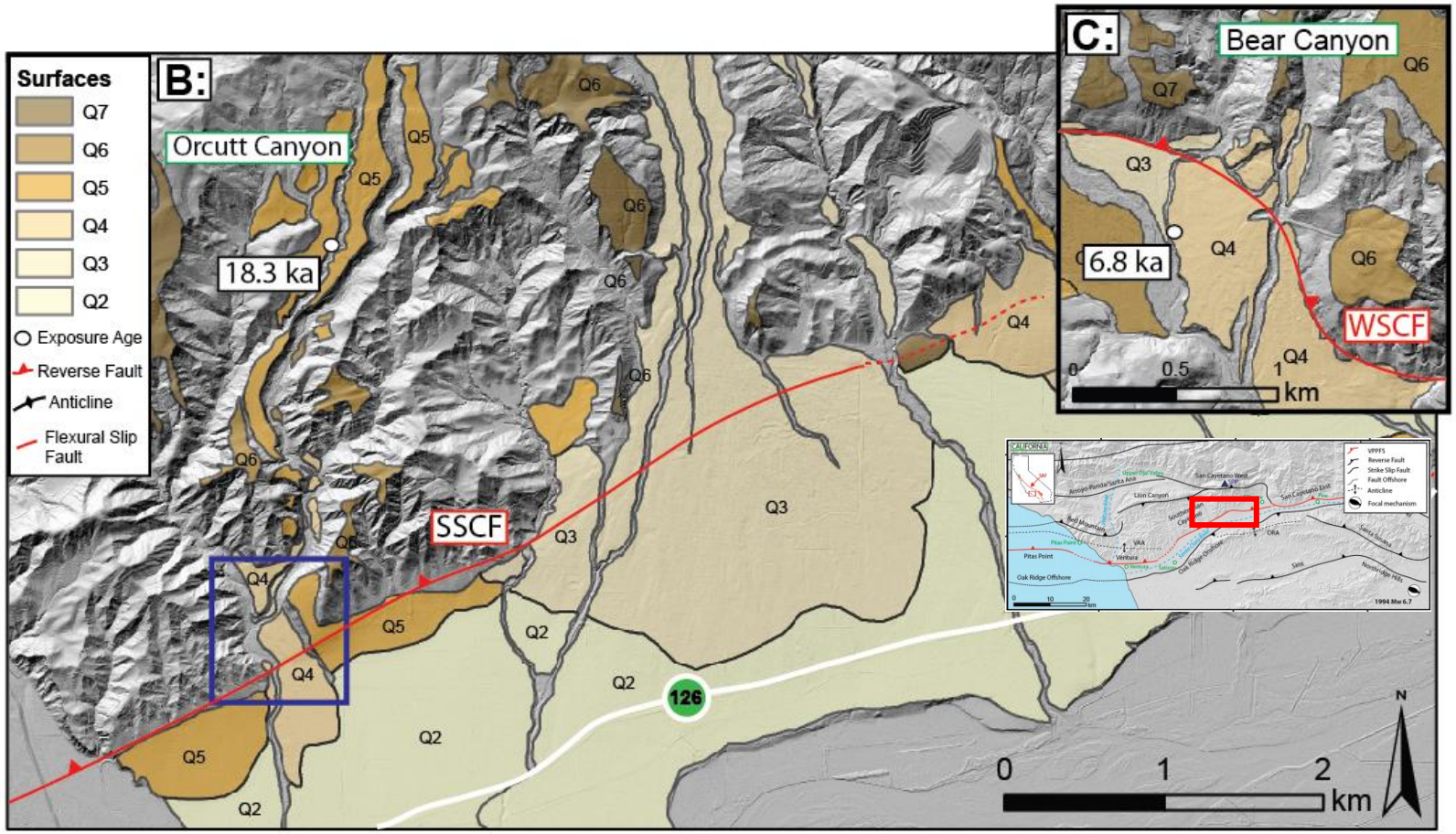
What if?
~100 km > Mw~8.0

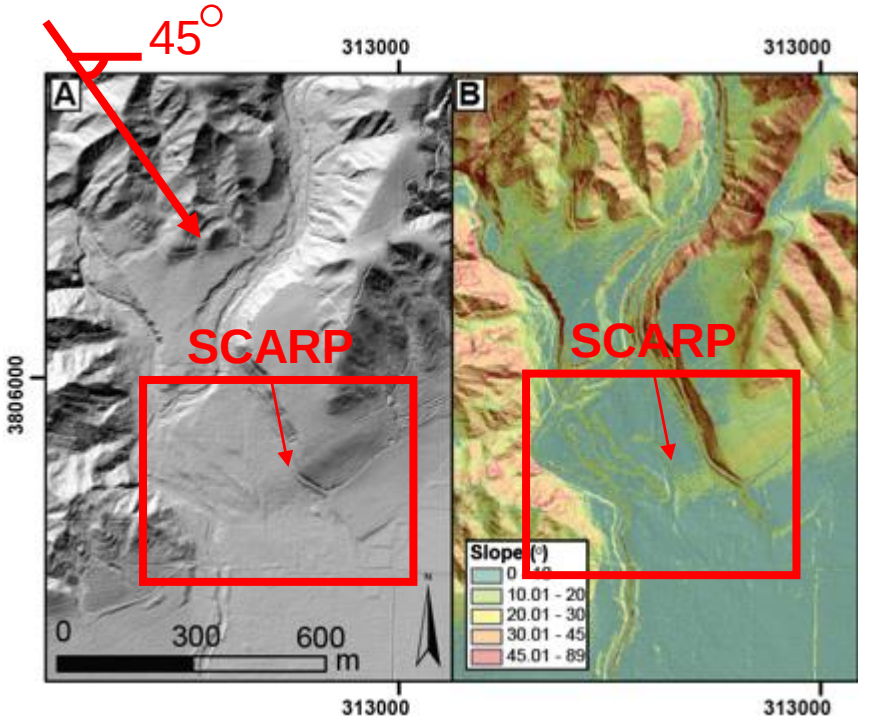
- M8: Damaging regionally hundreds of km's from epicentre

1. Find evidence for the SSCF
2. Is this a series of smaller faults each capable of moderate earthquakes?
Or one large fault capable of large earthquakes??

River Terrace Mapping:

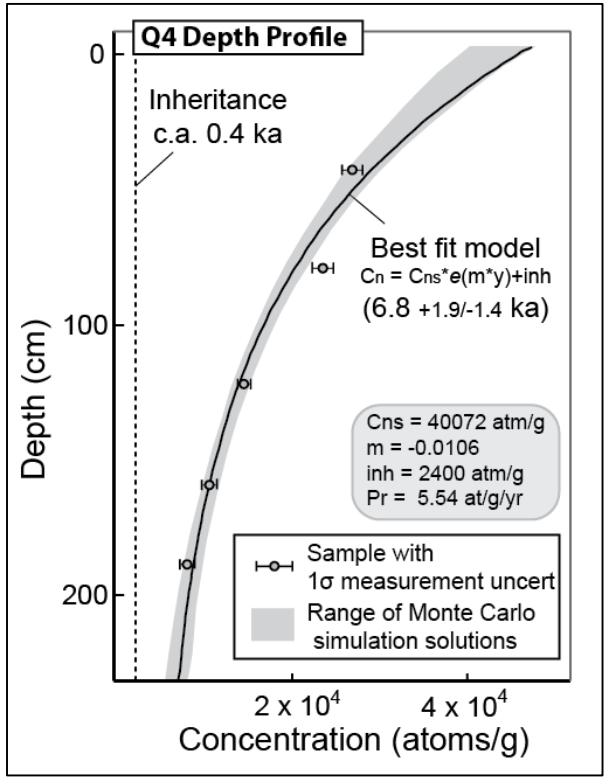
- Identify river terraces or alluvial fans offset by fault activity
  Quantify offsets
- Find surfaces to use cosmogenic exposure dating
  Apply time constraints

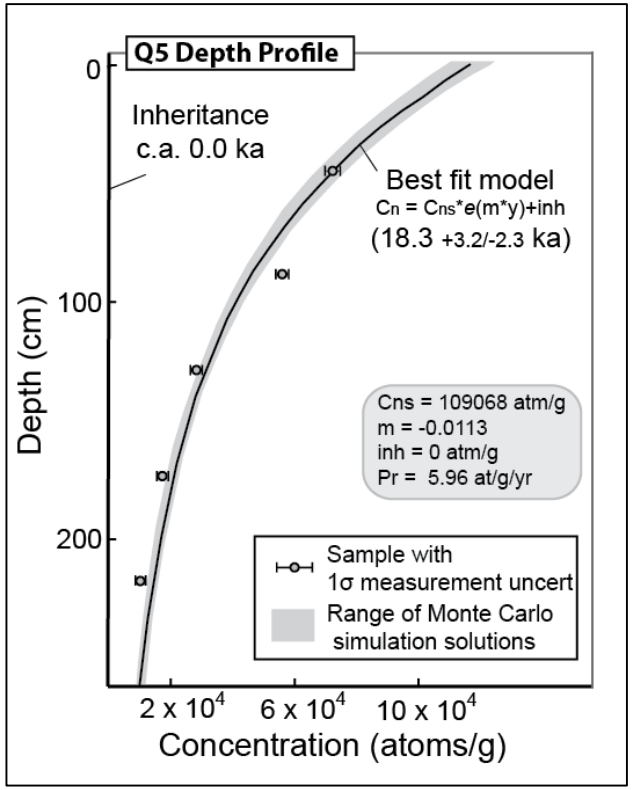




Cosmogenic Exposure dating, Depth Profiles:

- Identify river terraces or alluvial fans offset by fault activity
  Quantify offsets
- Find surfaces to use cosmogenic exposure dating
  Apply time constraints

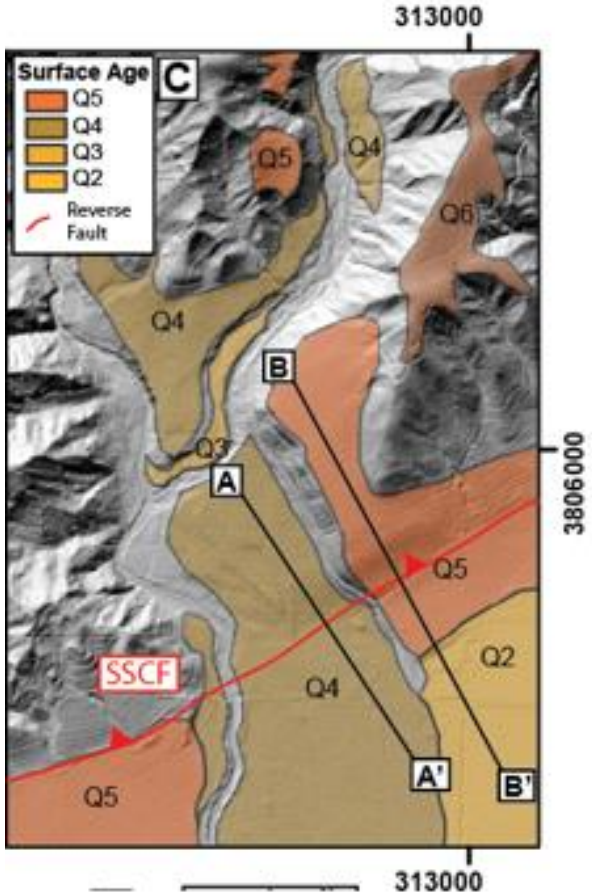


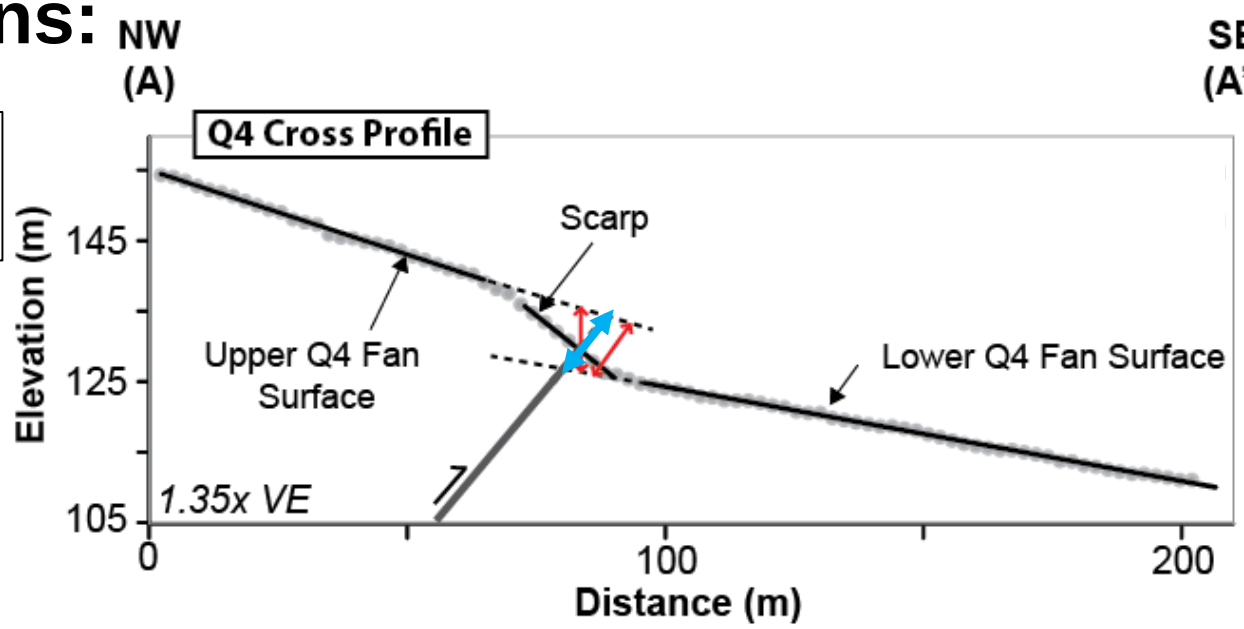


- Younger surface is 6.8 +1.9/-1.4 ka
- Older surface is 18.3 +3.2/-2.3 ka

Slip rate calculations:

- *Quantify offsets*
- *Apply time constraints*

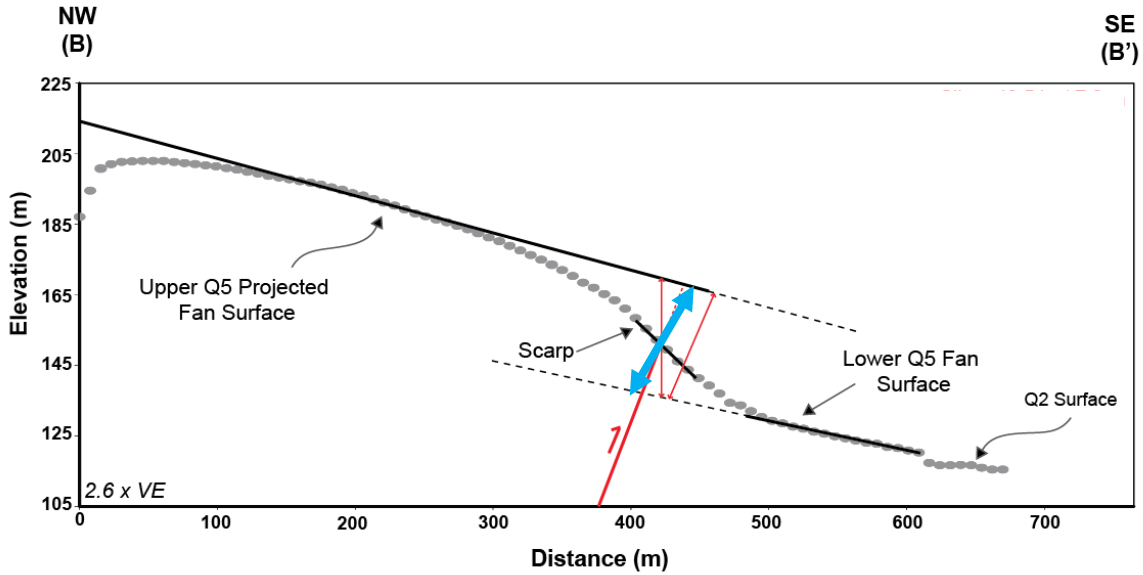




Slip = 11.56 + 2.8/- 2.0 m

Age = 6.8 + 1.9/- 1.4 ka

Slip rate = 1.7 + 0.7/- 0.5 mm/yr



Slip = 49.54 +/- 7.0 m

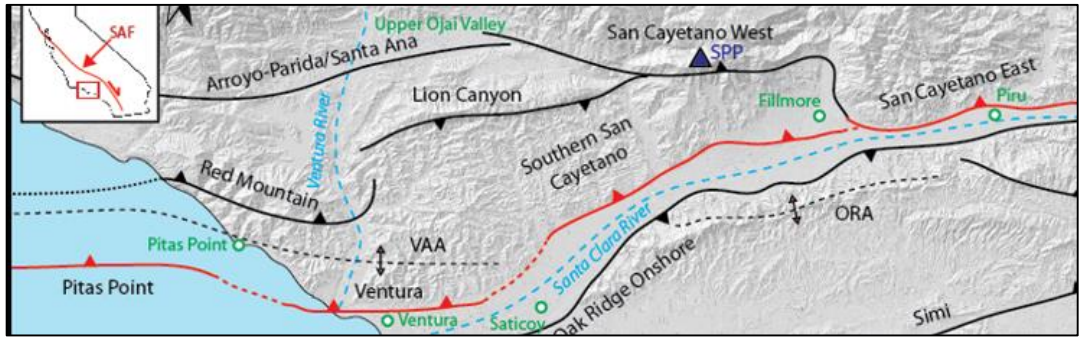
Age = 18.3 + 3.2/- 2.3 ka

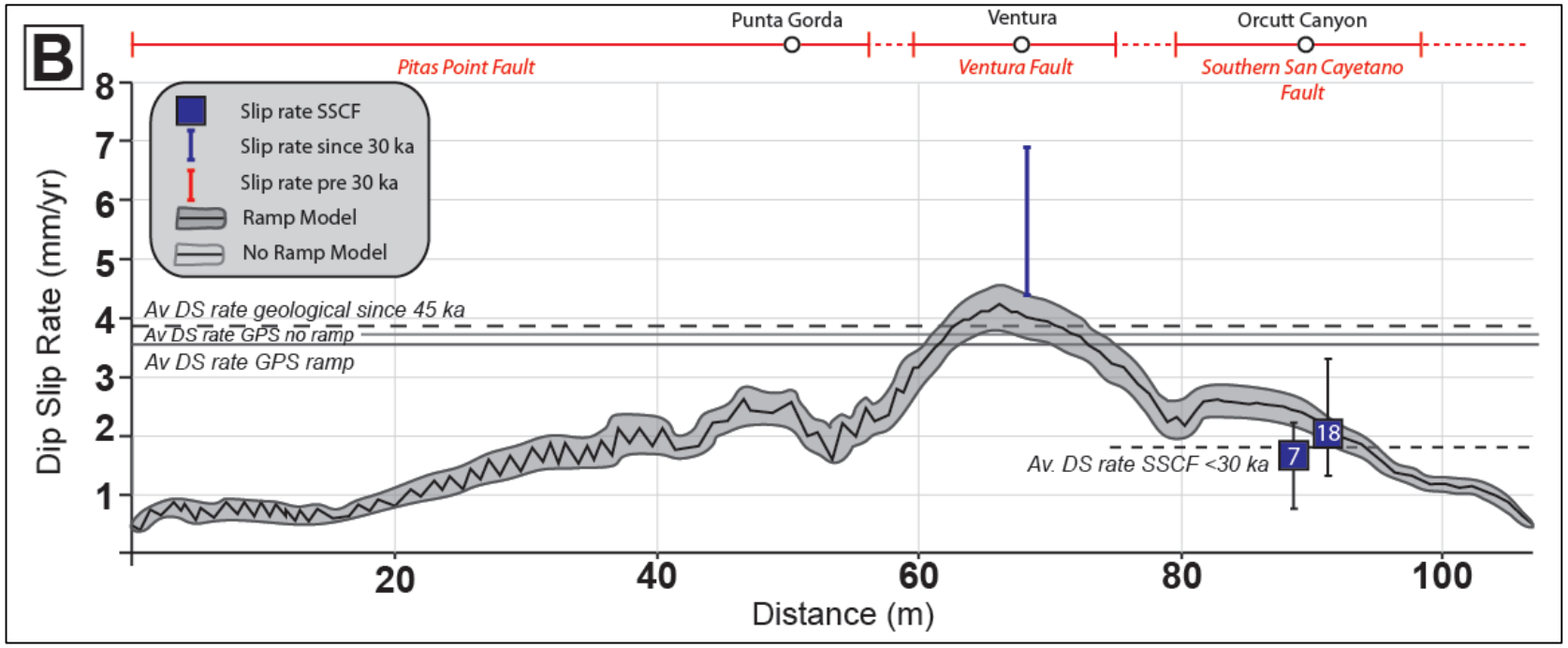
Slip rate = 2.2 +1.0/-0.4 mm/yr

- Slip rate relatively constant at 1.7 +0.7/-0.5 mm/yr since 6.8 ka & 2.2 +1.0/-0.4 mm/yr since 18.3 ka

Implications

Temporal Comparison: Remember: *is there evidence for a fault....is this one long fault....or several smaller ones??*





- Geomorphological evidence suggests a fault at the range front
  - *This alone presents a significant seismic hazard*
- Continuation of geomorphic expression suggests faults are connected

- Our slip rates overlap with GPS model that suggests a ramp geometry in subsurface
  - *This model infers a greater fault area, therefore, larger magnitude earthquakes*

GPS data from Marshal et al 2017. Slip rates for the Ventura and Pitas Point faults from Hubbard et al 2014. Uplift rates for the Ventura Fault from Hubbard et al 2014 and Rockwell 1988.

Summary:

- Highlight geomorphological evidence for a previously unmapped fault in southern California, the Southern San Cayetano fault (SSCF)
  - *Needs to be incorporated in to future seismic hazards assessment*
- Slip rates for the SSCF relatively constant for the last ~20 ka at 1.7 +0.7/-0.5 mm/yr since 6.8 ka & 2.2 +1.0/-0.4 mm/yr since 18.3 ka
  - *Hazard has not changed for the last ~20 ka*
- Our rates agree with GPS derived models that suggests greater fault surface area, therefore, potential for larger magnitude earthquakes
- Combination of slip rates and geomorphology highlight possibility of multi-fault ruptures and M8.0 earthquakes
- Future work will look at subsurface data

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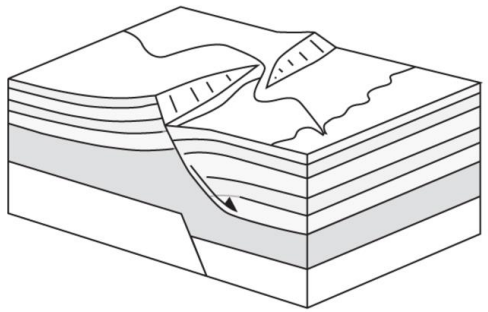
NERC SCIENCE OF THE ENVIRONMENT

SCEC an NSF+USGS center

ansto

Basins Research Group



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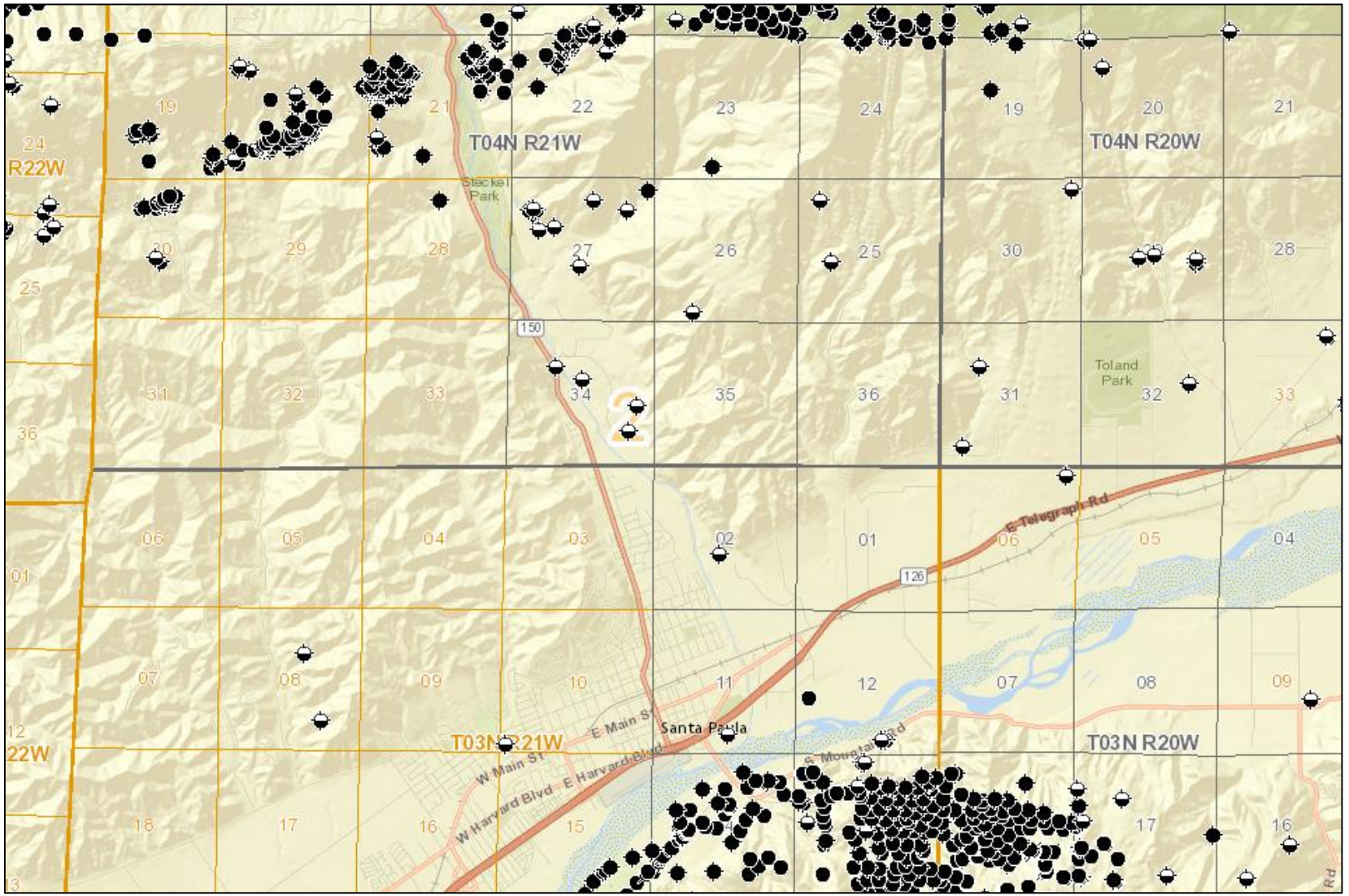
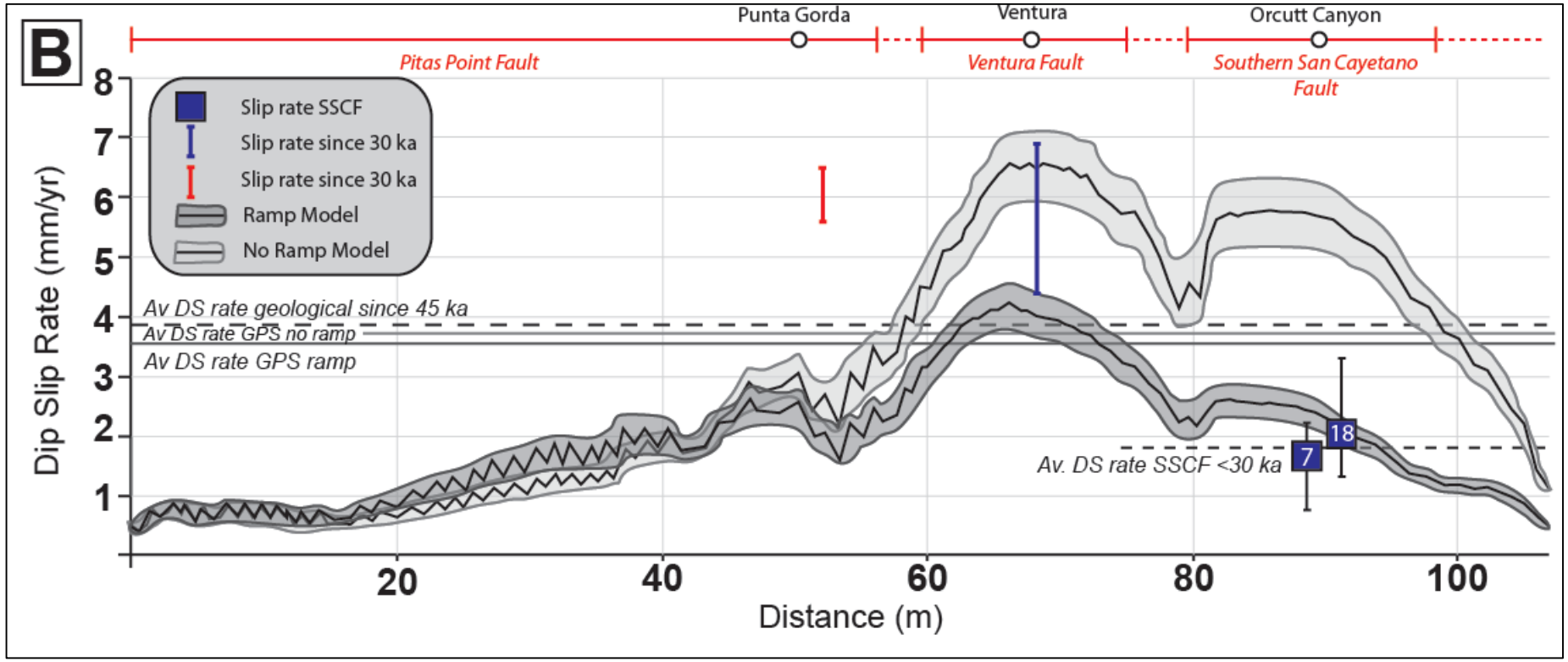
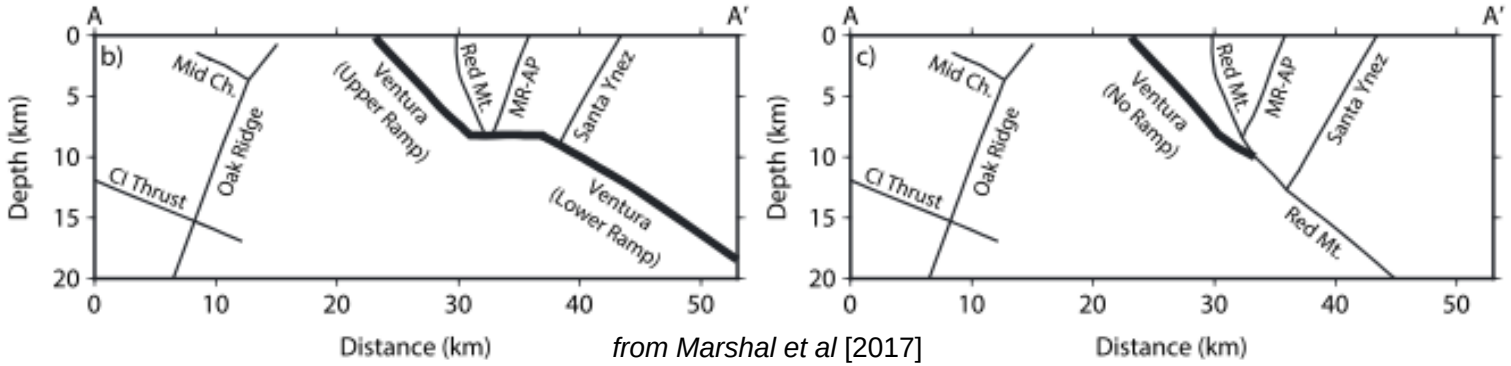


https://maps.conservation.ca.gov/doggr/wellfinder/#close



GPS data from Marshal et al [2017]. *Slip rates for the Ventura and Pitas Point faults from Hubbard et al 2014. (GPS data is surface deformation, grey boundaries are regional strain rate boundary conditions uncertainties).*



from Marshal et al [2017]