Estimating evolving shear tractions on the southern San Andreas fault system based on the paleoseismic record

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SCEC UNREST
June 2, 2026

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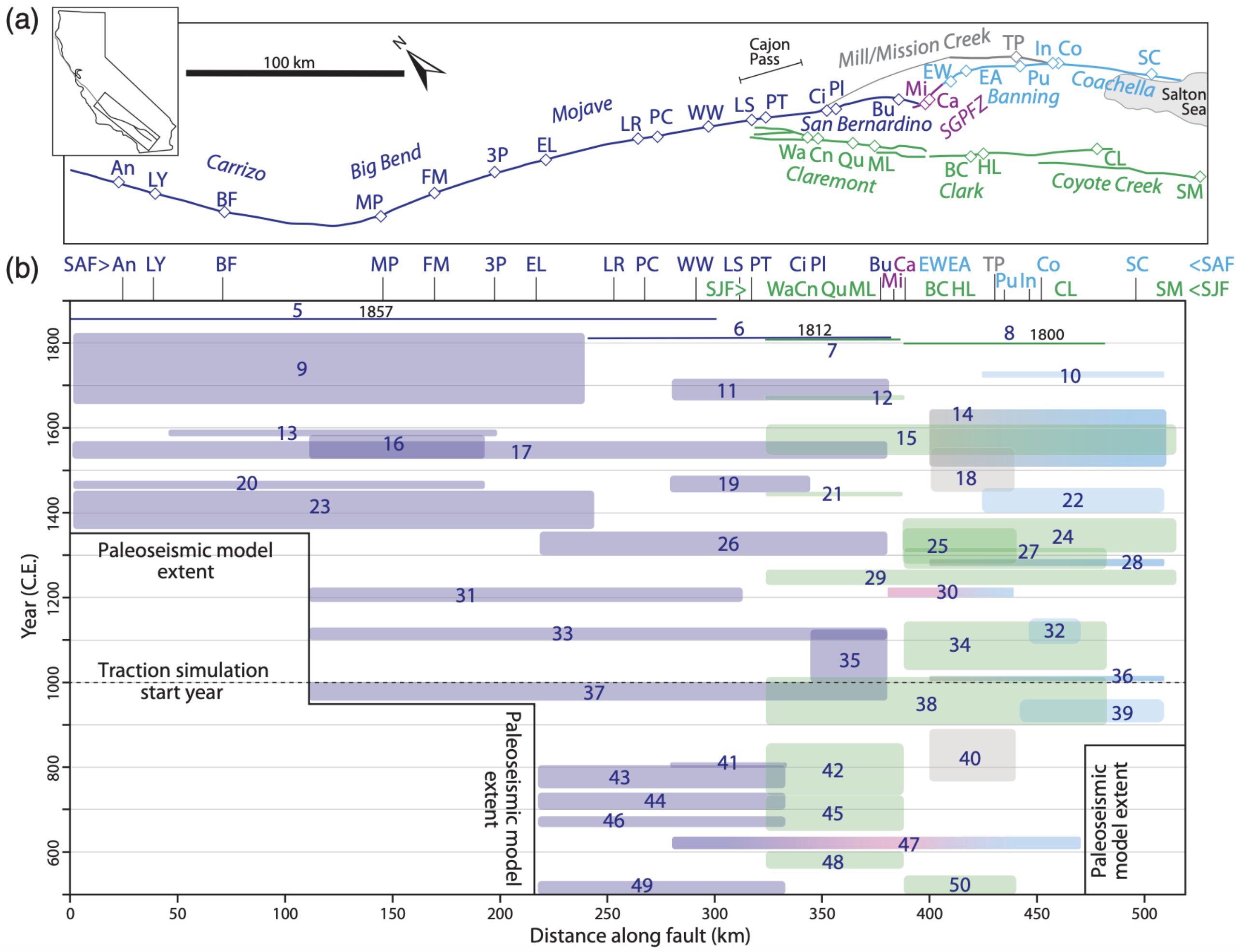
Why model evolving shear tractions?

- What tractions (stresses) drive ground-rupturing earthquakes?
- How do pre-quake traction and fault geometry influence the rupture length of earthquakes?
- And… pre-quake tractions are useful inputs for dynamic rupture models



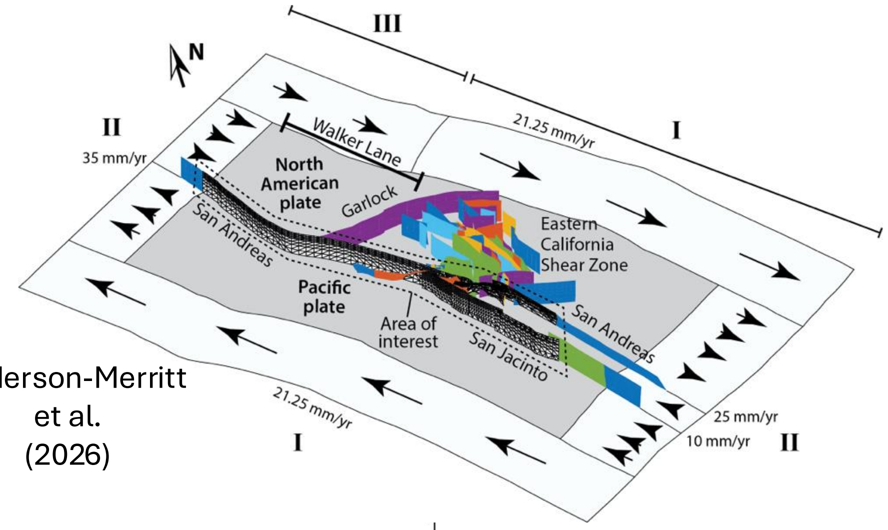
Scharer & Yule (2020)

Modeling fault traction through time

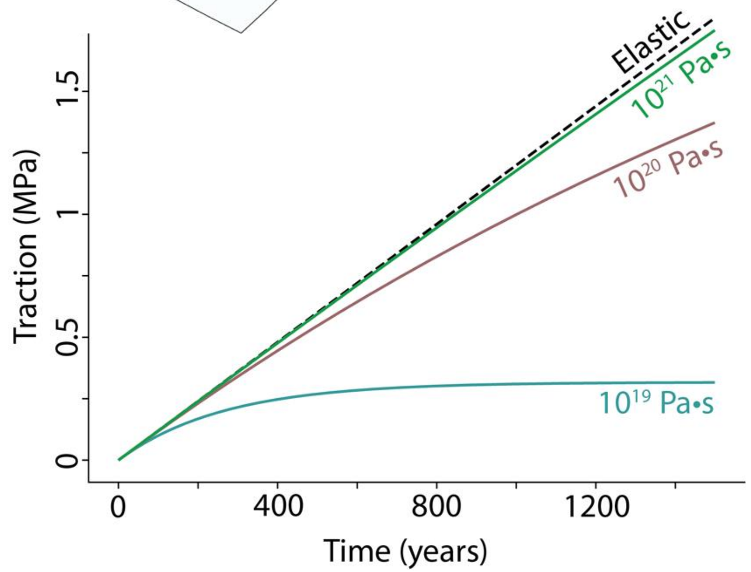
Shear traction = interseismic stressing + earthquake effects

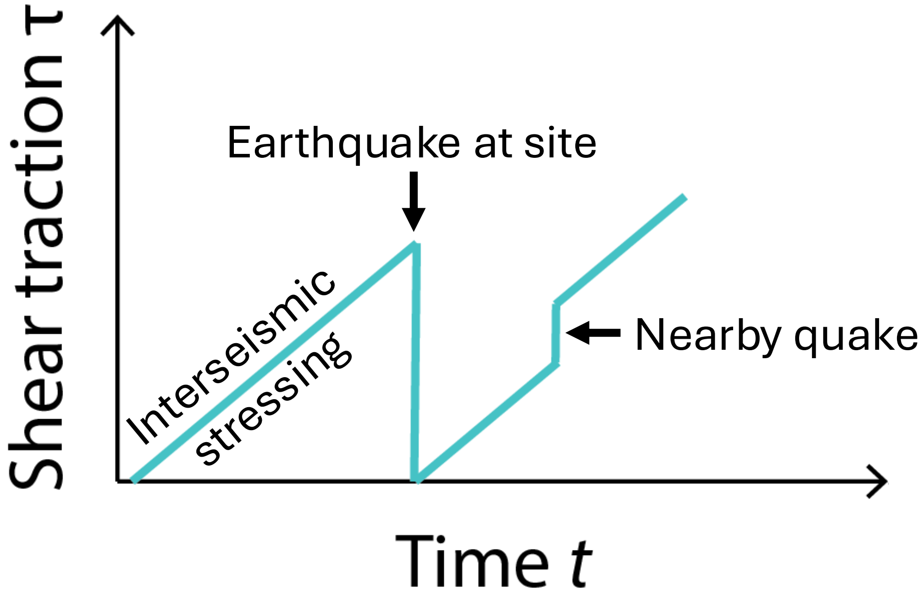
- Tectonic loading
- Varying viscoelastic stress relaxation

- Earthquakes at site
- Nearby earthquakes



Anderson-Merritt et al. (2026)





Modeling fault traction through time

Shear traction = interseismic stressing + earthquake effects

interseismic stressing:

- Tectonic loading
- Varying viscoelastic stress relaxation

earthquake effects:

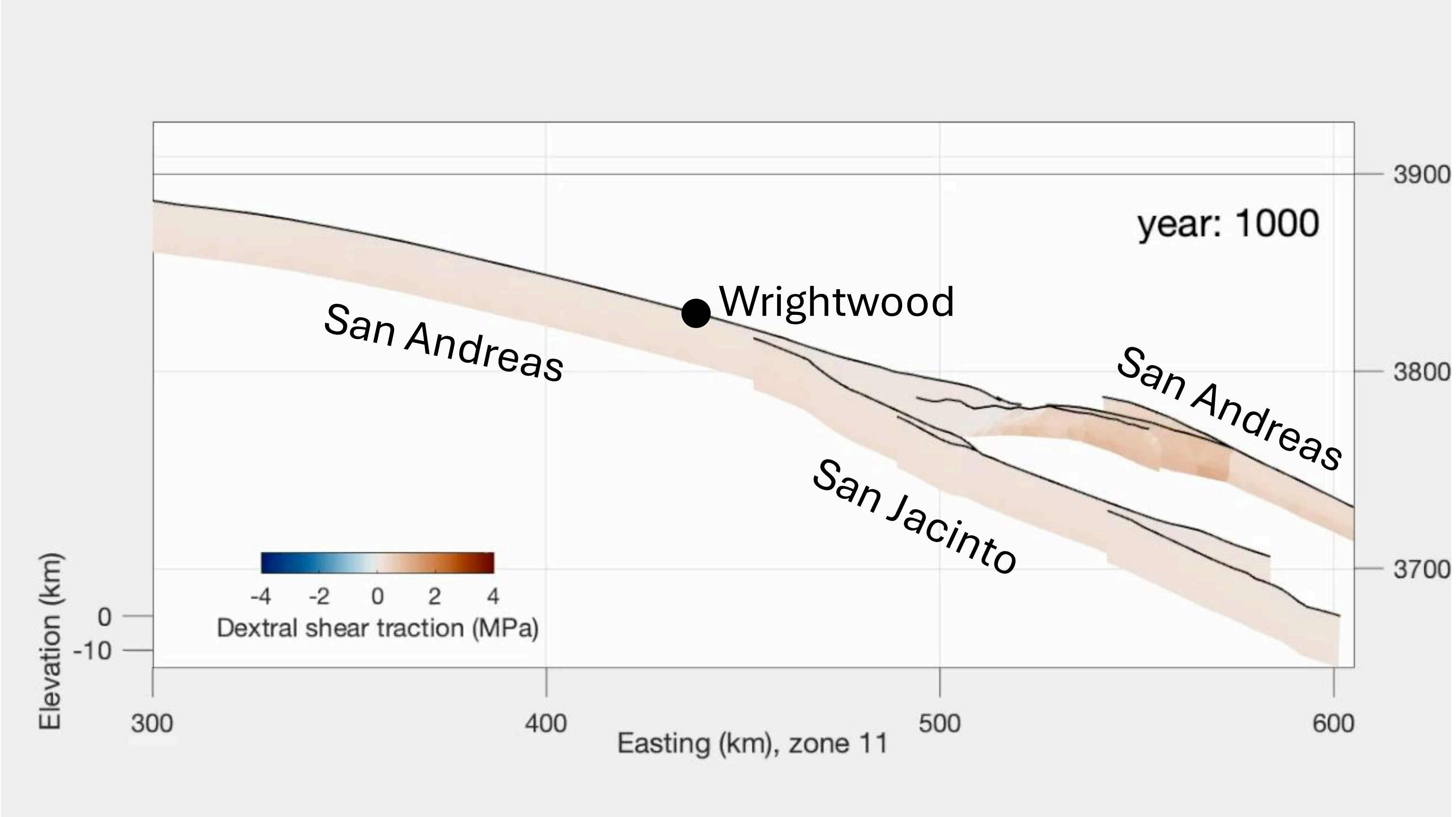
- Earthquakes at site
- Nearby earthquakes

Model outputs:

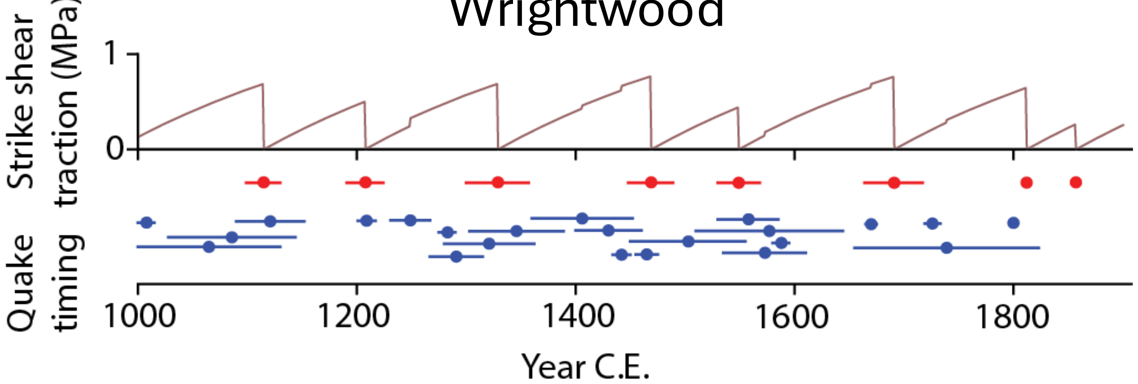
- Evolving shear tractions over time
- Average slip per event in earthquakes (used to validate simulations)

- We vary effective upper crustal viscosity, earthquake timing, and stress drop completeness in Monte Carlo simulations

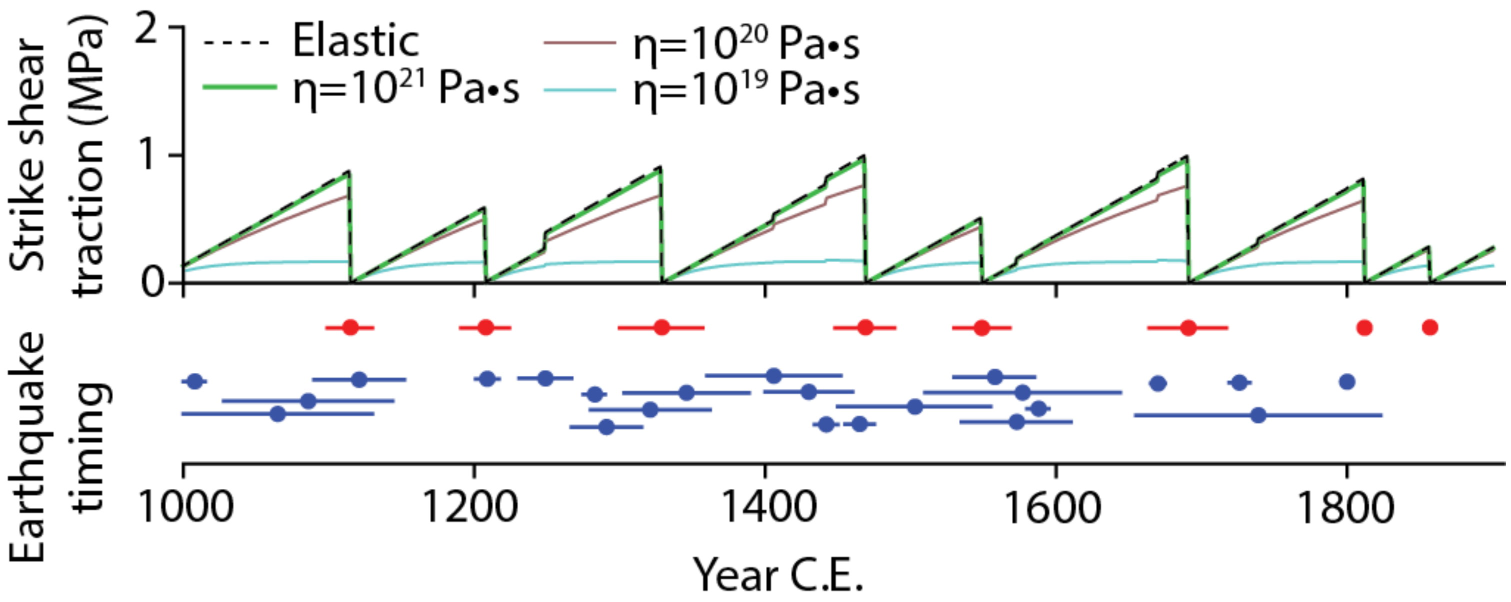
Evolving strike shear tractions



Anderson-Merritt et al. (2026)



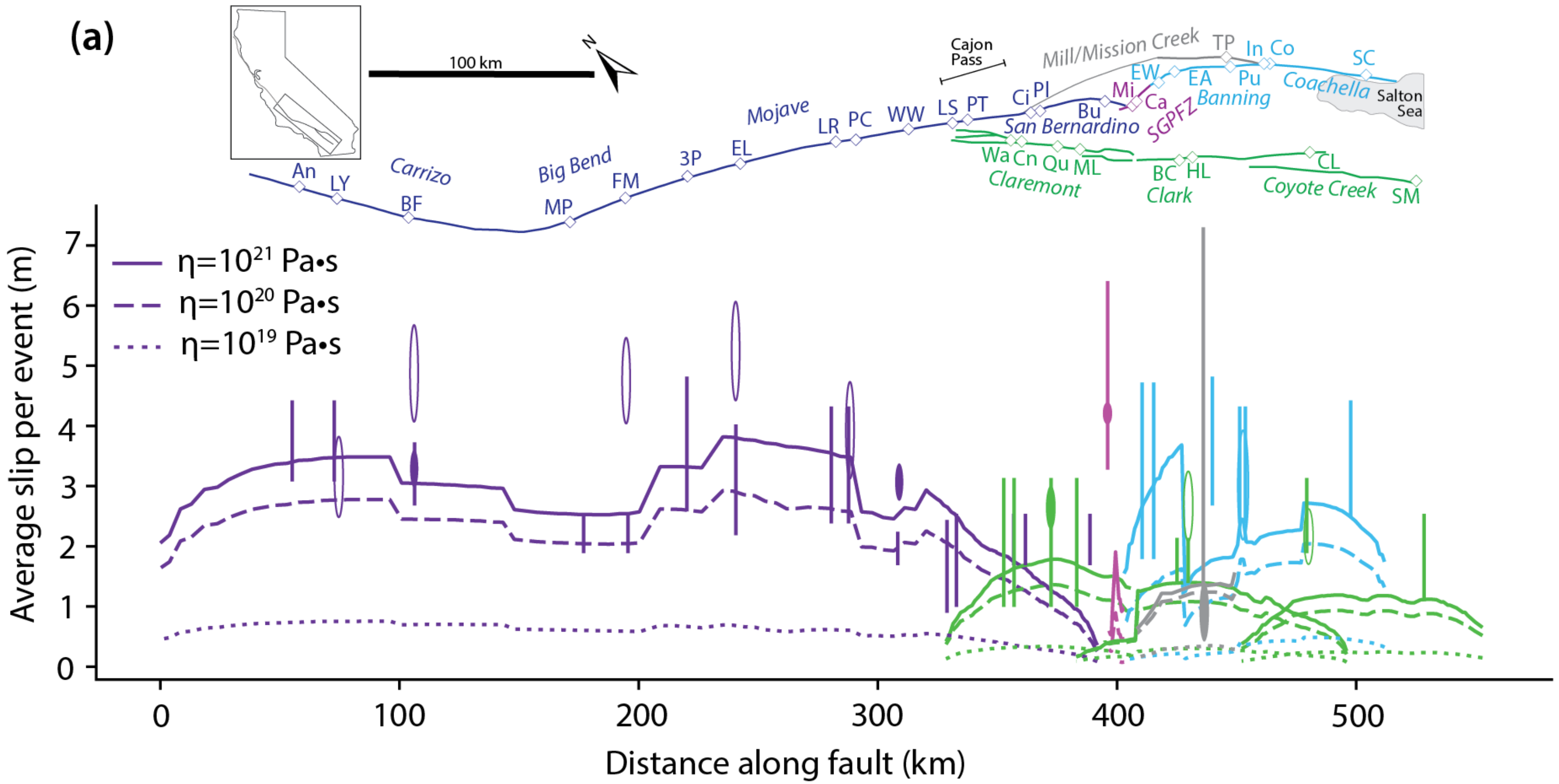
Evolving shear traction example: Wrightwood



Anderson-Merritt et al. (2026)

- Most traction accumulates from interseismic stressing
- Choice of upper crustal viscosity greatly affects accumulated tractions
- Nearby earthquakes have small effects on traction

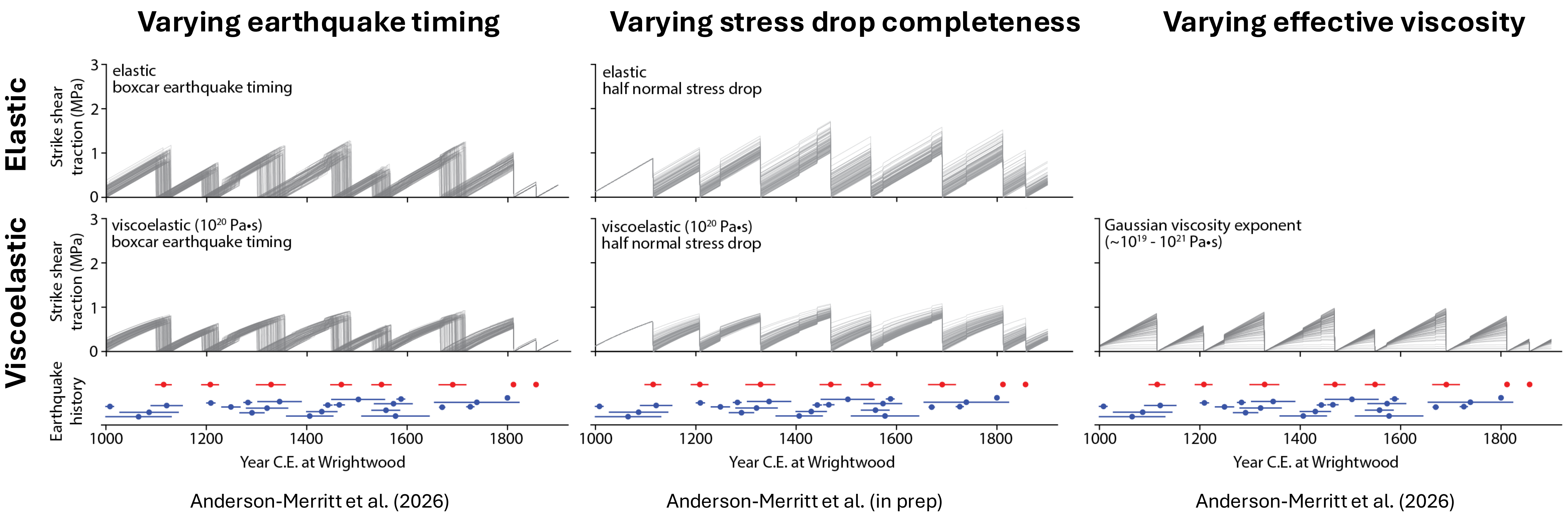
Model validation: average slip per event



Anderson-Merritt et al. (2026)

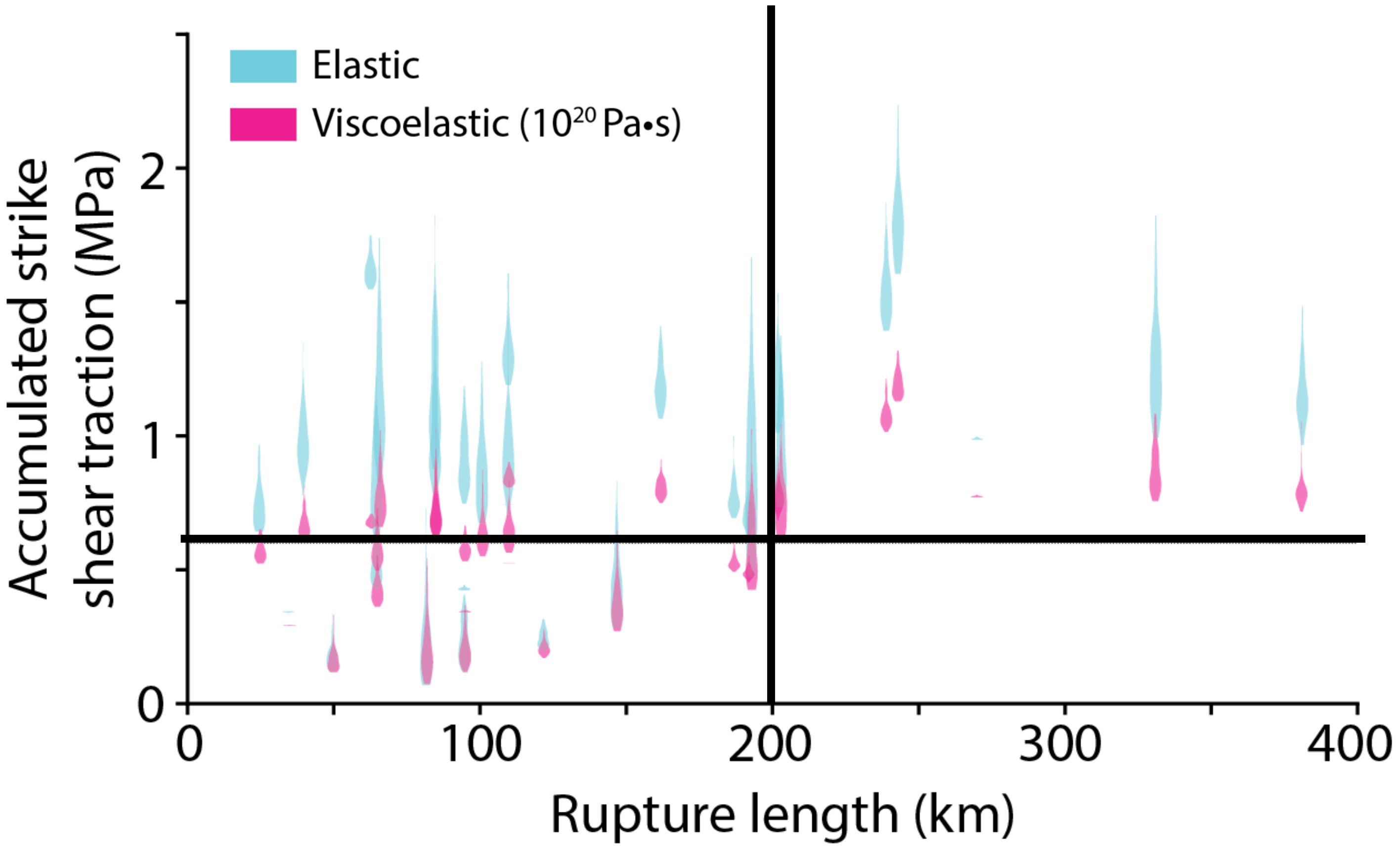
High and moderate viscosity simulations reproduce average slip per event from field studies, but low viscosity doesn’t

Monte Carlo simulations – Wrightwood



Uncertainty in effective upper crustal viscosity has the greatest impact on shear traction uncertainty

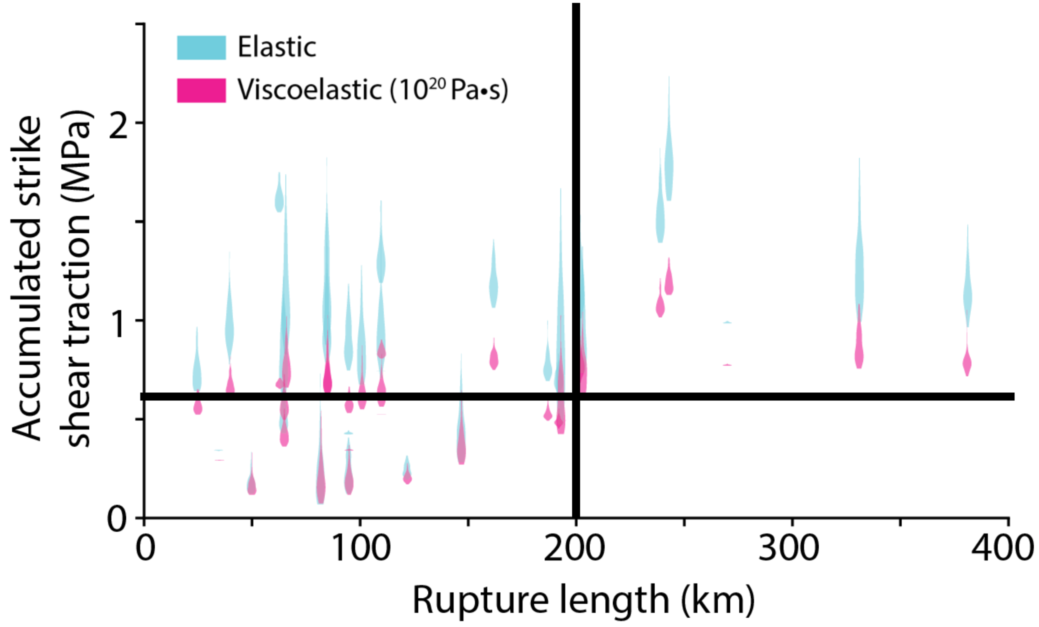
Pre-quake tractions and rupture length



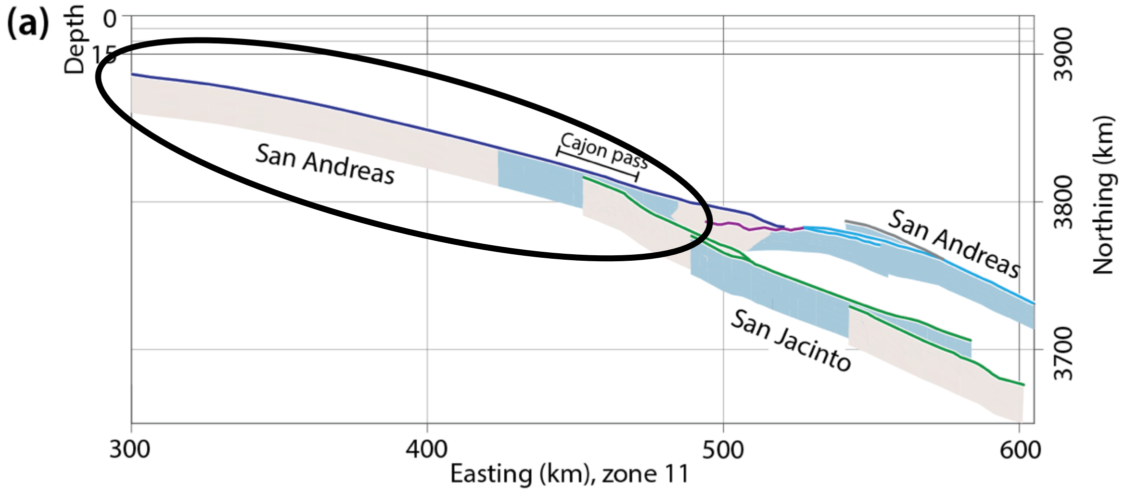
Anderson-Merritt et al. (in prep)

- Short ruptures have a variety of pre-quake shear tractions
- Long ruptures have pre-quake shear tractions > ~0.6 MPa

Pre-quake traction and location



Anderson-Merritt et al. (in prep)



Anderson-Merritt et al. (2026)

- Short rupture length, high shear traction: near stepovers and branches
- Long rupture length, high shear traction: San Andreas north of Cajon Pass where fault geometry is simple

Conclusions

- Choice of effective upper crustal viscosity significantly impacts traction estimates
  - Tighter constraints on average slip per event could help narrow the plausible range
- Pre-earthquake traction and fault geometry inform rupture extent of earthquakes
  - This result depends on the input rupture model
  - Other rupture models are compatible with the paleoseismic data