Funding provided by SCEC Award #23105

Event timing and slip kinematics of relay zone faults suggest **strain is transferred seismogenically** between the Ash Hill and the Panamint fault

Modelled static Coulomb stress changes discourage earthquake triggering, **dynamic triggering may be required**

For full report and citations, please scan code below:

Testing the potential for static triggering of Holocene earthquakes on the Panamint Valley, Ash Hill, and PVTR faults, northern ECSZ

Aubrey LaPlante, Christine Regalla; *School of Earth and Sustainability, Northern Arizona University, Flagstaff, AZ*

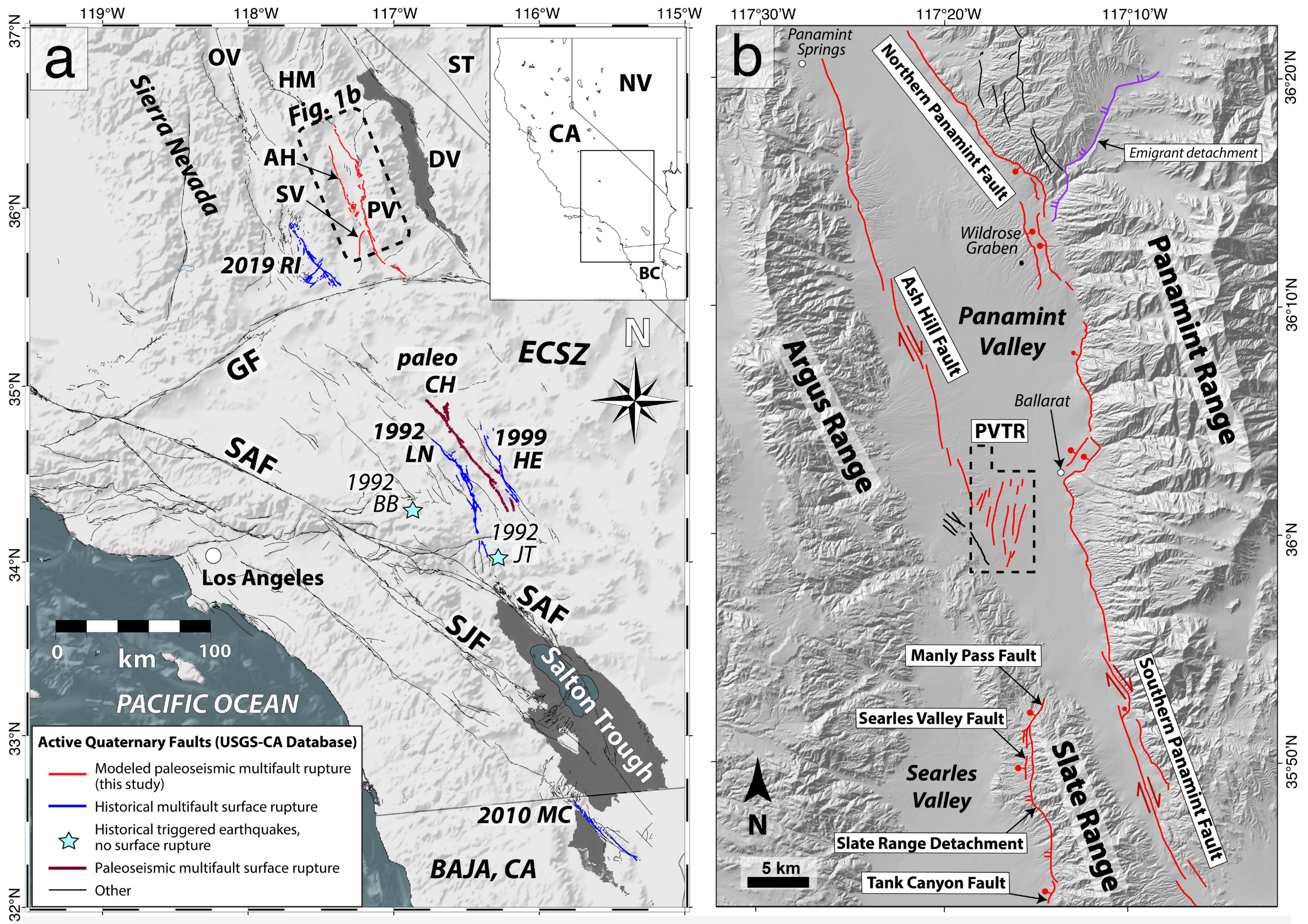


Figure 1. **A.** Regional map of the ECSZ, with active Quaternary faults from the USGS-CA Geologic Survey. **B.** Hillshaded DEM of Panamint Valley with modeled faults (this study) in red. The location of a the complex transfer zone, the Panamint Valley transtensional relay (PVTR), is outlined by a black dashed box.

Introduction

Evidence for multifault or triggered events have been documented in the ECSZ for historical and paleoseismic earthquakes (Fig. 1a) [Hauksson et al., 1993; Cramer and Darragh, 1994; Rymer et al., 2002; Fletcher et al., 2014; Vadman et al., 2023]. In Panamint Valley (Fig. 1a-b), the **temporal overlap** (Fig. 2) of late Holocene earthquakes on the Panamint Valley fault, Ash Hill fault, and the Panamint Valley transtensional relay suggests that faults in this region can also rupture in coordinated, triggered, or multifault events. In this study, we modeled different **source-receiver fault parameters** and **Coulomb failure stress changes** on receiver faults, which could lead to **static triggering or coordinated earthquakes** between faults within the Panamint and/or Searles Valleys, in the northern Eastern California Shear Zone (ECSZ, Fig. 1a).

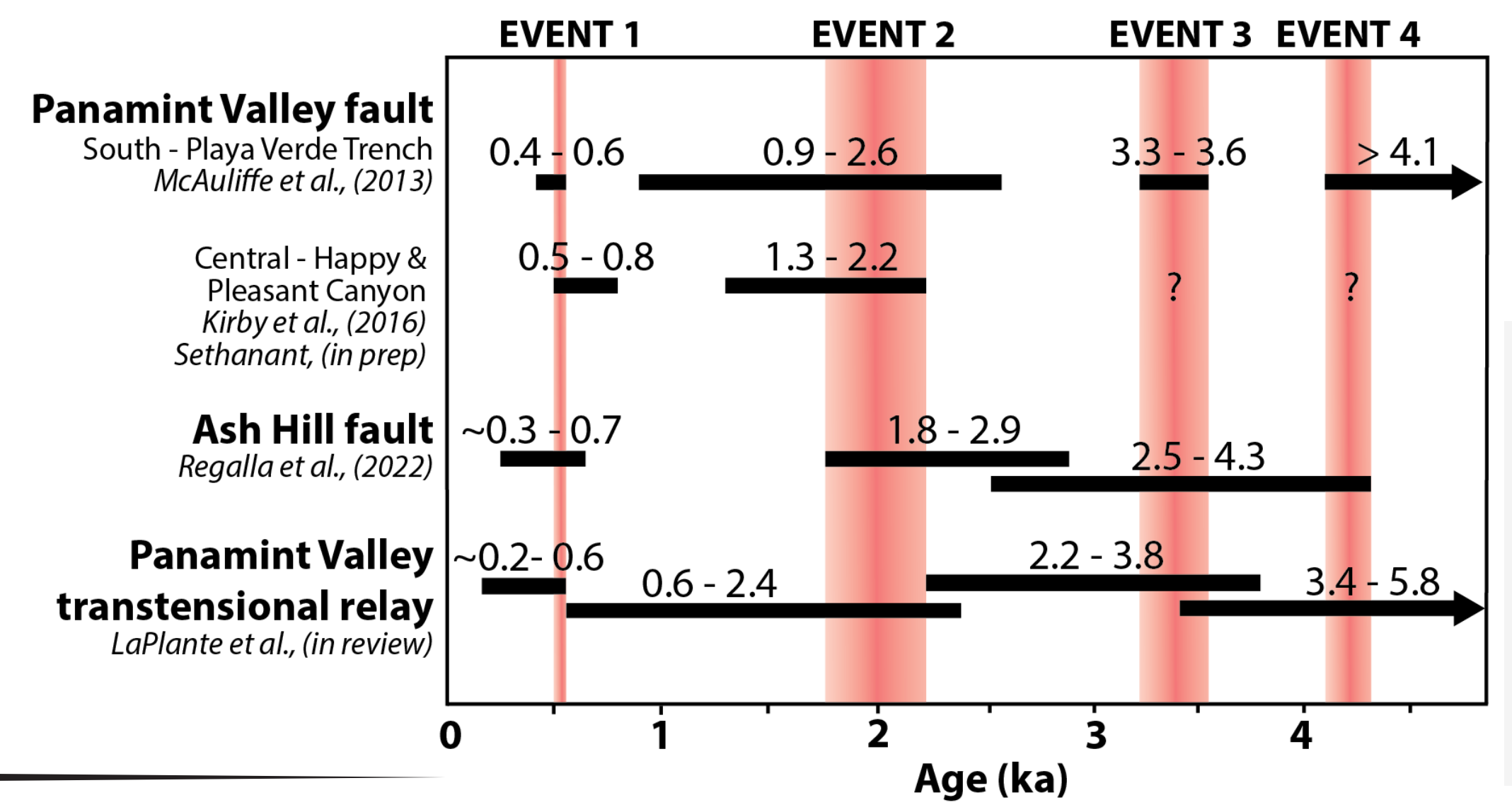


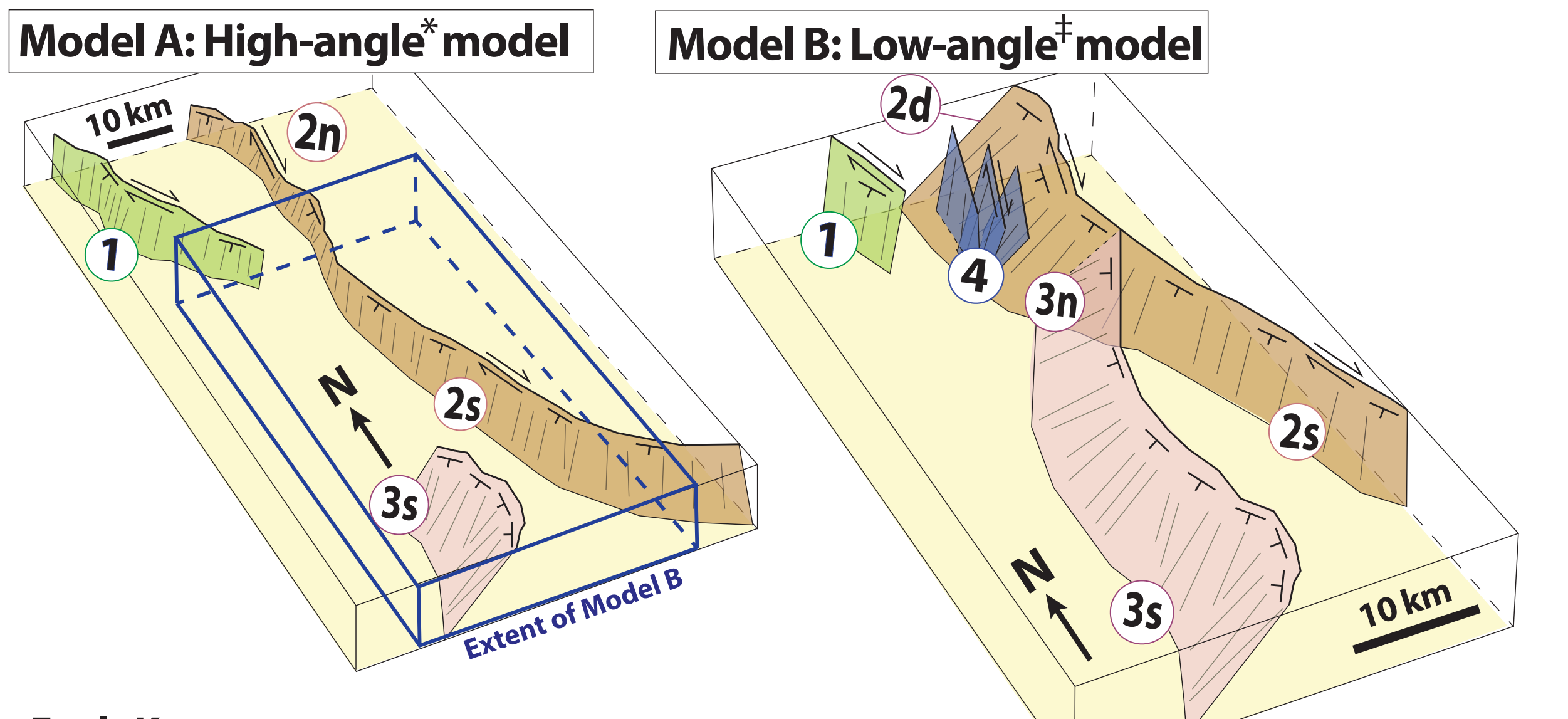
Figure 2. Timing of the last 3 - 4 late Holocene earthquakes along the PVTR, the Ash Hill and the Panamint Valley faults. Black bars indicate the rupture timing on each fault system. Vertical red bars indicate the time interval in which the late Holocene ruptures of all three systems overlap.

Modeled fault geometries

We tested whether multifault earthquakes in Panamint Valley could be explained by static triggering. Using Coulomb 3.3 [Toda et al., 2005], we varied earthquake-source fault locations, fault kinematics, and subsurface fault geometries (Table 1), to produce Coulomb failure stress (CFS) change maps. For a full table of parameters and references, please scan the QR code in the bottom left corner.

Table 1. Modeled fault parameters.

	Length (km)	Strike	Dip Angle° and Direction	Slip vector	Slip per event (m)
Panamint fault	100	147°-175°	W-dipping		
north of Ballarat			>60° (Model A) or < 30° (Model B)	~300°- 325°	~2.5 - 5.5
south of Ballarat			~70 - 90°	~325°- 340°	~2.5 - 5.5
Ash Hill fault	40	148°-197°	W-dipping, ~70-90°	~345°	1.0 ± 0.2
Manly Pass-Searles Valley faults	45	143°-232°	W- to NW-dipping, ~20-50°	~230° - 310°	unknown, modeled 1m
Panamint Valley transtensional relay (PVTR)	10	184-195°	W and E-dipping, ~70-90°	~354° - 365°	0.6 - 1.1



Fault Key

1: Ash Hill fault
2n: N. Panamint fault
2s: S. Panamint fault
2d: Detachment fault
3n: Manly Pass - Searles Valley fault
3s: Tank Canyon fault
4: PVTR

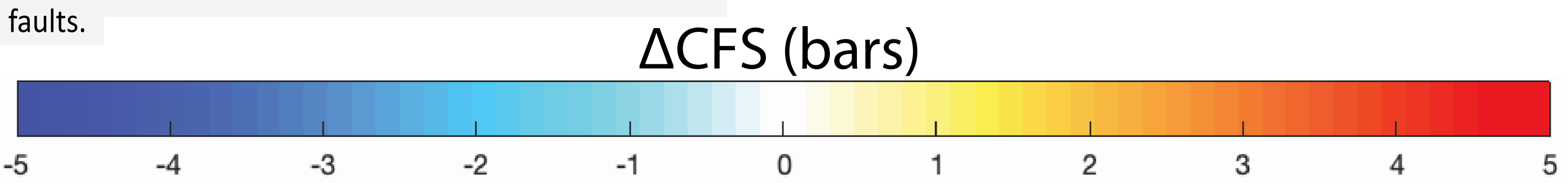
*High-angle faults modeled after the SCEC Community Fault Model (Plesch et al., 2007; Marshall et al., 2023)

‡Modeled fault geometies are modified from models presented by Walker et al., 2005.

Figure 3. Modeled end member subsurface fault geometries. Model A. High-angle fault model (SCEC CFM5.3) includes high-angle Panamint fault and no PVTR. Model B. Low-angle fault model includes low-angle central Panamint and high-angle PVTR faults.

Summary of findings

All **Panamint-Ash Hill-PVTR source-receiver geometries** produced Coulomb failure stress changes (Figs. 4-6) that **discourage earthquake triggering via static stress transfer.** Stresses resolved at the southern tip of the Ash Hill discourage static triggering on PVTR (NE-SW striking) faults. The **Manly Pass-Searles Valley-Panamint Valley source-receiver** models produced Coulomb stress changes to **encourage static stress triggering** between the Searles Valley faults and Panamint Valley faults. However, the Manly Pass-Searles Valley faults have very low Quaternary slip rates, and are unlikely the primary driver of seismogenic stress transfer in this region.



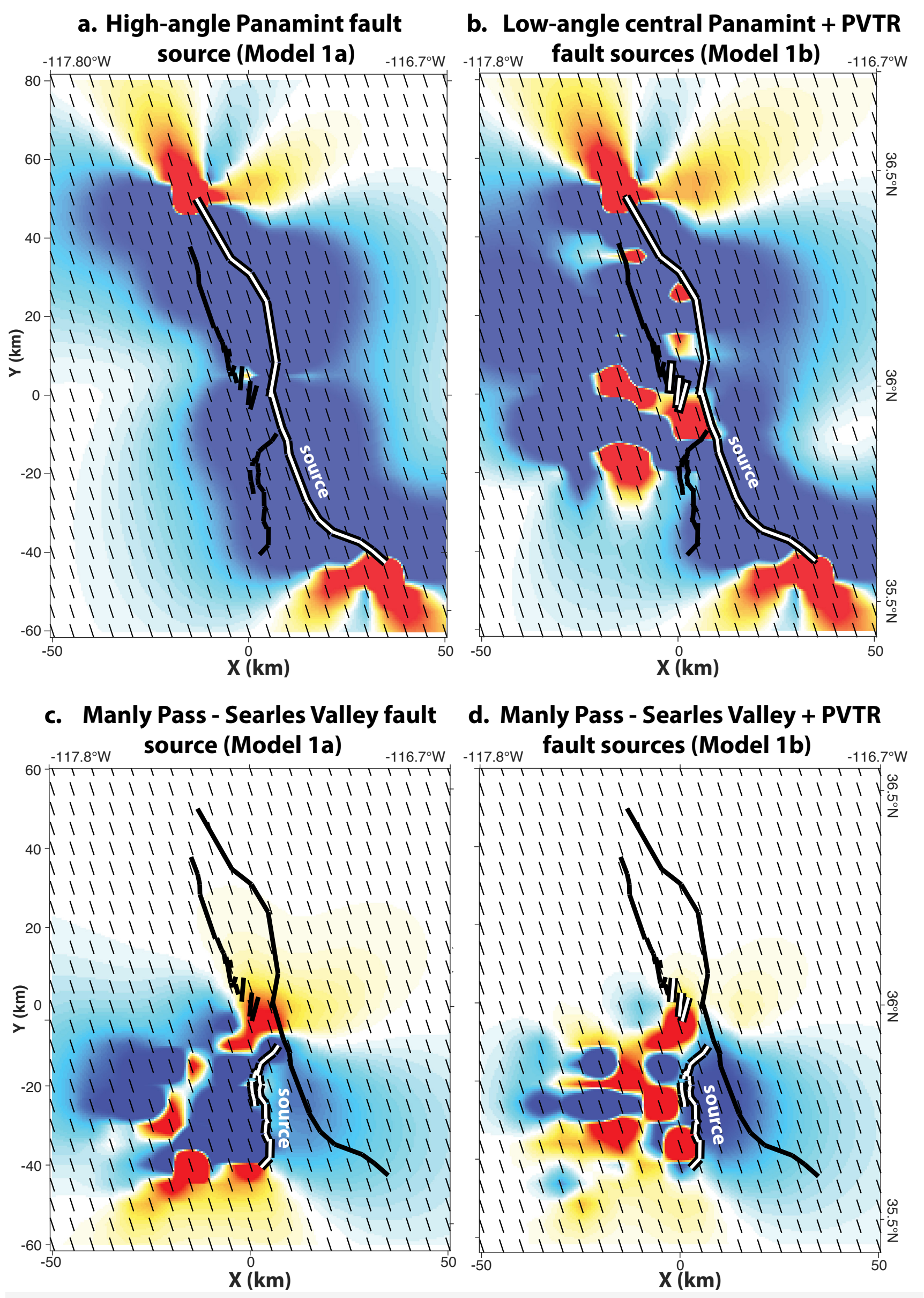


Figure 4. Modelled coulomb stress changes on a receiver fault with a strike and dip of 162°/80°, and a rake of -170. Source faults are highlighted white in each scenario.

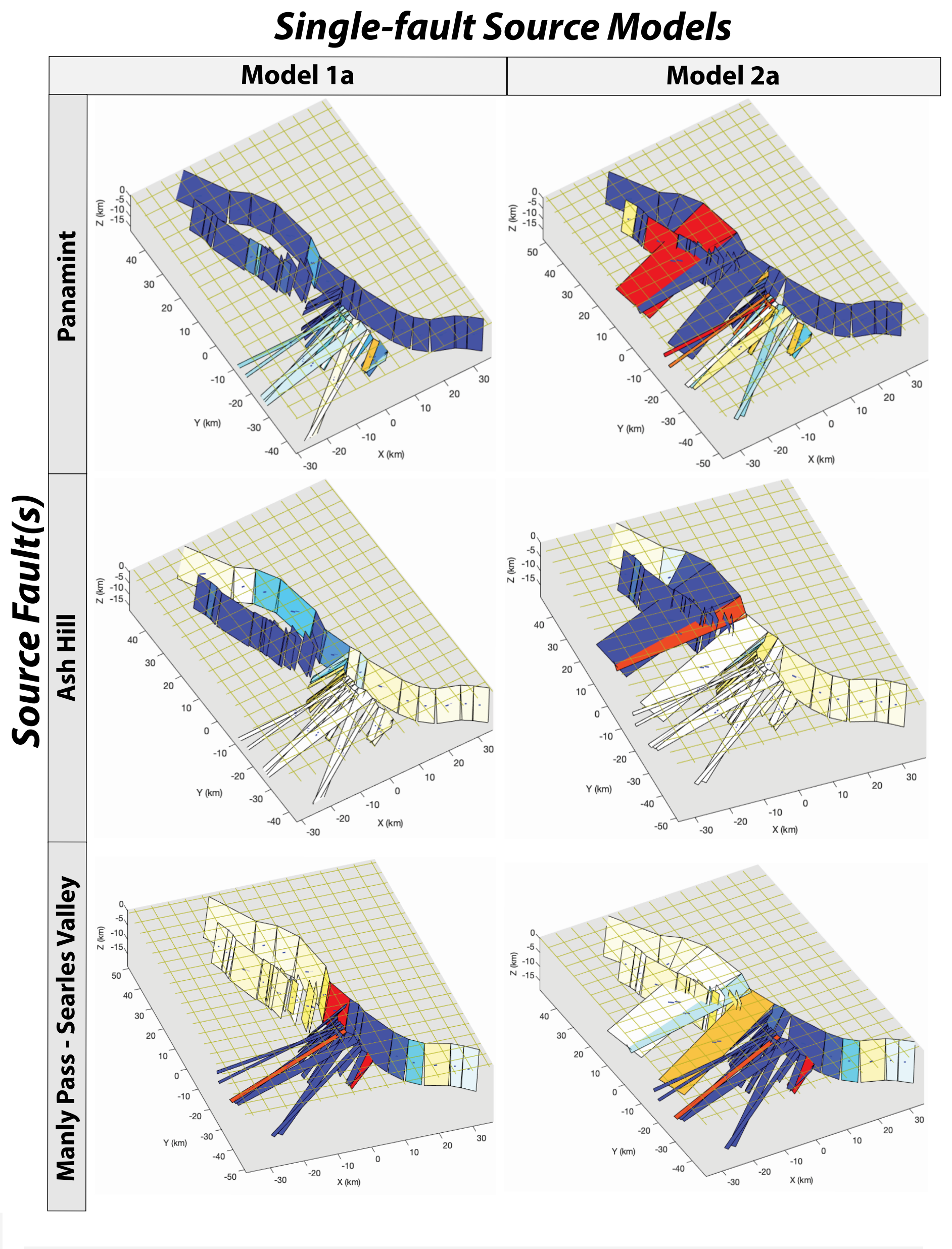


Figure 5. Coulomb stress change distributions resolved on modeled fault planes for single-source fault models, based on individual segment rake.

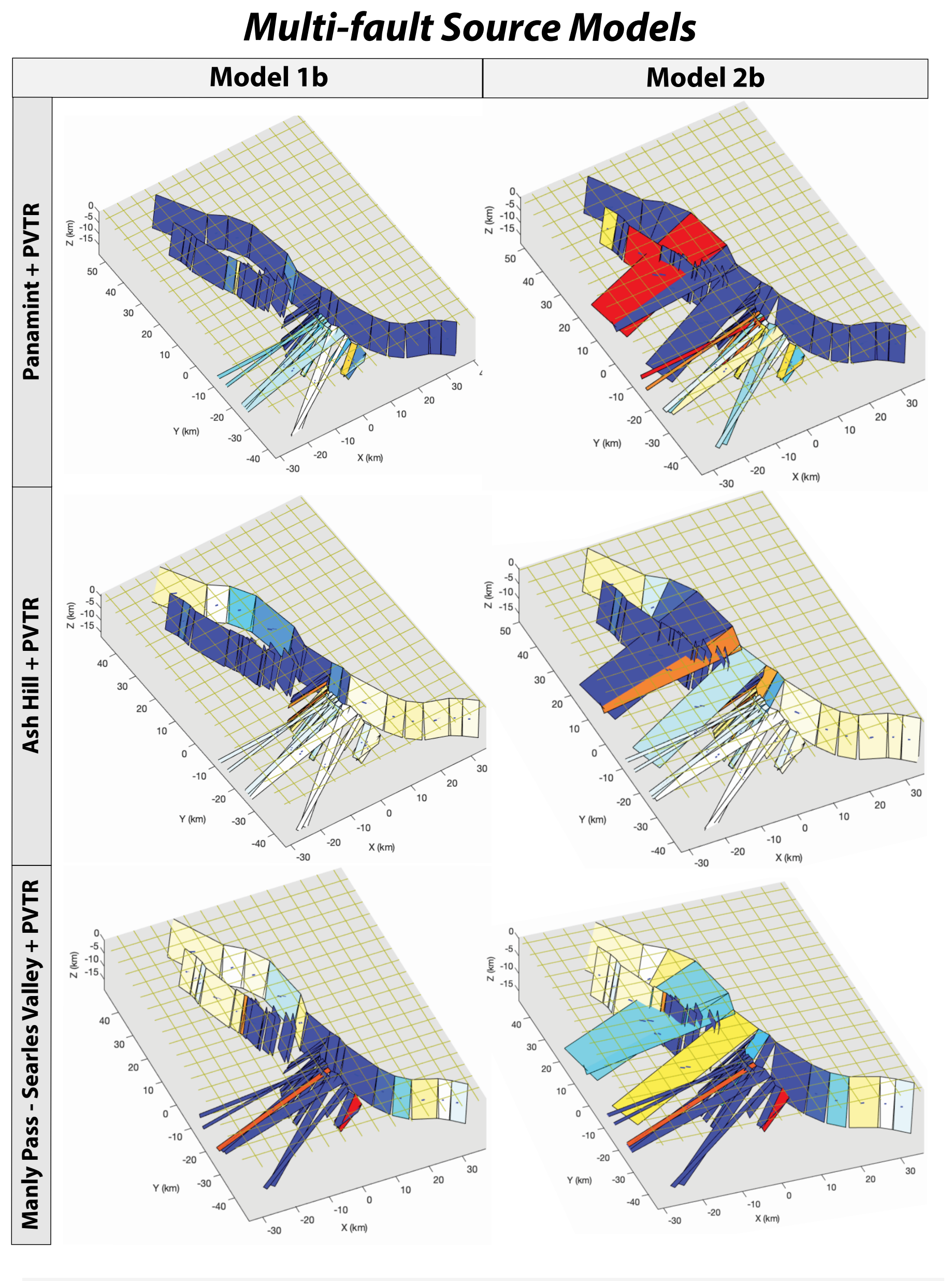


Figure 6. Coulomb stress change distributions resolved on modeled fault planes for multifault source models, based on individual segment rake.

Implications

- These models provide evidence that **static stress transfer is possible with a Manly Pass-Searles Valley source fault** system and the receiver faults of Panamint, Ash Hill and/or the PVTR.
- If **the Panamint, Ash Hill, and PVTR faults** do rupture in closely timed events, as is suggested by paleoseismic data, the results of this study imply that they **are unlikely to be rupturing** at similar times as a result of **static stress transfer.**
- Alternatively, **dynamic stress triggering may be required** to explain the overlap in earthquake timing of the 3 - 4 most recent, late Holocene events on Panamint, Ash Hill, and PVTR faults.
- More complex models may incorporate **transtensional extension** of a basin, **strain accomodation via rotation**, or seismogenic **dynamic stress triggering.**