Fault zone controls on the spatial distribution of slow-moving landslides

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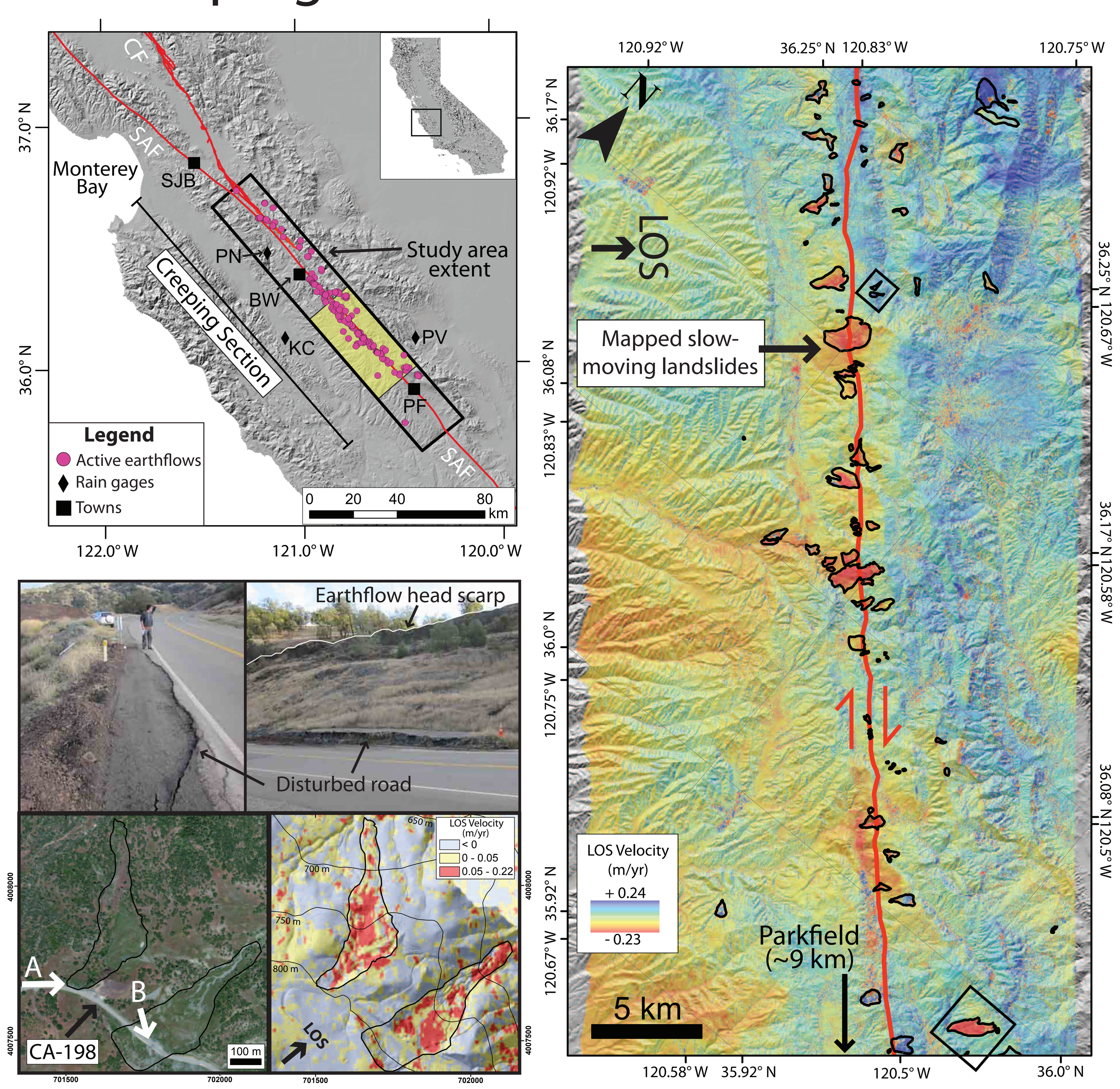
Motivation

- Slow-moving landslides (earthflows) can be the primary drivers of hillslope lowering and the dominant source of sediment to river networks in areas of weak, fine-grained bedrock with low to moderate hillslope gradients.
- Controls on the occurrence of slow-moving landslides are poorly constrained, and need to be understood for landscape evolution models, sediment budgets, and infrastructure and hazards planning.

Methods

- We used a combination of airborne interferometric synthetic aperture radar (InSAR) from the UAVSAR instrument and high resolution aerial photographs to map 150 active earthflows along the creeping portion of the San Andreas Fault.
- Increased resolution (compared to conventional satellite InSAR) and the ability to fly at any heading with the UAVSAR instrument allowed identification of earthflows as small as 50 m in width.

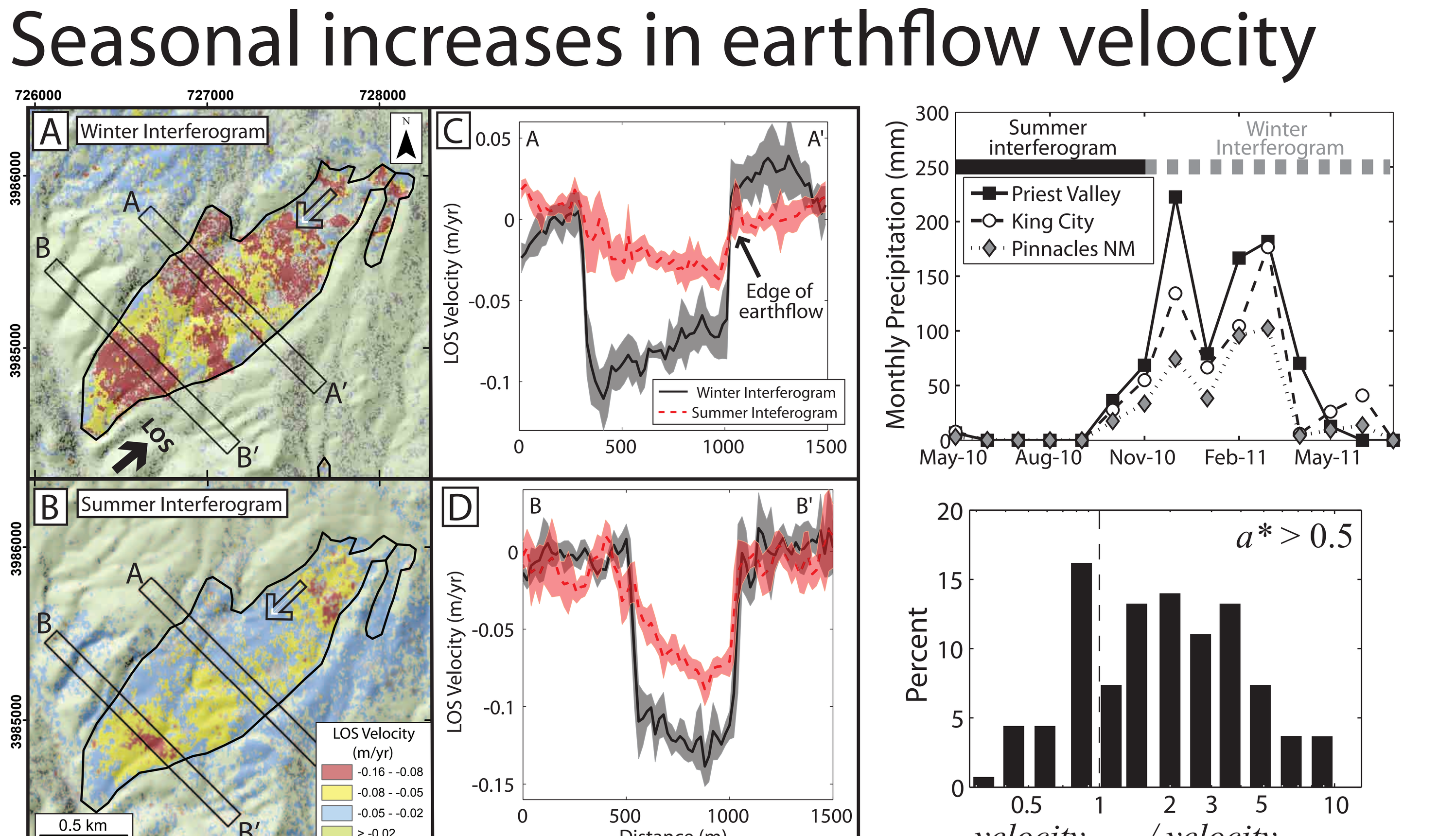
Slow-moving landslides (earthflows) along the creeping San Andreas Fault



UAVSAR line 14003, collected November 16, 2010 and July 12, 2011 (238 days elapsed)

UAVSAR line 14003, collected May 11, 2010 and 12 July 2011 (427 days elapsed between collections)

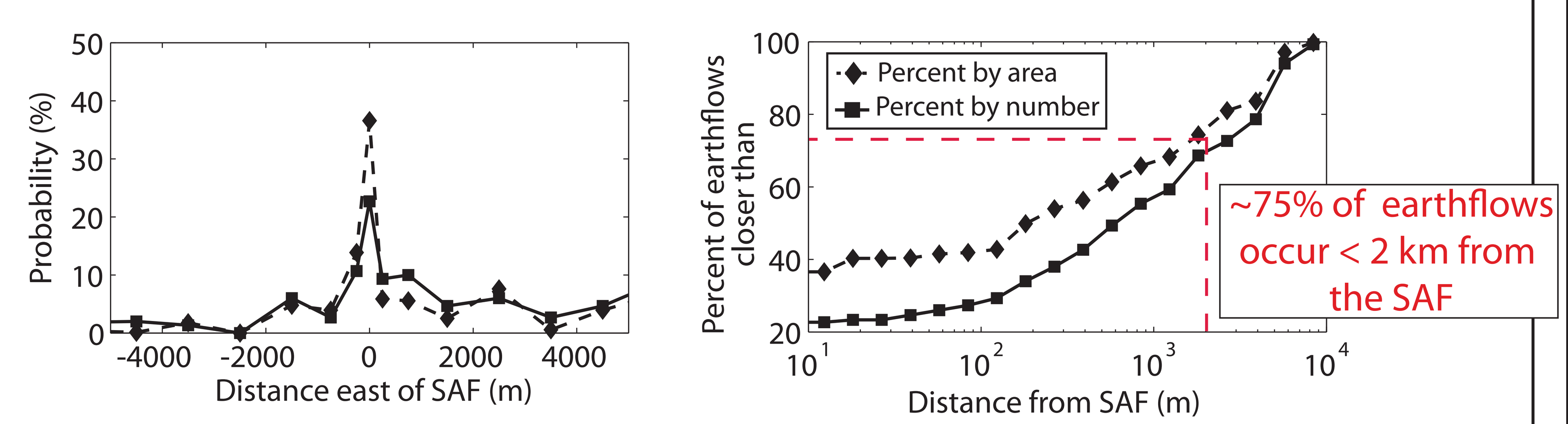
Seasonal increases in earthflow velocity



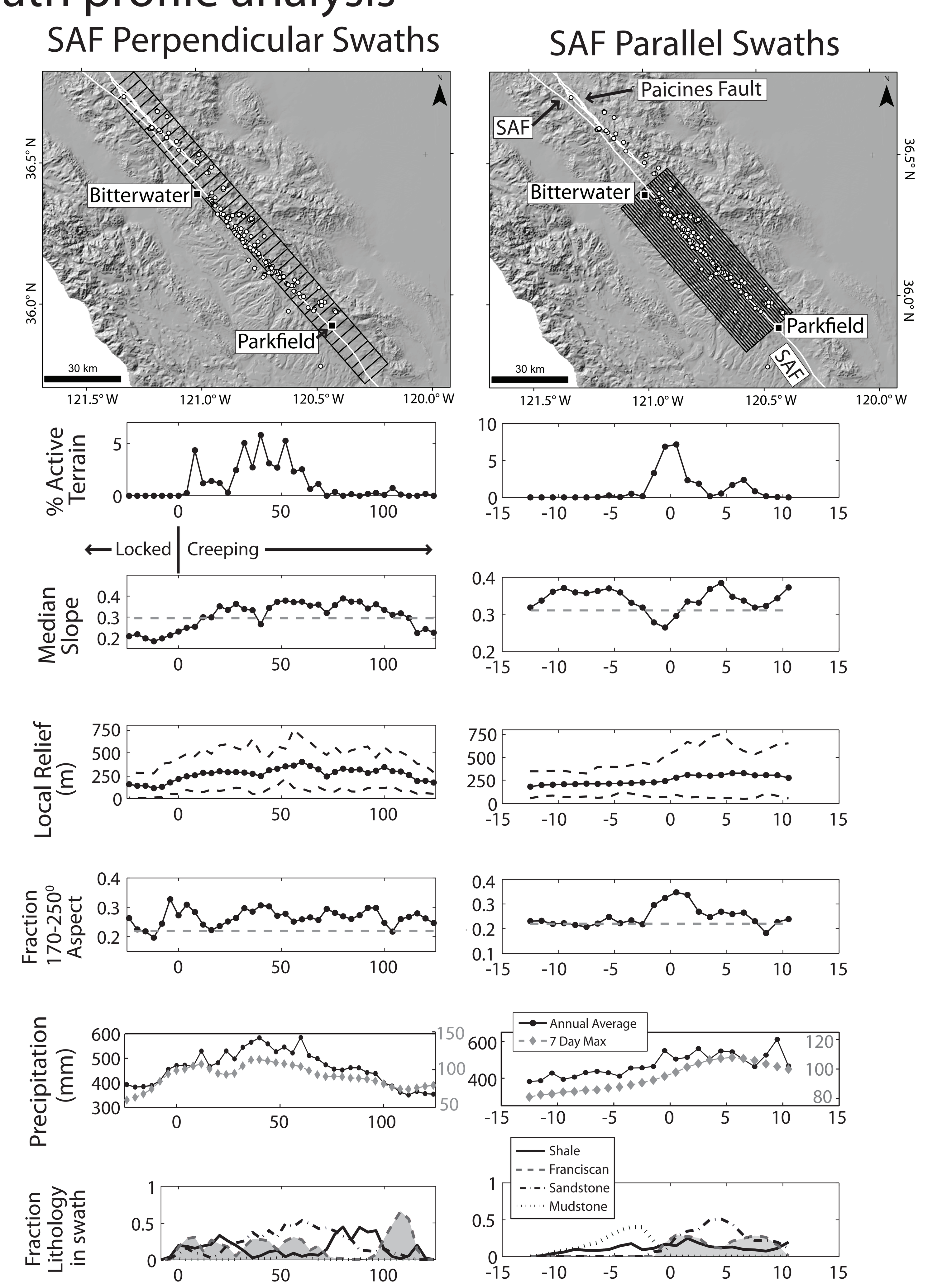
Key Findings

1. Fault zone damage promotes slow-moving landslide occurrence.
2. Large-magnitude earthquakes may suppress slow-moving landslide development.
3. Slow-moving landslide activity is partially modulated by seasonal rainfall.

Earthflows are concentrated near the creeping SAF



Swath profile analysis

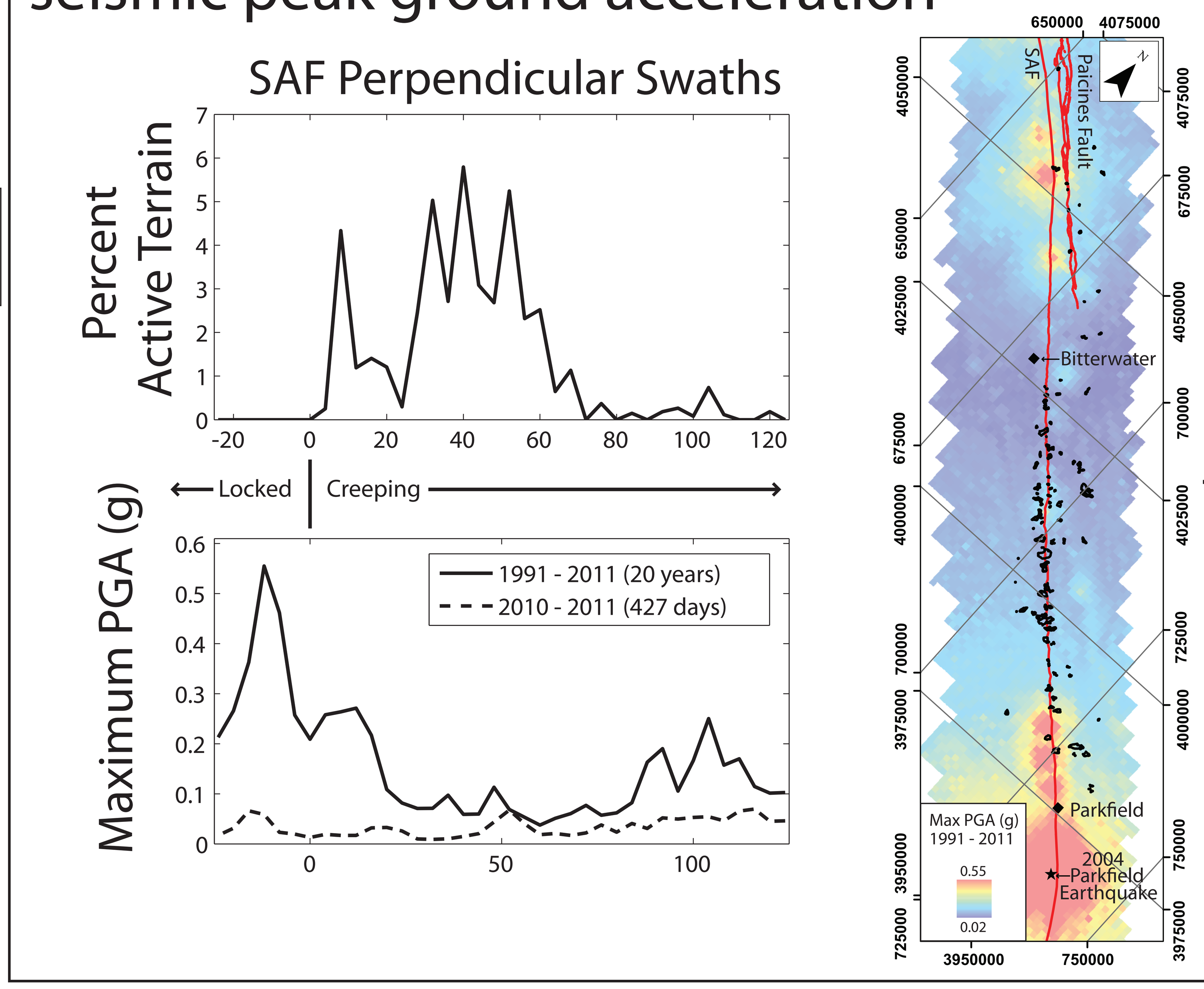


Topographic, precipitation, and rock type metrics alone are not enough to explain the observed spatial distribution of earthflows. Instead, **we hypothesize that earthflows cluster near the creeping San Andreas Fault because of a fault-induced zone of reduced bulk-rock strength** that increases hillslope susceptibility to failure.

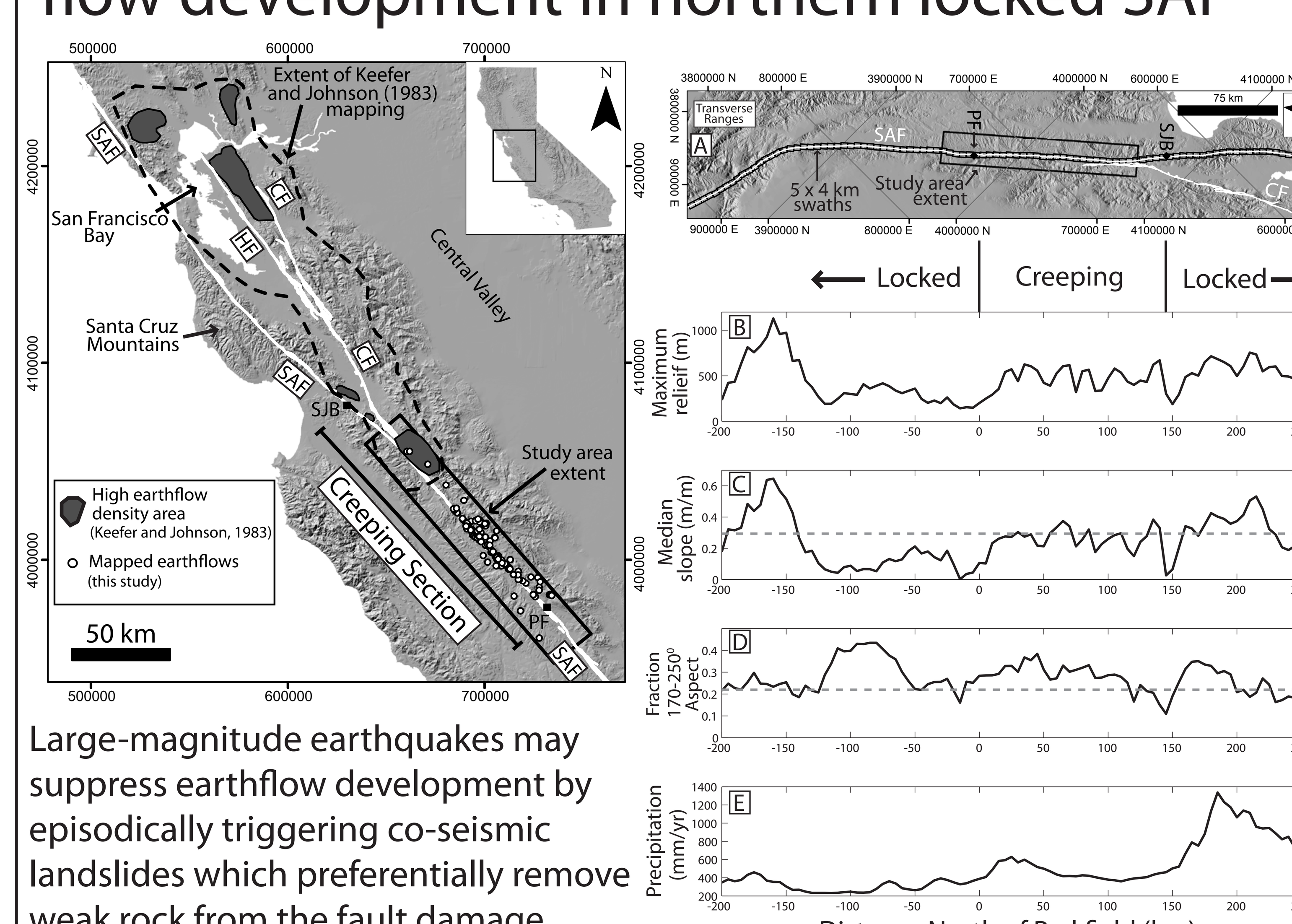
Fault zone damage controls on earthflow spatial distribution

1. Reduced bulk rock strength increases hillslope susceptibility to failure.
2. Bedrock fractures facilitate water delivery to failure plane.
3. Bedrock fractures promote weathering, likely increasing earthflow thickness.

Earthflows appear anti-correlated with seismic peak ground acceleration



Large-magnitude earthquakes inhibit earthflow development in northern locked SAF



Large-magnitude earthquakes may suppress earthflow development by episodically triggering co-seismic landslides which preferentially remove weak rock from the fault damage zone.

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