Can we reliably resolve near-fault complexity along the creeping central San Andreas with high-resolution lidar differencing?

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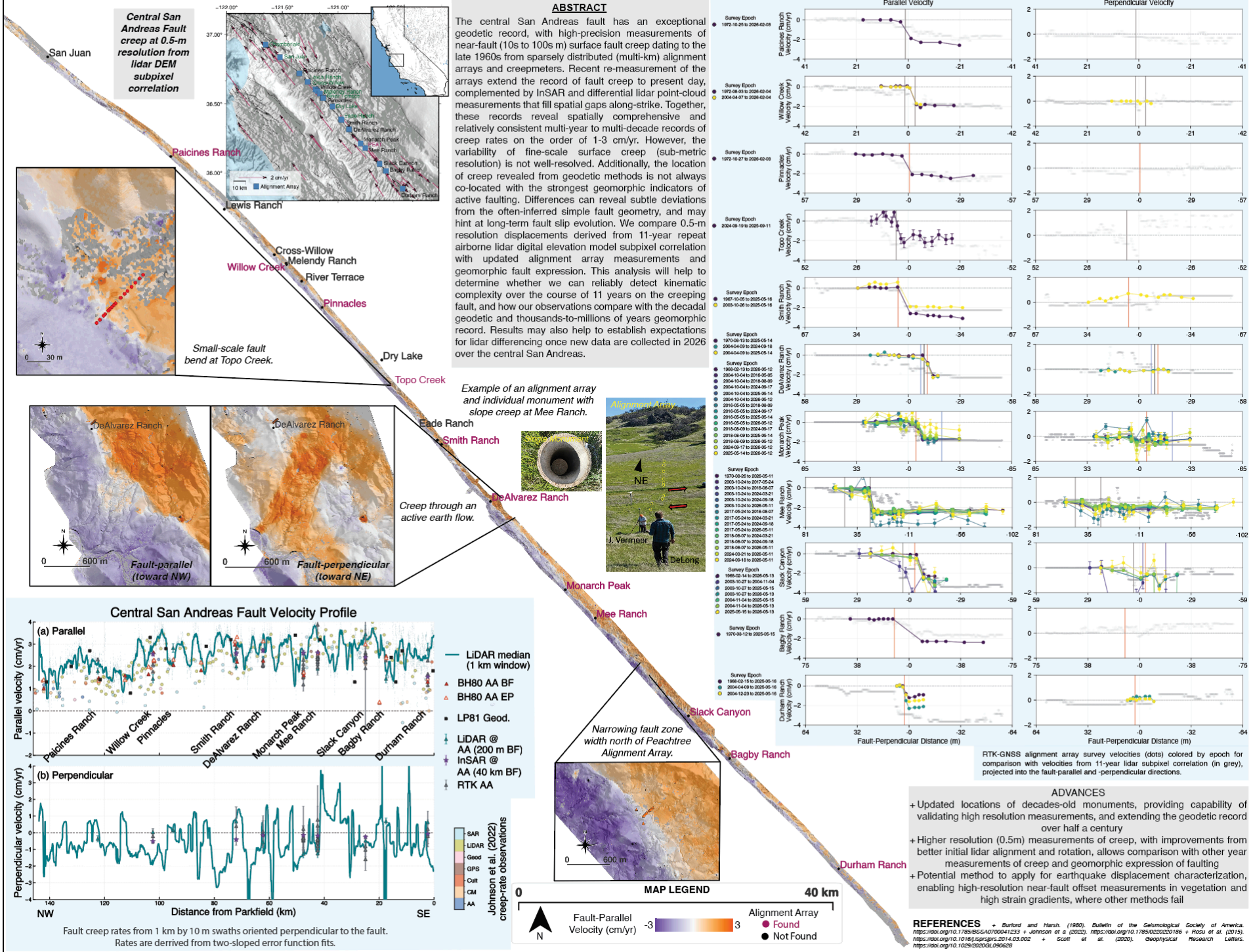
ABSTRACT

The central San Andreas fault has an exceptional geodetic record, with high-precision measurements of near-fault (10s to 100s m) surface fault creep dating to the late 1960s from sparsely distributed (multi-km) alignment arrays and creepmeters. Recent re-measurement of the arrays extend the record of fault creep to present day, complemented by InSAR and differential lidar point-cloud measurements that fill spatial gaps along-strike. Together, these records reveal spatially comprehensive and relatively consistent multi-year to multi-decade records of creep rates on the order of 1-3 cm/yr. However, the variability of fine-scale surface creep (sub-metric resolution) is not well-resolved. Additionally, the location of creep revealed from geodetic methods is not always co-located with the strongest geomorphic indicators of active faulting. Differences can reveal subtle deviations from the often-inferred simple fault geometry, and may hint at long-term fault slip evolution. We compare 0.5-m resolution displacements derived from 11-year repeat airborne lidar digital elevation model subpixel correlation with updated alignment array measurements and geomorphic fault expression. This analysis will help to determine whether we can reliably detect kinematic complexity over the course of 11 years on the creeping fault, and how our observations compare with the decadal geodetic and thousands-to-millions of years geomorphic record. Results may also help to establish expectations for lidar differencing once new data are collected in 2026 over the central San Andreas.

Central San Andreas Fault creep at 0.5-m resolution from lidar DEM subpixel correlation



Central San Andreas Fault Velocity Profile

Fault creep rates from 1 km by 10 m swaths oriented perpendicular to the fault.
Rates are derrived from two-sloped error function fits.

RTK-GNSS alignment array survey velocities (dots) colored by epoch for comparison with velocities from 11-year lidar subpixel correlation (in grey), projected into the fault-parallel and -perpendicular directions.

MAP LEGEND

0 40 km

N

Fault-Parallel Velocity (cm/yr) -3 3

Alignment Array
Found
Not Found

ADVANCES

+ Updated locations of decades-old monuments, providing capability of validating high resolution measurements, and extending the geodetic record over half a century
+ Higher resolution (0.5m) measurements of creep, with improvements from better initial lidar alignment and rotation, allows comparison with other year measurements of creep and geomorphic expression of faulting
+ Potential method to apply for earthquake displacement characterization, enabling high-resolution near-fault offset measurements in vegetation and high strain gradients, where other methods fail

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