Spatiotemporal variability of shallow creep along Mount Etna's segmented faults: 2015–2025 Sentinel-1 InSAR time series

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1. Introduction

- Mount Etna's eastern flank is dissected by active faults characterized by shallow seismicity, **surface rupture and aseismic deformation.**
- **Fault behaviour varies along strike**, defining transitions between seismogenic (locked) and creeping sectors
- The **left-lateral Pernicana Fault (PF)** is our first case study because it combines coseismic surface faulting and stable-sliding motion, with marked structural and kinematic variability (Azzaro et al., 2001).

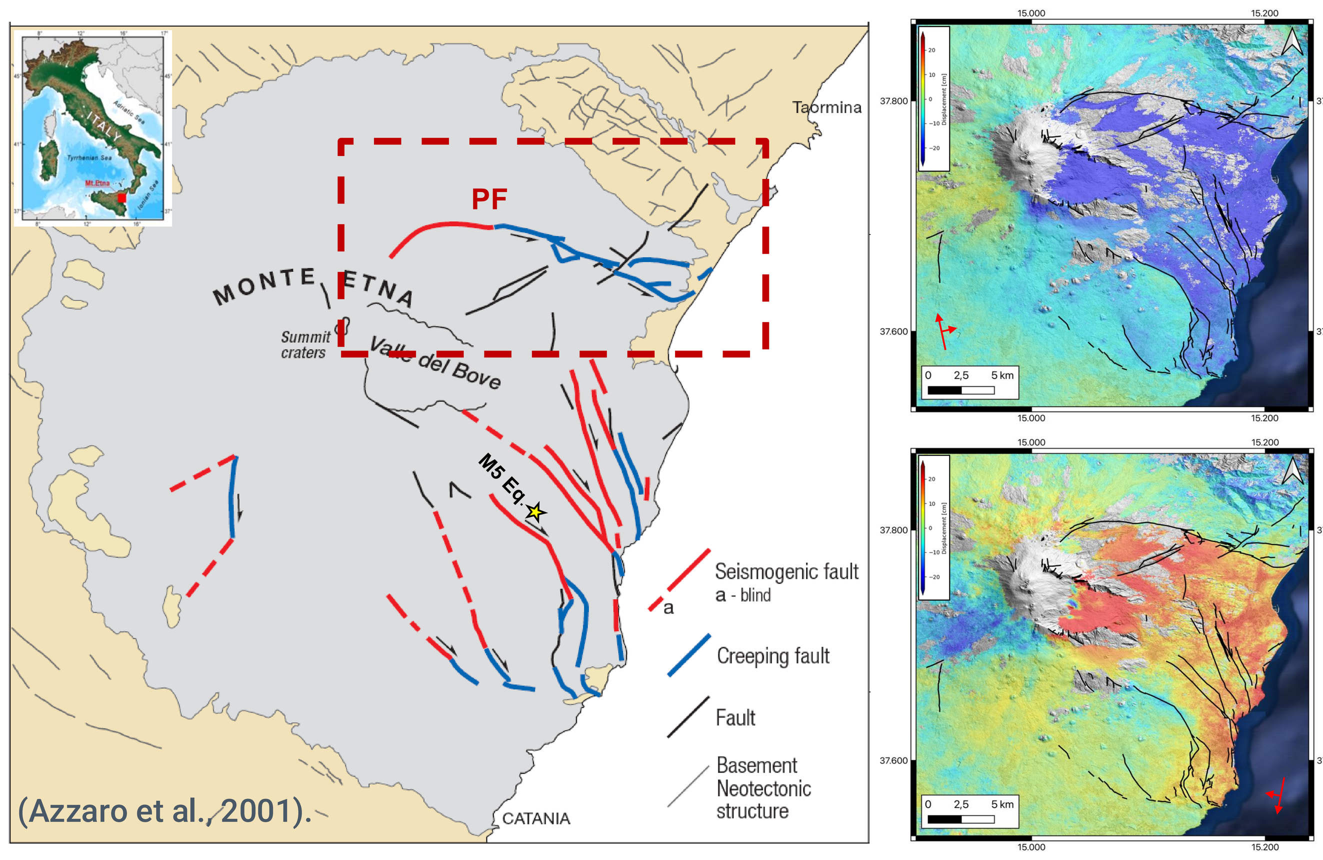

Figure 1: Seismotectonic setting and InSAR observations of Mt. Etna' eastern Flank. The structural framework is shown together with Sentinel-1 ascending and descending LOS displacement time series (2015–2025). The complementary viewing geometries reveal persistent deformation and spatial variations in fault behaviour. Red dashed box captures the PF. Yellow star refers to the 26/12/2018 M5 Eq. along the Fiandaca Fault.

2. Scientific Objective and Data

Can a decade of dual-orbit InSAR reveal where shallow fault motion localizes and how it varies along strike and through time?

- Sentinel-1 ascending and descending time series, 2015–2025.
- Preliminary profiles reveal contrasting cross-fault behaviour along the PF.

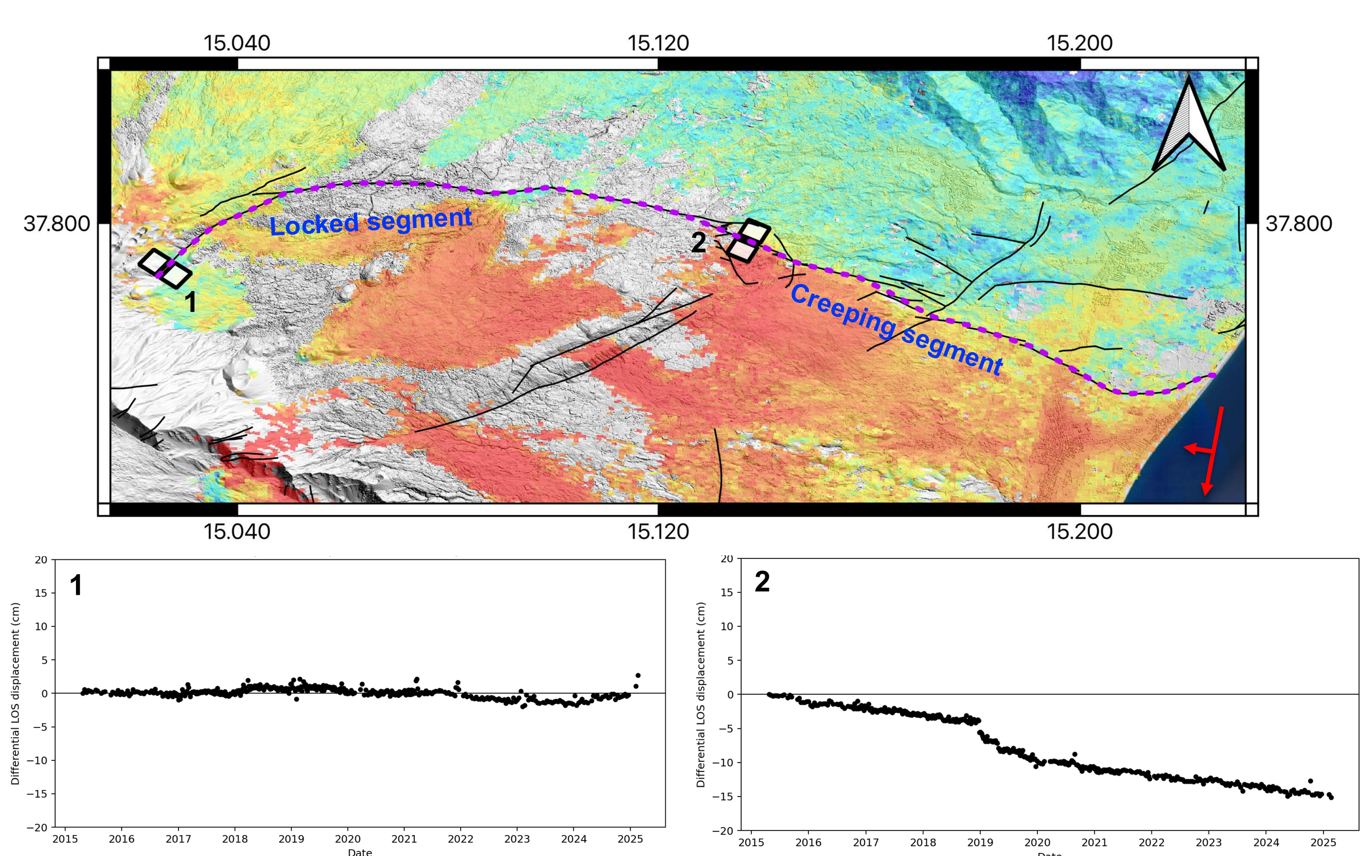

Figure 2: Contrasting behaviour along the Pernicana fault from descending Sentinel-1 data (2015–2025). North–south area-median differences show negligible motion at Site 1 (locked) and persistent creep, accelerated after December 2018, at Site 2.

References

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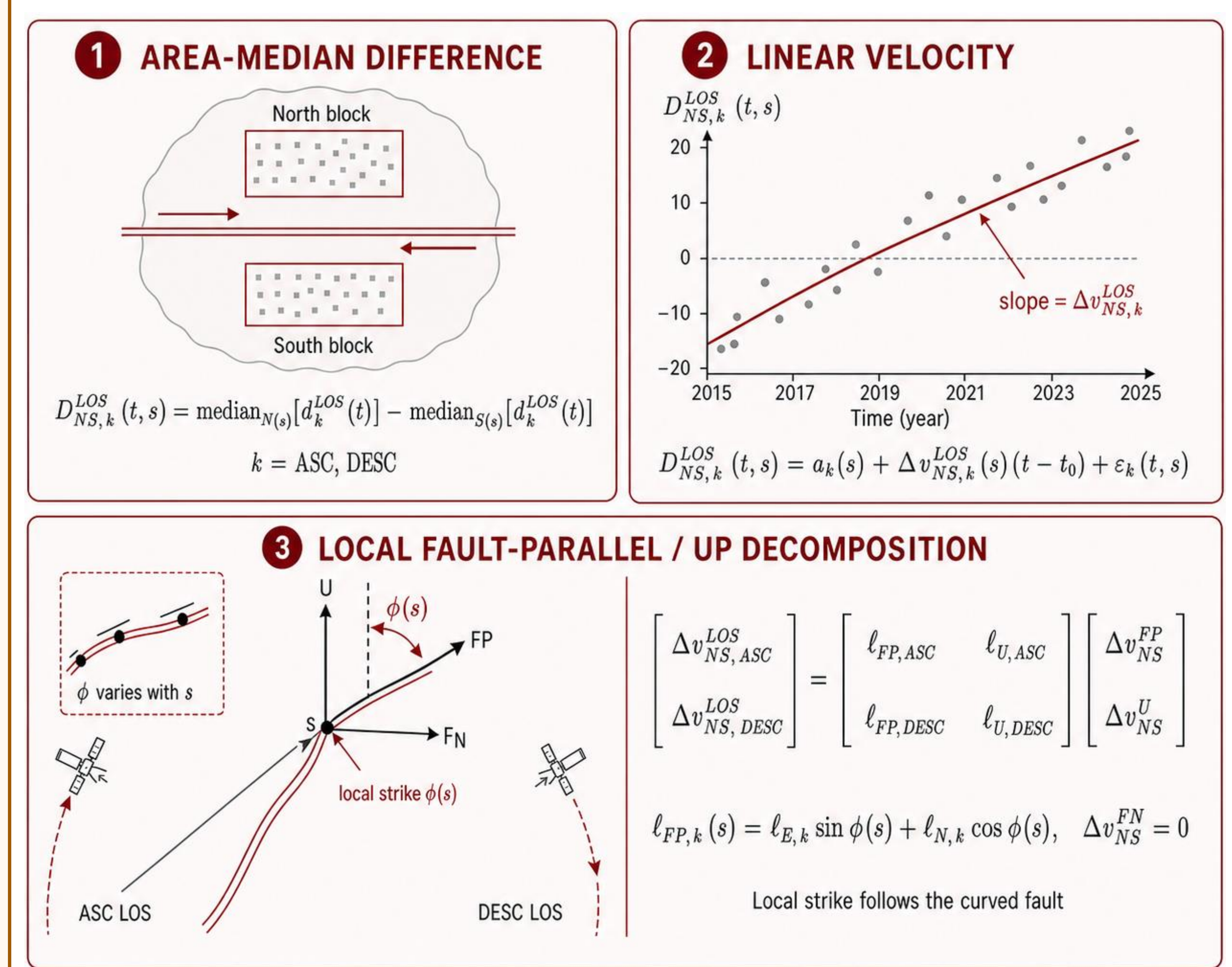
3. Methodology

To study **along-strike variations in shallow fault creep**, we propose an InSAR-based workflow that tracks the persistence, amplitude and width of the **cross-fault velocity** discontinuities.



- **Fault-parallel decomposition** following Jin and Funning (2017)

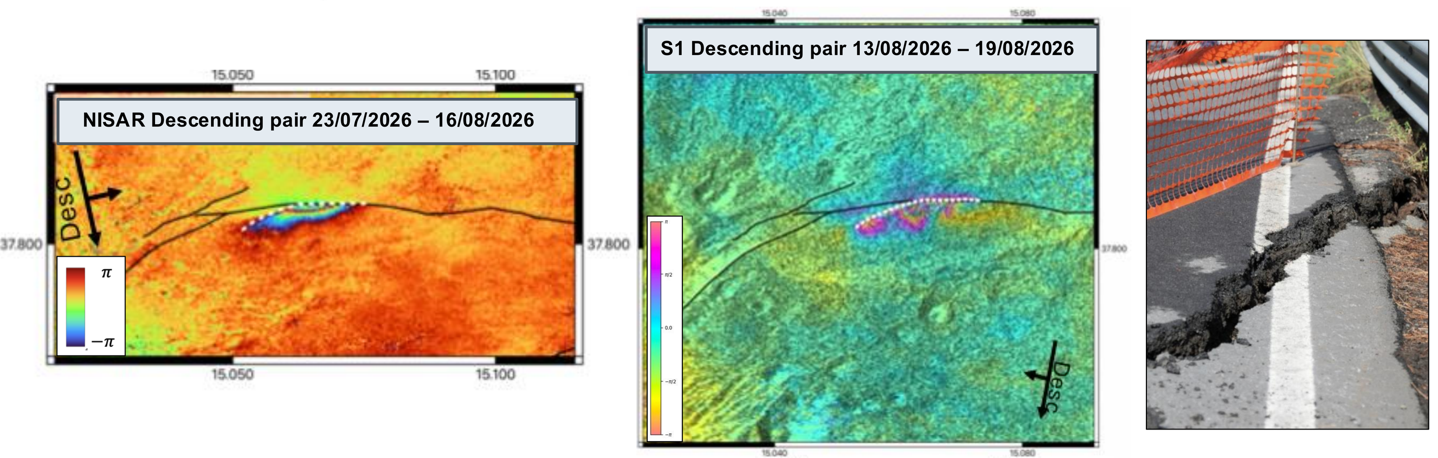
5. Conclusions/Discussion

Preliminary InSAR results reveal contrasting dynamics along the Pernicana Fault, while its first-order segmentation persisted throughout the 2015–2025 record.

- Profiles range from **weak or absent discontinuities** to **sharp trace-centred steps** and broader deformation zones.
- Sharp **fault-parallel steps are consistent with localized shallow creep**, whereas weak discontinuities identify locked sectors.
- Broad transitions may reflect **distributed deformation or deeper** slip, but do not alone distinguish deep creep from shallow locking.

Hot off the press!

Preliminary Sentinel-1 and NISAR interferograms provide independent observations of the **15/08/2026 M_L3.9 Eq. along the PF** and a new test of the inferred fault segmentation.



4. Results

These results reveal **when cross-fault deformation occurs**, which kinematic component dominates, **where it is observed along strike**, and whether it is **localized or distributed.**

R1 — Does the signal persist through time?

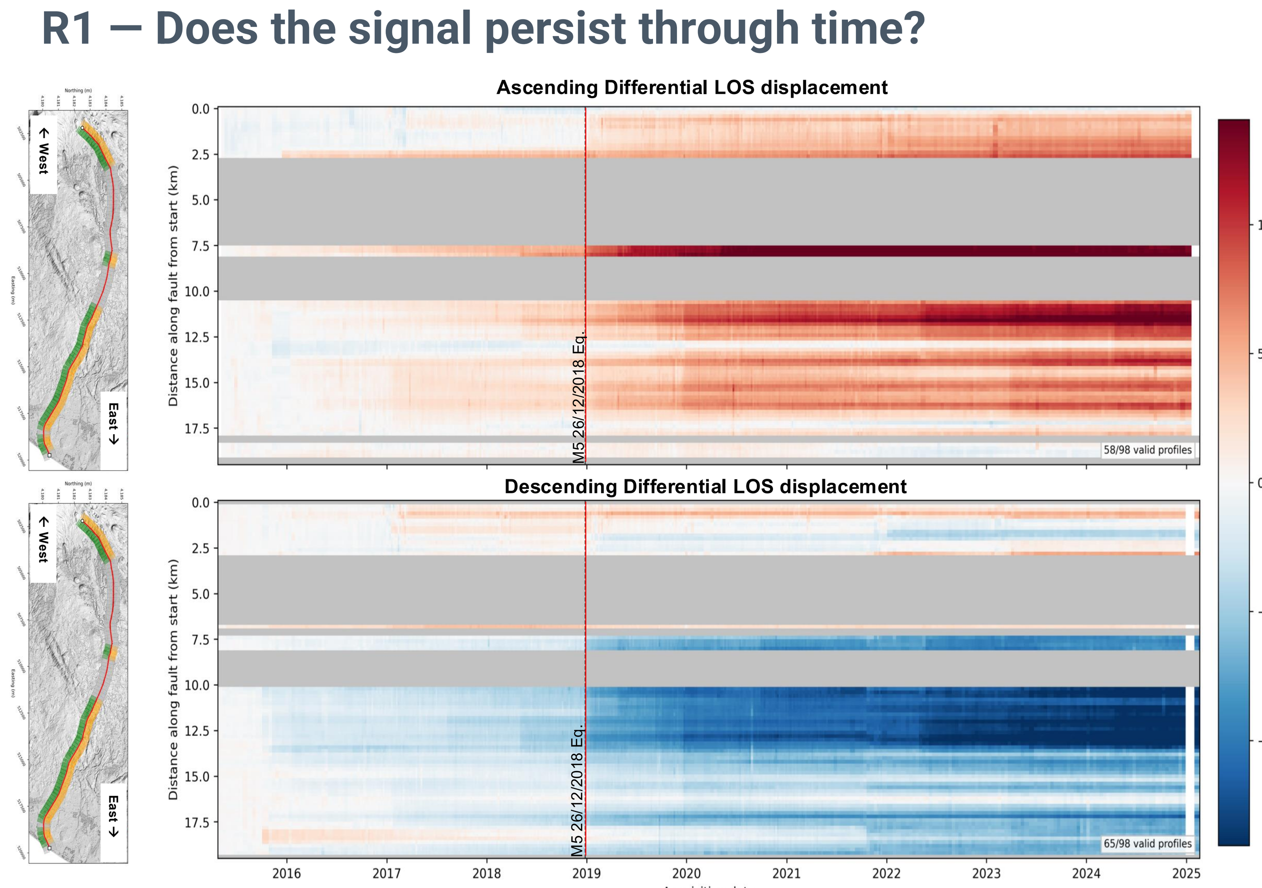


Figure 3: Time-space diagrams show where cross-fault displacement persists and how it changes through time.

R2 — Is differential motion mainly fault-parallel or vertical?

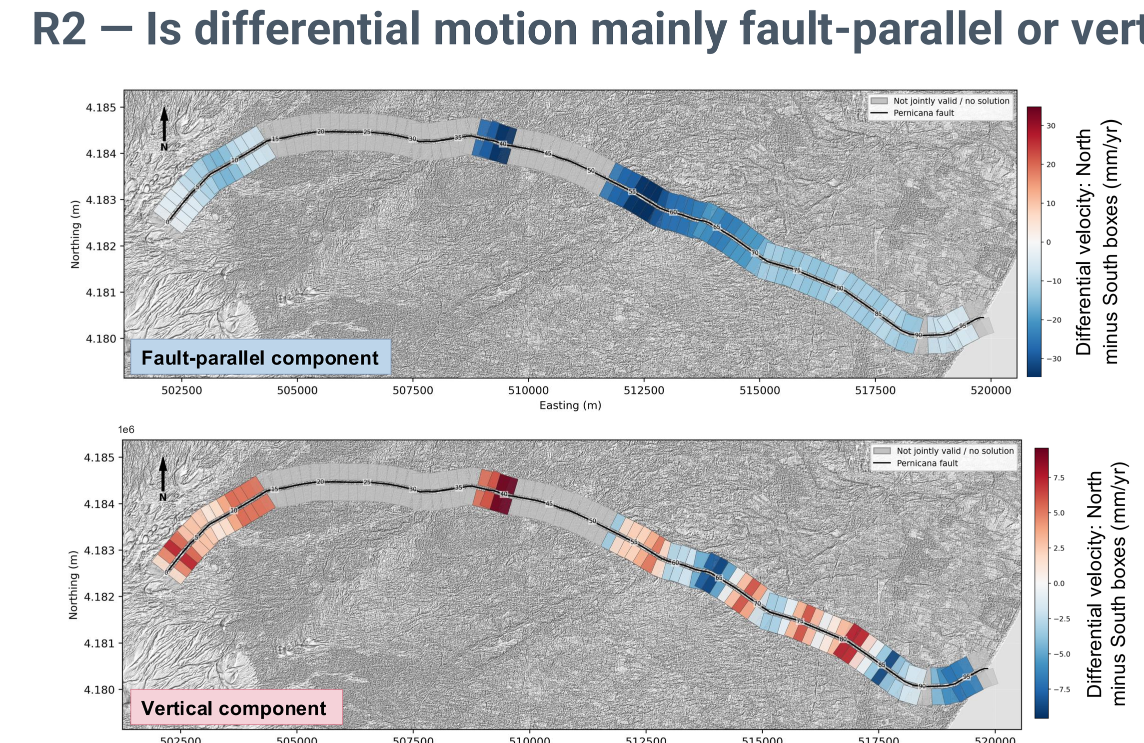


Figure 4: Fault-parallel and vertical differential velocities obtained from paired-box decomposition, assuming negligible fault-normal motion.

R3 — Where is fault-parallel deformation observed along strike, and how localized is it on the fault trace?

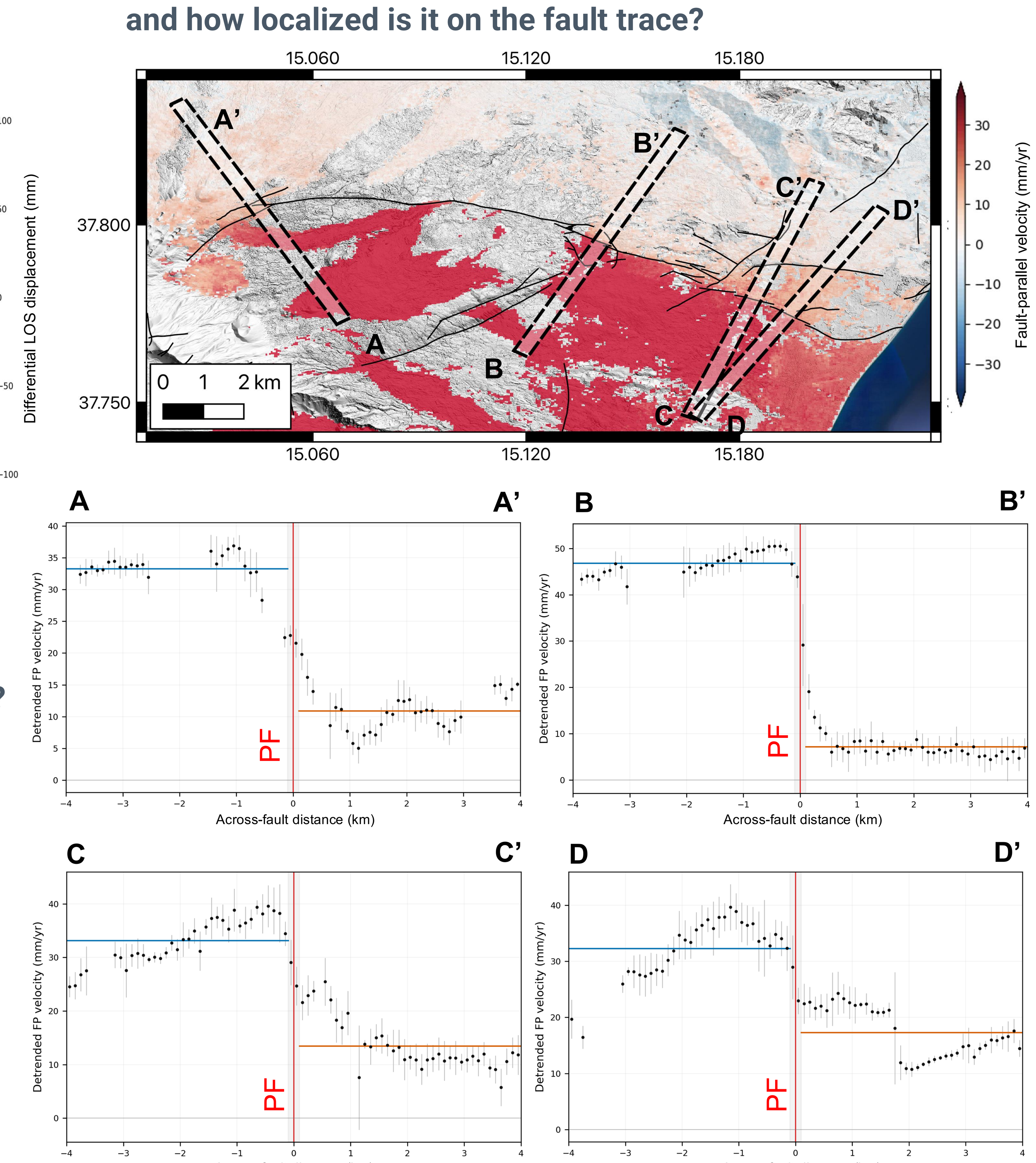


Figure 6: The continuous fault-parallel field identifies the main deformation sectors, while four cross-fault profiles reveal how velocity transitions vary from weak to sharp or broadly distributed along strike.

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