Imaging the Garlock Fault Zone with Distributed Acoustic Sensing

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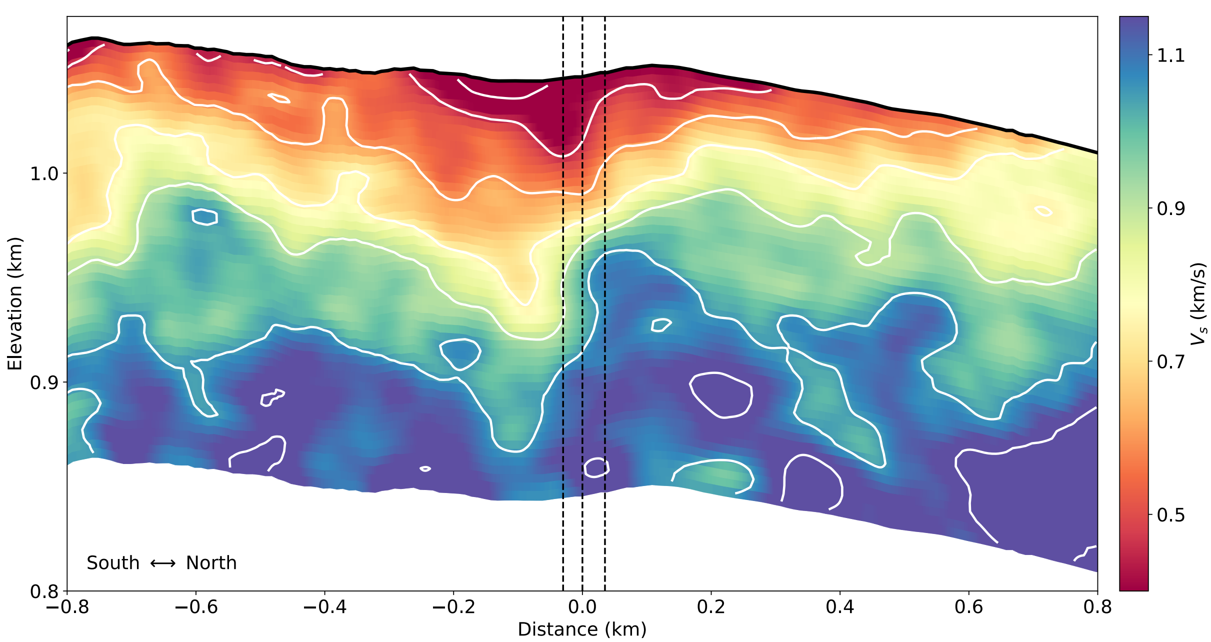
Multi-scale fault zone structure may largely control the behavior of earthquake ruptures and encode the long-term slip history of the fault. Detailed images of subsurface fault zone structure fill an observational gap between surface mapping and low frequency tomography studies. These images are best illuminated using multiple types of complementary observations recorded by dense instrumentation. Distributed acoustic sensing (DAS), an emergent technology that transforms fiber optic cables into dense arrays of strainmeters, yields high-density and long-duration seismic deployments that can help fill this observational gap at relatively low cost and effort. We illustrate this potential by using a DAS array that extends from Ridgecrest, CA to Barstow, CA to image the Garlock Fault Zone, a major strike-slip fault zone in the Eastern California Shear Zone. The versatility of DAS allows us to employ a multifaceted approach to imaging this fault zone that includes an active source experiment, ambient noise tomography, and travel-time anomalies from earthquakes. These approaches each provide unique constraints that together yield a highly detailed picture of the fault zone's lateral complexity and depth-dependent structure. We observe an asymmetric fault zone with a highly heterogeneous shallow structure that accounts for much of the variability in depth-integrated measurements from earthquakes.



2D velocity structure of a cross-section of the Garlock Fault Zone produced in this study. Dotted lines show lateral locations of mapped fault strands in the USGS Quaternary Fault Database.