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Imaging Fracture Networks beneath the Los Angeles Metropolitan Area using High-Frequency Seismic Attenuation Tomography

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In the northern Los Angeles area, the interaction of complex tectonics and sedimentary structures has a significant influence on the attenuation characteristics of the crust. The region is also characterized by partially fluid-saturated crust and seismic sequences that promote intense fracturing. Modelling high-frequency seismic attenuation to image fine-scale crustal features and gain insight into the driving mechanisms of the seismicity is a powerful tool for seismic hazard assessment across this densely populated area.

We develop the first high-resolution 3D seismic attenuation model across the Chino and San Bernardino basins using 5,300 three-component seismograms from local earthquakes (M<3.6). The events were recorded by 410 nodal stations deployed along eight linear arrays during the 2017-2020 Basin Amplification Seismic Investigation experiment and 10 Southern California Seismic Network broadband stations. We present peak delay and coda-attenuation tomography in 6-12 and 12-24 Hz frequency bands (with horizontal and vertical grid spacings of 3 km and 1 km) as proxies of seismic scattering and absorption, respectively.

The attenuation models show distinct scattering contrasts in the uppermost 10 km of the crust across two major faults in the northern edge and in the middle of the Chino basin, suggesting variations in fracture intensity in the basement. Low scattering values characterize the crustal block bounded by these two faults, while high scattering coincides with zones of seismicity indicating highly fractured fault-rocks, such as the areas across the Cucamonga, Fontana, and San Andreas faults. The N-S pattern of high absorption and seismicity migration associated with the 2019 Fontana seismic sequence suggests potential groundwater movement across the fault into a buried intensely fractured zone in the basement that we interpret was once an elevated part of the Perris Block. Low scattering values beneath the Chino basin in the source region of the seismic sequence may confirm the presence of fluid-saturated rocks and increased pore pressure. The attenuation results allow the small-scale characterization of fractured basement rocks and fluid migration pathways, and show a heterogenous pattern of seismic wave amplification beneath the region.