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Relating seismicity to the velocity structure of the San Andreas Fault near Parkfield, CA

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The central section of the San Andreas Fault (SAF) displays a range of seismic phenomena including normal earthquakes, low frequency earthquakes (LFE), repeating micro-earthquakes (REQ), and aseismic creep. Although many lines of evidence suggest that LFEs are tied to the presence of fluids, their mechanisms are still poorly understood. Here, we map the seismic velocity structures associated with LFEs beneath the central SAF using surface wave tomography from ambient seismic noise to provide constraints on the physical conditions that control LFE occurrence. Fault perpendicular sections show that the SAF, as revealed by lateral contrasts in relative velocities, is contiguous to depths of 50 km and appears to be relatively localized at depths between about 15 and 30 km. This localization is consistent with the hypothesis that LFEs are shear-slip events on a deep extension of the SAF. We find that along strike variations in seismic behavior correspond to changes in the seismic structure, which support proposed connections between fluids and seismicity. LFEs and repeating earthquakes (REQs) occur within low velocity structures, suggesting that the presence of fluids, weaker minerals, or hydrous phase minerals may play an important role in the generation of slow-slip phenomena.