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The geodetic signature of slow slip events in the roots of the San Andreas Fault

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Episodic tremor and accompanying slow slip (ETS) is observed at the down-dip edge of some subduction seismogenic zones and contributes to the loading of shallow seismic asperities. While tremors are the seismic signature of this phenomena, the majority of accumulated stress is aseismically released and thus the associated fault slip can only be quantified by geodetic observations. On continental strike-slip faults, tremors have been observed in the roots of the Parkfield segment of the San Andreas fault. However, associated transient aseismic slip has never been detected. Here, by using the timing of transient tremor activity and taking advantage of the dense Parkfield-area global positioning system (GPS) network with more than a decade of continuously recorded position time series, we are able to detect and characterize the moment of average deep slow slip events (SSEs) on the Parkfield segment. SSEs with an average moment equivalent to M_W 4.90 ± 0.08 at 16 km depth are releasing ~ 25% of the loading rate during 5.5% of the time. Our study shows that low amplitude signals, with surface amplitudes of order 0.1 mm, can be extracted with dense geodetic networks. We provide new constraints for scaling laws of strike-slip faults, which help us better understand the diversity of slip modes and seismic cycle mechanics on faults.