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Multiscale postseismic behavior on a mega-thrust: the 2012 Nicoya earthquake, Costa Rica.

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Surface displacements in the days, months and years following large and great earthquakes can be sensitive probes of frictional conditions on the fault interface and rheology of the nearby crust and upper mantle. For subduction zone earthquakes, often producing Earth's largest earthquakes and most tsunamis, these studies can be challenging, as critical areas undergoing seismic rupture and post-seismic motion usually lie far offshore, where on-land instrumentation lacks sensitivity.

On September 5, 2012, after years of slow-slip event observations, a large moment magnitude (MW) 7.6 megathrust earthquake occurred just underneath a dense continuous GPS (CGPS) network on the Nicoya Peninsula of northern Costa Rica. The network recorded at high rate and is uniquely located above the seismogenic zone of the Cocos-Caribbean subduction boundary and has allowed sensitivity to measure deformation from aseismic slip on the plate interface both updip and downdip of the locked subduction interface.

In this study, we analyze the temporal and spatial evolution of the surface deformation at different temporal scales (from hours to years after the earthquake) to infer the aseismic slip on the fault interface.

Our results show that the main rupture was followed by significant early afterslip for the first 3 hours after the main event. The behavior of the fault can then be represented by relaxation processes with three characteristic times (7, 70 and 420 days). We suggest that the three relaxation times correspond to poroelastic, afterslip and viscous processes. We show that with this assumption, during the first few months, the afterslip has most likely filled different gaps left by the coseismic rupture (in particular updip). We also show that the afteslip seems to be bound by region affected by SSE.

The results clearly indicate that observation of slip on the shallow part of the fault is very important to fully understand the subduction earthquake cycle.