Transient Forearc Sliver Transport Found During Postseismic Recovery

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Abstract

Postseismic deformation of a megathrust involves temporal and spatially variable relocking of the subduction interface, making it an invaluable opportunity to better understand fault physics and stress accumulation. While we expect to see a transition from seaward afterslip to wholesale landward interseismic motion in the years following a large megathrust earthquake, the effect of oblique convergence on this transition has not been previously detailed. In the five years following the 2012 moment magnitude (Mw) 7.6 Nicoya Earthquake, in Costa Rica, there was a unique opportunity to capture the lithospheric recovery of a subduction environment directly above and surrounding the rupture region. Campaign and continuous GNSS observations through the postseismic period were used to evaluate slip at depth along the megathrust. These data initially show strong seaward afterslip, that within five years reversed to oblique landward motion due to a substantially relocked megathrust. Within that transition, however, was a never before observed period of exclusively trench-parallel motion across the entire forearc. Accordingly, trench-parallel motion that can vary in magnitude over several years contrasts previous observations of constant rate. During this period of accelerated transient forearc slip, locking along the subduction megathrust practically disappears. We present a conceptual model of oblique relocking in which low megathrust coupling (i.e. little locking) during the postseismic period tends to generate partitioned slip: trench-normal motion on the megathrust and seemingly aseismic, transient, trench-parallel motion accommodated presumably along an arc bounding fault. Conversely, relatively high coupling (i.e. strong locking) during the interseismic period drives oblique, convergent surface motions. Given that the majority of subduction zones have some level of obliquity, explaining these observations is critical to understanding how stress is accommodated through the seismic cycle in many megathrust systems, with emphasis on time-dependent subduction hazards. These results also challenge existing ideas about sliver motion and contradict the tectonic escape hypothesis of Central American tectonics.

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