Postseismic deformation following the 2010 Mw 8.8 Maule earthquake in Chile: implications for the rheology of the central Andean crust and upper mantle

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Abstract

Geodetic observations of surface displacements associated with megathrust earthquakes aid our understanding of the subduction zone earthquake cycle and help place constraints on the rheology and structure of the crust and upper mantle. Here we investigate postseismic deformation following the 2010 *Mw* 8.8 Maule earthquake in Chile using continuous data from a large regional network of GNSS sites and a new technique that simultaneously inverts for the spatiotemporal distribution of after-slip on the fault and viscoelastic flow in the mantle wedge without *a priori* assumptions regarding the rheology or deformation mechanism. We find that significant afterslip occurs primarily up-dip of the coseismic rupture and that viscous strain decays with distance and depth from the megathrust. The concentration of postseismic strain is well-correlated with the region of maximum coseismic stress change and further modeling suggests that the observed transient mantle flow behavior is consistent with a bi-viscous (i.e. Burgers) rheology; estimated viscosities start low ($<$ 1e18 Pa s) and increase by up to two orders of magnitude within a year or two after the earthquake. We also find a close spatial correlation between the area of maximum postseismic strain and the location of the active volcanic arc, lending further support to the notion that a strong link exists between volcanism and tectonics across the region. Our results for Maule and other megathrust earthquakes illuminate the evolution of stress and strain during the subduction zone earthquake cycle and can help assess the associated seismic hazard.

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