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# Active deformation processes across a megathrust-segment boundary, south-central Chile

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The south-central Chile margin is an active plate boundary where a variety of tectonic processes, including postseismic mantle relaxation, interseismic strain accumulation, sliver motions and crustal faulting are documented. GPS data and finite-element models with complex geometries are presented to gain insight into the active deformation in the vicinity of two megathrust-earthquake segments: the Valdivia and Concepción rupture zones. GPS vectors are heterogeneously distributed in two domains that follow the megathrust segments. Models which simulate only interseismic locking on the plate interface and postseismic relaxation after an uniform coseismic slip during the 1960 Valdivia earthquake ($M_w$=9.5) not fully reproduce the observed surface deformation. In order to distinguish between the main processes producing the regional-scale heterogeneity of surface velocities, we model: (1) the postseismic viscoelastic deformation induced by a non-uniform coseismic slip distribution, (2) the interseismic kinematic coupling, and (3) the interseismic effect of a crustal fault rooted in the plate interface. We find that interseismic locked asperities are spatially coincident with the historic earthquake rupture zones, which are separated by a sharp boundary of low ($\sim$ 50%) kinematic coupling. A regional pattern of clockwise rotations arise from postseismic mantle rebound at the overlap area of the rupture zones and extend over a broad segment between the forearc and the back-arc. Locally, counterclockwise block rotation is observed in a limited area south of the Lanalhue fault, and may be related to transpression at the northern leading edge of a forearc sliver. In the Concepción domain, models that include a dextral-reverse crustal fault better reproduce the GPS observations. Our study suggests that upper-plate crustal faults in addition to earthquake-cycle transients exert an important control on deformation processes at megathrust-segment boundaries.