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Locking, mass flux and topographic response at convergent plate boundaries – the Chilean case

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On the long term, convergent plate boundaries have been shown to be controlled by either accretion/underplating or by subduction erosion. Vertical surface motion is coupled to convergence rate - typically with an uplift rate of the coastal area ranging from 0 to +50% of convergence rate in accretive systems, and -20 to +30% in erosive systems. Vertical kinematics, however, are not necessarily linked to horizontal strain mode, i.e. upper plate shortening or extension, in a simple way. This range of kinematic behaviors – as well as their acceleration where forearcs collide with oceanic ridges/plateau – is well expressed along the Chilean plate margin.
Towards the short end of the time scale, deformation appears to exhibit a close correlation with the frictional properties and geodetic locking at the plate interface. Corroborating analogue experiments of strain accumulation during multiple earthquake cycles, forearc deformation and uplift focus above the downdip and updip end of seismic coupling and slip and are each related to a particular stage of the seismic cycle, but with opposite trends for both domains. Similarly, barriers separating locked domains along strike appear to accumulate most upper plate faulting interseismically. Hence, locking patters are reflected in topography. From the long-term memory contained in the forearc topography the relief of the Chilean forearc seems to reflect long term stability of the observed heterogeneity of locking at the plate interface. This has fundamental implications for spatial and temporal distribution of seismic hazard. Finally, the nature of locking at the plate interface controlling the above kinematic behavior appears to be strongly controlled by the degree of fluid overpressuring at the plate interface suggesting that the hydraulic system at the interface takes a key role for the forearc response.