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Permanent deformation in seaward-concave forearcs: insights from Coulomb-wedge theory and forearc seismicity

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Seaward-concave subduction forearcs are controversial settings that exhibit remarkable along-strike variations of surface uplift and rock exhumation, the causes of which are still a matter of debate. While short-term ($10-10^2$ a) forearc uplift relates to locking of the megathrust, it is unclear which mechanism produces long-term (10^4-10^6 a) permanent surface uplift. In this work we use Coulomb-wedge solutions and background forearc seismicity (not megathrust) in order to investigate permanent deformation of the overriding plate in Peru-Chile and northern Japan. According to the Coulomb-wedge theory, the observed along-strike variations of long-term forearc uplift may reflect changes of (i) slab dip angle, (ii) wedge material strength and/or (iii) plate interface friction. Here, we explore the latter hypothesis through a comparison of the spatial distribution of basal friction (inferred from the taper geometry) and the pattern of background forearc seismicity (obtained from the International Seismological Center global earthquake catalog).

In Peru-Chile, concordant patterns of cumulative seismic moment and inferred basal strength suggest that (i) at the curvature apex, low interplate friction is needed to explain the forearc morphology; (ii) permanent vertical displacement of the proximal wedge is likely accomplished through repeated non-megathrust seismic events; (iii) the wedge is largely in equilibrium. Conversely, in northern Japan a complex relationship between long-term deformation and plate-interface processes is deduced.