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Co-location of the locking depth and the shelf break, not the coastline, at active margins.

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Identifying the extent of the seismogenic plate interface is key to assessing earthquake hazard. In subduction settings, onshore geodesy provides the main data used to map locking patterns on the plate interface and it is inherently spatially limited. We propose here a new offshore control by establishing a mechanistic relationship between the respective positions of the shelf break and the fault locking zone.
It has been proposed that coastlines of active margins are co-located with locking depth, for example over the Andean subduction zone. Yet the coastline is not a tectonic feature, but is instead an erosive feature sensitive to eustasy, coastal lithology and wave climate. The continental shelf (which is erosive over active margins), in contrast, depends on the vertical deformation field and must reflect the pattern of deformation at depth. An erosive shelf results from both continuous uplift and active wave erosion. On an active margin, long-term uplift derives from 1) the non-recoverable fraction of the interseismic deformation and 2) continental uplift (due to isostatic response to denudation and underplating).
We combine a wave erosion model with an elastic deformation model to explore processes driving shelf morphology. The model illustrates how the hinge line that marks the transition from interseismic subsidence to uplift pins the location of the shelf break. It lies over the locking depth when continental uplift is low and is pushed offshore when the latter is large. The shelf grows landward from the break by erosive retreat of the coastline. The position of the coastline depends on offshore wave energy, uplift rates, and rock erodibility. The previously assumed coincidence of coastline and locking depth is thereby lost.
Finally, we apply this model to the morphology of the Cascadia subduction. In Oregon, the locking depth overlaps the shelf break within 10 km and does not overlap the coastline that lies up to 60 km landward of the locking depth. In coastal Oregon, a wide shelf separates the shelf break from the coast. On the contrary, in the Andes the locking depth corresponds to both the shelf break, and the coast by virtue of the absence of shelf.