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Linking the kinematics of the interplate and the offshore morphology along the Chilean subduction margin

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Abstract

Morphological features at subduction zones are undoubtedly influenced by the complex interplay between the subducting slab and the overriding plate. Several studies suggest that the subduction dynamics is strongly dependent on the geometry and rheology of the margin (including gravity/density anomalies, viscous mantle flow and roughness of the slab, among others). However, it is not clear how the geomorphological variation of the forearc along strike can be used as a proxy for better understanding the mechanics on the interface and seismotectonic segmentation. Here we investigate the links between the kinematics of the plate interface and the morphology of the overriding plate along the Chilean margin by combining morphometrical and statistical analysis. We constructed swath profiles subtracting the averaged topography and performed gradient analysis to characterize variations of morphological features, and we compared these results with the locking degree distribution derived from the inversion of GPS data. On the coastal area the bathymetry and topography analysis shows a planar feature, gently dipping ocean-wards and backed by a cliff, which exhibits spatial variations in its width, height and extension along-strike. This morphology suggests a quiescence process or a "stable tectonic condition", at least since the late Quaternary (over multiple seismic cycles). The results indicate that this planar feature spatially correlates with the rupture size of recent great earthquakes and locking degree areas, suggesting that earthquake cycle deformation has an imprint on the offshore morphology, which can be used to study the transfer of stresses among adjacent seismotectonic segments and the periodicity and location of large earthquakes. In addition, the longevity of this correlation between topography, earthquake rupture and geodetic locking that likely integrates over a time window of several 10^3 to several 10^5 years indicates that the instrumentally inferred locking has a long term memory across multiple seismic cycles.