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Forearc deformation: Insights to the coupling at the subduction thrust interface

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Marine forearcs at the site of great earthquakes such as the 1960 Valdivia event in South Chile are associated with a deep-sea terrace, basin and gravity low. The basins may be created by the accumulation of sediments behind the accretionary prism or in the depression caused by basal subduction erosion. Permanent subsidence of the upper plate coupled to the subducting slab is also suggested which would imply a direct relationship between basins and coupling at the subduction interface.

However only part of the asperity area, or locked zone, underlies the forearc basins beneath the deep-sea terrace. Moreover, in Valdivia, the basins formed mostly between 10.9 and 3.6 Ma. Uplift of the forearc is now observed, accommodated by thrust faults through the basin and transpression onshore. In numerical elastoplastic modelling, we find that interseismic strain accumulation and deformation by locking at asperities lead to subsidence without requiring erosion. However, the obtained widespread subsidence can not explain the formation of basins. We also predict uplift accommodated by a system of either symmetric or anti-symmetric thrust faults.

Therefore it is questionable whether basins are indices for recent and future occurrences of great earthquakes when they are old and inactive structures. A better indication of stress accumulation and potential seismic hazards may be active forearc thrusting. In this study, we review the forearc structures at various subduction zones and investigate whether outer-forearc widespread subsidence and inner-forearc uplift are common features of subduction zones. We study their relationship to the coupling at the subduction interface.