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Deformation of the forearc wedge along the obliquely convergent Chilean margin

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The forearc wedge along the Chilean margin between 37˚ and 42˚S, which results from oblique convergence between the Nazca plate and the South American plate, is characterized by a major margin parallel strike slip fault, the Liquiñe-Ofqui-Fault-Zone (LOFZ). Field studies show a recent dextral movement along the LOFZ of approximately 10 cm/a.

We present 3D numerical models that investigate the conditions in which the models develop the typical deformational pattern observed in nature. The numerical models are constrained by seismic profiles geometrically and by gravitational and seismic velocity models rheologically. The model setup includes a kinematical modelled subducting Nazca plate and a dynamically modelled South American plate, both lithospheres have an elasto-plastic rheology. The two converging plates are coupled by a frictional interface. The friction at the interface drops abruptly at the downdip end of the seismogenic zone. Parallely, the thermal field was analyzed in order to compare with available surface heat flow data.

Several parameters (e.g., coupling strength, obliquity, convergence rate, rheological properties of wedge material), which potentially govern the style of deformation, were varied in order to study their impact on forearc deformation and to most accurately match natural observations. We found that the frictional structure at the plate interface plays a key role for the segmentation of the strain in a trench normal and a trench parallel component. Without the sharply changed frictional conditions at the plate interface it would be not possible to obtain strain partitioning. This sharp transition in the strength of coupling between plates is attributed to the mainly thermally controlled updip and downdip end of the seismogenic zone. The strength of the material, which is itself highly controlled by temperature, is also an important factor controlling the style of deformation. Comparison of model results with GPS data shows a good conformity with velocities in trench parallel direction, but modelled velocities for the trench normal component are somewhat smaller than observed. In order to render the results of our modelling, we constructed a similar model for the northern part of the Chilean margin. Despite almost equal plate kinematic conditions along the entire Chilean margin, the style of deformation of the forearc wedge differs significantly between the north and the south. This comparison allows us to extract the parameters that control variations of styles of deformation along the Chilean margin.