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Crust rheology, slab detachment and topography

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The collision between continents following the closure of an ocean can lead to the subduction of continental crust. The introduction of buoyant crust within subduction zones triggers the development of extensional stresses in slabs which eventually result in their detachment. The dynamic consequences of slab detachment affects the development of topography, the exhumation of high-pressure rocks and the geodynamic evolution of collision zones. We employ two-dimensional thermo-mechanical modelling in order to study the importance of crustal rheology on the evolution of spontaneous subduction-collision systems and the occurrence of slab detachment. The modelling results indicate that varying the rheological structure of the crust can results in a broad range of collisional evolutions involving slab detachment, delamination (associated to slab rollback), or the combination of both mechanisms. By enhancing mechanical coupling at the Moho, a strong crust leads to the deep subduction of the crust (180 km). These collisions are subjected to slab detachment and subsequent coherent exhumation of the crust accommodated by eduction (inversion of subduction sense) and thrusting. In these conditions, slab detachment promotes the development of a high ($>$ 4.5 km) and narrow ($<$ 200 km) topographic plateau located in the vicinity of the suture. A contrasting style of collision is obtained by employing a weak crustal rheology. The weak mechanical coupling at the Moho promotes the widespread delamination of the lithosphere, preventing slab detachment to occur. Further shortening leads to buckling and thickening of the crust resulting in the development of topographic bulging on the lower plate. Collisions involving rheologically layered crust are characterised by a decoupling level at mid-crustal depths. These initial condition favours the delamination of the upper crust as well as the deep subduction of the lower crust. These collisions are thus successively affected by delamination and slab detachment and both processes contribute to the exhumation of the subducted crust. A wide ($>$ 200 km) topographic plateau develops as the results of the buoyant extrusion of the upper crust onto the foreland, this mechanism is further amplified by slab detachment. Our results suggest that the occurrence of both delamination (Apennines) and slab detachment (Himalayas) in orogens may highlight significant differences in their initial rheological structure.