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The influence of decoupling along plate boundaries on the mode of deformation and the geometry of collisional-type mountain belts

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The consequences of decoupling between weak orogenic wedges and strong adjacent foreland plates are investigated by means of lithospheric-scale analogue modeling. Decoupling is implemented in the three layer models by lubrication of the inclined boundary between the strong foreland and a weak orogenic wedge. Plate boundaries are orthogonal to the convergence direction. Experimental results show that strong decoupling between the foreland and the orogenic wedge leads to underthrusting of the former underneath the orogenic wedge, deformation of the orogenic wedge itself by folding, shearing and minor backthrusting. Shortening is mainly taken up along the main overthrust, the decoupled boundary, and within the orogenic wedge, leaving the indenter devoid of deformation. As a response to loading a foreland-type basin developed on the underthrusted plate. In contrast, strong coupling between the foreland and the orogenic wedge favors buckling, involving both, the weak zone and the strong plates. The development of topography through time reflects irregular folding (broad antiformal hinges are separated by narrow synforms), which is conditioned by the lateral strength variations from the strong encasing plates to the orogenic wedge. Our results show that (de)coupling between orogenic wedges and adjacent strong plates is a variable that can steer the structural and topographic evolution of collision zones as it controls the mechanisms by which the crust and lithosphere deform. The modelling results have implications for collision zones suggesting that an increase in resistive forces, as exemplified in this study through variable degrees of plate coupling, can lead to a change of the dominant deformation mechanism i.e. from thrusting to folding. Such a change is recorded in the evolution of the Eastern Alps in Europe, where subsidence and uplift/cooling data document the switch from localized deformation within the orogenic wedge proper during the Oligocene to Middle Miocene to orogen-scale uplift and deformation during the Late Miocene to recent. This younger phase of deformation involves the foreland and indenter plates and is interpreted as reflecting a change from a decoupled to a coupled system.