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Internal versus external forcing of orogenic detachments

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Fold-and-thrust belts which flank collisional orogens, result from the (partial) subduction of continental lithosphere and accretion of crustal material, respectively. According to the Critical Coulomb Wedge theory, this process leads to the formation of a critical wedge with a geometry controlled by the basal and internal mechanical properties. Such an orogenic wedge deforms to maintain its critical geometry as material is incorporated into the wedge or eroded away, and as the wedge is eventually tilted due to the flexural response of the supporting lithosphere. The respective evolution of fold-and-thrust belts should therefore depend on the coupling between deformation of the wedge, surface processes taking place with the wedge and its forelands and the flexural response of the lithosphere. Furthermore, the structure of orogenic wedges shows two modes of material accretion: Firstly, frontal accretion which occurs by thrust imbrication. Here, the wedge grows outward as a result of forward propagation of the frontal thrust fault. Thereby, the main detachment steps up within the stratigraphy of the foreland basin succession. Accordingly, the depth to the detachment decreases as the distance from the internal part of the fold and thrust belt increases. Secondly, basal accretion is achieved through duplex formation. During this accretion mode, the wedge grows vertically as a result of repeated downstepping of the main detachment within the stratigraphy of the underthrusting footwall.

Based on this classification, the South Pyrenean Fold and Thrust Belt can be considered to have grown mainly by frontal accretion. By contrast, the Himalayan orogenic wedge has grown primarily by basal accretion over the last 15Ma; a process that has contributed to scraping off the topmost 5-7 km of the Indian crust. While using results from sandbox simulations and field work we investigate these apparently different orogenic growth patterns found in nature which may point to an end-member behavior. We finally hypothesize that the position of the main detachment and the resulting growth scenario might be either driven externally, i.e. by surface processes (Himalayas) or internally, i.e. by wedge kinematics (Pyrenees).