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Coupled tectonic-surface processes modeling of the southern Pyrenean fold and thrust belt

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In the Central Pyrenees, the influence of syn- to post- orogenic deposits on the southern foreland may have influenced the late evolution. During middle to late Eocene, thrust deformation in the Pyrenean fold-and-thrust belt migrated to the south with in-sequence piggy-back thrust development. Then from Oligocene to Miocene, conglomerates sourced from the axial zone buried the fold and thrust belt until the Ebro foreland basin. At the same time thrust activity migrated from the front to the internal parts of the orogen reactivating major thrust in the foreland fold and thrust belt and in the south of the Axial zone. The reason for the out of sequence thrust activity is still a matter a debate. Moreover, thermal modeling of thermo-chronometric data and recent (U-Th)/He analysis on apatites in this area indicates conglomerate infill in excess of 2 km thick. Although the effect of changing orogen critical taper through wedge top sedimentation is known from theoretical studies, it has been difficult to demonstrate this behavior for natural system. The main objective of this study is to understand coupling between tectonics and surface processes during formation of the Pyrenean fold and thrust belt, the causes of out of sequence thrust activity, and the possible relationship with conglomeratic wedge top sedimentation.
We use an Arbitrary Lagrangian Eulerian (ALE) numerical model called Sopale to model the thin-skinned fold and thrust belt at upper crustal scales (7 km depth and 200 km long). Sopale takes into account the main parameters that influence the development of a fold and thrust belt such as flexure, strain softening of materials, erosion and sedimentation. Main controlling factors in these models include a detachment horizon, strain-softening of strong layers, flexural isostasy and the addition of erosion and sedimentation processes. The modeling is first focusing on the syn-orogenic part with wedge development coupled with syn-orogenic sedimentation. The sedimentation, affecting the taper angle, clearly modifies the behavior of the wedge with the development of long thrust sheets, over the décollement level. Then, a sediment cover that progrades towards the south with time is added to reproduce the syn- to post- orogenic infilling of the conglomerates. The numerical models of FTB formation show a strong sensitivity to syn-tectonic deposition. This presentation was supported by the EUROCORES programme TOPO-EUROPE of the European Science Foundation.