



Numerical modeling of sedimentation controls on the growth of the fold-and-thrust belts

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In the Southern Central Pyrenees, a major phase of late syn-orogenic sedimentation may have influenced the wedge growth and propagation. During Middle Eocene times, thrust deformation in the Pyrenean fold-and-thrust belt propagated to the south with long thrust sheets and significant wedge-top sedimentation. From Late Eocene to Oligo-miocene times, combined thermochronometric, modeling and field studies have shown that a thick pile of conglomerates sourced from the hinterland buried the fold-and-thrust belt until and the Ebro foreland basin. Simultaneously, thrust activity migrated from the front to the internal parts of the orogen reactivating major proximal thrusts, but the reason for the out-of-sequence activity is still a matter of debate. The main objective of this study is to understand the coupling between tectonics and surface processes during formation of a thin-skinned fold-and-thrust belt. To that purpose, we focus on the controls of syn-orogenic sedimentation on thrust development during wedge building before applying a more quantitative study to the southern Pyrenees. There, we investigate the causes for out-of-sequence thrust activity, and the relationship with conglomeratic wedge-top sedimentation.

We use an Arbitrary LagrangianEulerian finite-element model (Sopale) to model the thin-skinned fold-and-thrust belt at upper crustal scales (7 km depth and 200 km length). Sopale takes into account the main features and processes that influence the development of a fold-and-thrust belt including detachment horizons, strain-softening, flexural isostasy, and erosion and sedimentation processes. Initial, more conceptual modeling focuses on wedge development coupled with syn-orogenic sedimentation. Wedge-top sedimentation directly affects the taper angle and clearly modifies the behavior of the wedge; a clear relationship between average thrust-sheet length and the thickness of syn-tectonic sediments is highlighted. Subsequently, a sediment cover that progrades towards the foreland with time is added to reproduce the late syn-orogenic burial of the southern Pyrenean fold-and-thrust belt by conglomerates. By perturbing the forward progression of the wedge, this pattern of sedimentation can explain the out-of-sequence activity in the southern central Pyrenees.