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Late extension in compressional wedges above a weak, viscous décollement: results from analogue modeling

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Extension during convergence is a structural process commonly encountered in different geodynamic settings, such as accretionary wedges subjected to tectonic erosion, or mountain belts undergoing post-orogenic collapse. This has been investigated with experimental models at the scale of doubly-vergent wedges (Haq and Davis 2008; Bonini et al. 2000, Buck and Sokoutis 1994) but not thoroughly at the scale of fold-and-thrust belts. During an experimental investigation carried out on the behavior of segmented fold-and-thrust belts induced by stratigraphic inheritance in the foreland series (Borderie et al., EGU this session), unexpected shallow normal faulting occurred. The models comprised one basal frictional décollement (glass microbeads) and one upper viscous décollement embedded in the cover (silicone polymer). Extension took place during the late stages of the experiments and it was localized at the transition zone between the rear domain of the wedge and the frontal fold-and-thrust belt that detached on the upper viscous décollement. Normal faults strike parallel to the compressional structures and mainly dip toward the foreland. They root in the viscous décollement. Through a series of parametrized experiments dedicated to constrain the timing of formation of these extensional structures, we could evidence that these normal faults appear once the bulk shortening in the rear domain has created enough uplift of the internal zone by antiformal stacking and enough forelandward tilting of the upper viscous décollement. These two latter mechanisms are direct consequences of the whole wedge dynamics that links the thrust fault dynamics in the upper shallow sedimentary sequence and the thrust dynamics of the deep subsalt basement. The occurrence of this extension depends on the initial position of the upper viscous décollement and notably the position of the internal pinchout relative to the position of the backstop. Additional tests have also demonstrated that this extension is prevented by surface processes and notably sedimentation. We compare our experimental findings with natural examples of extensional features in various fold-and-thrust belts and accretionary features across the world (e.g. the Mediterranean ridge).

References:

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