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The role of lateral strength variations in collision dynamics: A 2D numerical study

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When continents collide mountain ranges with high topographies and complex internal geometries are formed. Yet, the process by which crustal material is transported and redistributed within a mountain belt remains poorly constrained.

Here we present a series of two-dimensional thermo-mechanical experiments to discuss the growth and evolution of mountain ranges under different conditions. The results show that continent collision may express itself in a variety of different crustal architectures, topographies, and deformation patterns, depending on the crustal rheology of the upper and lower plate. Upper plate indentation forms a sequence of foreland propagating thrust units on the lower plate and leads to minor back thrusting at the plate contact. The strong deformation of the lower plate stands in stark contrast to the undeformed upper plate. In contrast, subduction of strong lithosphere beneath a weak upper plate forms a complex pattern of deformation. Deformation initiates on the lower plate and forms an antiformal stack made of brittle upper crust. Successive accretion of thrust units forces the thrust system upwards and induces rotation, before it indents the upper plate.

The outcome of this study provides important constraints for the rheological state of continents during collision and may improve our understanding of natural collisional systems, in particular the Alps and the Pyrenees.