

Initiation of the Pyrenean plate boundary fault and its effect on the near- and far-field deformation of the European plate

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The European plate was affected by contractional deformation events in Late Cretaceous time. This is recorded by inception of thrusting and foreland basin subsidence in the Pyrenean realm, and inversion of Mesozoic rift systems in the interior of the European plate. It is widely accepted that the plate-wide deformation resulted from the onset of NE-directed convergence of Africa-Iberia relative to Europe, and a strong mechanical coupling of the plates, which allowed the transfer of stresses far into Europe. Geological data from both the Pyrenean orogen and the interior of the European plate indicate, however, that these conditions persisted only for $\sim 15\text{--}20$ Myr and that Europe experienced a plate-wide stress relaxation during Paleocene time. Although a slow down in plate convergence between Africa and Europe and North Atlantic continental rifting were proposed as potential causes for the stress relaxation, the subject has remained controversial. In particular, none of the mechanisms seem to be suitable to explain the required changes in the mechanical coupling of Iberian and European plates and the associated stress transfer. Here we propose a new model for the Upper Cretaceous to Paleocene tectonic evolution of the European plate, which takes the temporal evolution of the Pyrenean plate boundary fault into account. Based on plate reconstructions, geological field-data, and restored cross-sections we argue that the plate boundary fault initiated during the Upper Cretaceous within the exhumed mantle domain situated between the rifted margins of the Iberian and European plates. At the transition from the Late Cretaceous to Paleocene, the mantle domain was closed and the rifted margins collided. This evolution was associated with a substantial change in the fault rheology leading to an overall decrease in the plate coupling force. During Paleocene time, the plate coupling force was efficiently balanced by the gravitational push of the European plate, leading to a near neutral stress state in the upper plate and the observed plate-wide stress relaxation in Europe. This study is part of the Orogen research program and conducted in close collaboration with the BRGM (Bureau de Recherches Géologiques et Minières), the CNRS (Centre National de la Recherche Scientifique), and Total.