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Rift inversion to full collision: intrinsic threshold and characteristics

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Defining the history of shortening distribution in an orogeny, integrating both the pro- and retro-wedges, can help identify the transition from rift inversion to full collision. The Pyrenees are a Late Cretaceous to Miocene orogen that inverted a hyperextended rift system with exhumed mantle between Europe and Iberia. We performed a detailed study of the Eastern Pyrenees and its forelands to constrain shortening and timing for individual structures. These data were then used to reconstruct a shortening history across both wedges, revealing a change in the distribution of shortening through time. During early inversion (Late Cretaceous) shortening was distributed roughly equally between the European and Iberian rifted margins. A quiescent period (Paleocene) was apparently limited to the retro-wedge. During full collision (Eocene) around 80% of the overall shortening was accommodated in the pro-wedge, and the retro-wedge was reactivated slowly.

A similar change in the shortening distribution is reproduced by numerical models, coinciding with the onset of continental subduction. The change in shortening distribution is thus the result of reaching a threshold that is intrinsic to inverted rift systems, implying other inverted rifts should behave similarly. Based on these results, we propose a generic evolutionary model for inverted rift systems. The transition from rift inversion to full collision is caused by the onset of continental subduction. This transition can be recognised by a change to a pro-wedge dominant shortening distribution, and may be accompanied by a temporary abandonment of the retro-wedge. This model cannot be applied to orogens with inherited asymmetry (e.g., precursor oceanic subduction). The High Atlas (Morocco) and Pyrenees can be regarded as examples of initial symmetric rift inversion and later asymmetric full collision phases, respectively.