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Hyperextension in the SE tip of the Bay of Biscay: a new tectonic model for the Cretaceous Basque-Cantabrian Basin, North Spain

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The interest in the study of passive continental margins incorporated currently in orogenic systems has greatly increased in recent years, due to the possibility of observing in a direct way the structures responsible for the rupture of the continents. Many of these studies have revealed the existence of major extensional detachments, cross-cutting the whole crust, as the ones imaged by seismic methods in modern continental margins. In this work we present a model for the extensional structure of the Basque-Cantabrian Basin. This basin was the most subsident (almost 20 km of sediments) of all basins developed during the opening of the Bay of Biscay in the Mesozoic. The basin is currently incorporated into the Cantabrian-Pyrenean belt as a consequence of the Cenozoic (Alpine) convergence between the Iberian and European plates. The relatively minor overprint of contractional structures in this particular area, however, has allowed the precise reconstruction of the extensional structure. Extension was severe but without oceanization, and therefore it represents a good example to study intermediate stages of lithospheric rupture.

The structure of the upper part of the crust was established through geological mapping and varied subsoil information have been taken into account. The structure of the middle and lower crust is derived from 3D gravity and magnetic modelling, constrained by deep seismic reflection and refraction profiles. These data have been integrated into a crustal-scale transect across the most subsiding part of the basin, and this transect was restored to its pre-contractional stage to display the extensional architecture.

The structure of the upper part of the crust in the Iberian paleomargin consists of a wedge of syn-rift materials thickening towards the NE against a normal fault dipping to the SW, known as the Bilbao fault. In the footwall of this structure, the sedimentary succession is much thinner and rests almost directly on a dense and magnetized body attributed to the lower crust. We interpret the omission of the major part of the upper crust as a result of the activity of a SW-dipping extensional detachment, joining the Bilbao fault in depth. The European paleomargin would be located in the footwall of this detachment, holding a thin sedimentary succession. The structure of the basin reveals that the lower crustal body must have been dismembered from the lower crust during the extensional stage. This body is located in the area of maximum lithospheric thinning, where the final rupture would be localized in case the extension would have continued. The Upper Cretaceous post-rift facies support this model, since the area of maximum crustal thinning (experiencing the maximum amount of thermal subsidence) show turbiditic successions with interbedded volcanic rocks, whereas the Iberian and European proximal margins show typical carbonate platform facies.