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A Permo-Triassic border rift structure within the south-western Bay of Biscay controlling the shape of the Alpine crustal root beneath the Cantabrian Mountains

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The Bay of Biscay-Pyrenean geological system is an inverted hyperextended rift that illustrates in its deep structure the transition between an oceanic underthrusting in the west to a continent-continent collision in the east. We developed a structural analysis of the south-western reactivated rift system, which represents at present-day the western branch of the Cantabrian-Pyrenean collisional chain, including the Cantabrian Mountains onshore and the central and western segments of the North Iberian margin in the southern Bay of Biscay. This passive margin was structured during polyphase Triassic to Lower Cretaceous rifting events and subsequently inverted in the Cenozoic during the Alpine orogeny, when the Cantabrian-Pyrenean realm formed in the Iberian-European plate boundary. The reactivated rift system shows a significant structural variability resulting from the strong segmentation and strain partitioning during the subsequent tectonic events. Thus, it is a natural laboratory to study the constraints imposed by tectonic inheritance in the successive stages of an almost complete orogenic cycle.
From the interpretation of offshore geological and geophysical data and the integration of onshore wide-angle results, where Mesozoic fossil remnants are very scarce, we analyzed the crustal structure of the reactivated rift system and mapped the now inverted rift domains. Our results show that the inherited rift architecture controlled the subsequent compressional reactivation of the hyperextended rift system. Of particular interest are the structural variations observed in proximal areas.
Offshore, the proximal domain includes classical shallow grabens and half-grabens with low degrees of extension developed during an early Permo-Triassic rift event governed by stretching processes. Its NW-SE distal limit runs parallel to the Cantabrian Fault. Following this trend, a major structure, called Ventaniella fault, has been traditionally mapped onshore, interpreted as a polyphase structure that dates from the initial post-Variscan reorganization of the Iberian massif. Its importance during the Mesozoic extension and the subsequent compressional reactivation remains poorly understood.
Relying on the structure of the western and central North Iberian margin, we suggest that this fault acted as the southern boundary of the initial Permo-Triassic rift and lost its importance during the main E-W to WNW-ESE Upper Jurassic to Lower Cretaceous rift, which moved towards the NE. Onshore, this fault limits towards the west the crustal root developed beneath the Cantabrian Mountains. Thus, we proposed that the limit of the initial Permo-Triassic rift played an important role as a rheological limit, at least during the first compressional phases, conditioning the compressional reactivation. We interpret that the Ventaniella fault is an Alpine reactivation of the Permo-Triassic border rift structure favoured by the obliquity between the NW-SE fault direction and the N-S compression.
We speculate that the crustal root developed within the necking domain and its dissapearance westwards of the Ventaniella fault was related to the presence of a thicker and thus more rigid crustal block, represented by the proximal domain. Therefore, the compressional reactivation is partitioned at both sides of the initial NW-SE Permo-Triassic border rift structure which separates at present-day two distinctive crustal domains with different seismic activity.