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Margin segmentation due to strain localization during polyphase rifting in the south-western Bay of Biscay

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It is widely agreed that the architecture of rift systems is controlled by the evolution of successive deformation modes linked to tectonic activity. However, progressive spatial and temporal strain localization, and the resulting structural segmentation characterizing rifted margins are still poorly constrained. The Bay of Biscay rift is a strongly segmented rift representing an ideal setting to study the evolution of rifting processes. This system developed during the Mesozoic as part of the southern North Atlantic rift system. Its central V-shaped oceanic basin formed during a short-lived spreading period preceded by polyphase Triassic to Lower Cretaceous rift events. The rift system was inverted to varying degrees from Late Cretaceous to Cenozoic, when the Pyrenean-Cantabrian orogen developed along the Iberian-European plate boundary.

In this work, we present the structural framework for the central and western North Iberian margin, at the southern Biscay margin, which is at present part of the Alpine collisional belt. The framework was constructed based on interpretation of a dense set of high quality 2D seismic reflection profiles together with boreholes and the integration of wide-angle models, and lithospheric density constraints derived from a constrained 3D gravity inversion. The studied region shows evidence of strong segmentation resulting from three extensional events. Remnants of an older Permo-Triassic rift have been recognized along the whole continental platform. A rift basin related to Permo-Triassic rifting is preserved in the western North Iberian margin. NW-SE structural patterns and faults characterize the architecture on this margin segment. A major NW-SE lithospheric lineament related to the trace of the present-day Ventaniella Fault can be recognized in this area, separating out the proximal and the former necking domains. Hyperextension and exhumation occurred during the second and third events from Late Jurassic to Late Albian in the central and eastern parts of the North Iberian margin. The hyperthinned Asturian Basin and the hyperextended domains within the abyssal plain developed during these two events in the central part of the margin. Major faults and structural variations trends in an E-W to WNW-ESE direction on this area.

Together, the central and western North Iberian margins preserve structures from three distinct rifting events. Two structural domains can be separated by a transitional zone located between 5º 30′W and 6ºW, where the observed structural and crustal variations are consistent with the presence of a N-S transfer zone, referred to as Peñas Transfer Zone. The presence of N-S to NNE-SSW transfer structures has been already interpreted as a sign of rift segmentation in the Basque-Cantabrian and Pyrenean domains where partitioning of deformation was widely acknowledged.

This work shows that the rifting in the Bay of Biscay was a complex and polyphase process. Our results enhance understanding of the structure of the North Iberian margin and add more insights to comprehending strain localization within inverted rift systems where both, extensional and the compressional processes are at play.