Mapping hyper-extended rift systems offshore and onshore: insights from the Bay of Biscay- Western Pyrenees

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Research conducted at present-day passive continental margins shows more varied crustal architectures than previously assumed. New seismic data together with drill-holes have revealed the occurrence of extremely thinned continental crust in the distal part of the margin as well as exhumed serpentinised sub-continental mantle oceanwards. In addition the understanding of the formation of hyper-extended rift systems has also greatly benefited from the study of onshore analogues preserved in mountain belts.

The Bay of Biscay and Western Pyrenees correspond to a Lower Cretaceous rift system leading to the development of hyper-extended domains and ultimately oceanic crust in the Bay of Biscay. This domain represents one of the best natural laboratories to study the formation processes and evolution of hyper-extended domains. During late Cretaceous compression, these rifted domains were inverted resulting in the present-day Pyrenean mountain belt.

In this contribution, we present a new paleogeographic map of the Bay of Biscay-Pyrenean rift system. We integrate results from previous works and new work using different mapping methods to distinguish distinctive crustal domains related to hyper-extended systems both offshore and onshore. We combine seismic interpretations with gravity anomaly inversion to distinguish the different crustal domains across the offshore margin. Onshore, we use an innovative approach based on observations from present-day rifted margin architecture associated with classical field work to map the former hyper-extended domains. Another outcome of this work is the creation of a crustal thickness map using gravity inversion linking offshore and onshore domains from the Bay of Biscay to that of the Western-Pyrenees. This multidisciplinary approach enables us to investigate the spatial and temporal evolution of the Bay of Biscay rift system with the aim of better understanding the formation of hyper-extended domains.

Results from both the interpretation of Bay of Biscay rift system and of the crustal thickness map suggest that (1) the spatial evolution of the hyper-extended rift system is more complex than previously assumed and (2) the rift system is strongly segmented at different scales by inherited transfer faults and shear zones bounding different rift basins (e.g. the Pamplona fault, onshore) or delimiting major changes of architecture (e.g. the South Armorican Shear Zone, offshore).

Through this work, we aim to illustrate and investigate the processes related to the formation the Bay of Biscay-Western Pyrenees rift system. Moreover, the mapping methods used in this study may be applied to better understand other hyper-extended rift systems.