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What is the crustal architecture of hyper-extended domains at rifted continental margins: The Bay of Biscay-Western Pyrenees example

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Research into the formation of passive continental margins is currently evolving. The discovery of exhumed continental mantle and hyper-extended continental crust devoid of major normal faulting in deep-water rifted margins casts doubt on classical rift models. The development of new concepts that could explain passive margin formation is strongly limited by the resolution of offshore public seismic data and by the lack of drilling. However, the investigation of remnants of ancient margins or hyper-extended rift systems preserved in collisional belts gives important new insights on the study of rift structures and architecture.

We use the Bay of Biscay-Western Pyrenees as a natural laboratory to study the processes and evolution related to passive continental margin formation. Offshore in the Bay of Biscay, this domain represents an embryonic oceanic basin that formed during Aptian time. At the south-eastern termination of the Bay of Biscay, several rift basins, likely to have formed in similar settings (as a consequence of Early Cretaceous rifting), show evidence of hyper-extended continental domains (e.g. Parentis, Arzacq-Mauléon, Cantabrian basins). The structural inversion of these basins during Pyrenean compression resulted in the reactivation of some of the rift structures as observed offshore on seismic sections and outcropping onland in the Western Pyrenees.

We combine offshore studies, based on seismic reflection data and using gravity inversion and residual depth anomaly analysis, with onshore field observations to investigate the Bay of Biscay-Western Pyrenees rift system with the aim of better understanding the architecture of present-day deep-water rifted margins (in the Bay of Biscay) and of hyper-extended rift basins (Arzacq-Mauléon, Cantabrian basins). In order to compare the rift structures of the Bay of Biscay rifted margin with the onshore analog basins in the Western Pyrenees, we reconstruct several crustal scale cross-sections across the rift system.

Initial results suggest that the rift architecture of the Arzacq-Mauléon basin is controlled by low-angle detachment fault systems. Interpretations indicate that the 3D evolution of the system is complex and that the basin is segmented by lateral ramps. In order to compare this hyper-extended domain onshore to a present-day passive margin, we have reinterpreted selected seismic lines across the North Biscay margin. First results show a well-defined hyper-extended domain between the continental proximal margin and distal oceanic domains. Two types of architecture can be distinguished across the margin within the hyper-extended domain. We believe that this change of architecture is linked with a switch from a lower to upper plate margin going from the northwest to the southeast.

With this work, we aim to illustrate the architecture of hyper-extended domains and to investigate the processes responsible for the formation of hyper-extended rift systems.