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What is the tectono-sedimentary record of hyper-extended, magma-poor rifted margins ?

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The tectono-sedimentary record of hyper-extended, deep-water rifted margins is yet poorly understood due to the limited access to direct observations. The study of fossil analogues shows that the major change from low strain (e.g. North Sea) to high-strain rift systems is controlled by the occurrence of low-angle detachment systems associated with extensional allochthons. In such systems classical syn- to post-rift sedimentary models cannot be directly applied because the depositional geometries, the creation of space as well as the relation to potential sources are different. In our study we investigate the tectono-sedimentary record of high strain, hyper-extended deep-water rifted margins.

We studied a present-day and two fossil hyper-extended rift systems, which preserve detachment systems that control the syn- to post-rift sedimentary record. The three examples are:
(1) The SE Alpine Tethys (AT) rifted margin preserved in SE Switzerland.
(2) The Mauléon basin in the Western Pyrenees (WP)
(3) The southeastern termination of the Baja California peninsula in the Gulf of California (GC) representing a subactual system.

For all three examples rift related detachment structures and their relations to pre-, syn-, and post-rift sediments can be mapped. Despite of the different plate kinematic settings (orthogonal (AT), segmented (WP), transtensional (GC)), sediment supply (starved (AT) vs. rich (WP, GC), and facies (marine (AT, WP) vs. subareal (GC)), the overall tectono-sedimentary evolution shows strong similarities and can be described as following.

The detachment faulting is recorded by the generation of extensional allochthons derived from the delamination of the former hanging-wall. These syn-tectonic sediments show the progressive switch from hanging-wall to footwall derived lithologies. The sourcing change reflects the exhumation and formation of top-basement detachment systems. Sediments related to this stage represent poorly organized locally-derived tectono-sedimentary sequences, which overlie top-basement detachment systems.

During a subsequent stage, when tectonic activity migrates oceanwards, the stratigraphic record is not anymore controlled by the detachment system, but by flexural and isostatic movements and the sedimentary system is re-organized and controlled on a more regional scale. For the starved margin (AT), the absence of terrigenous sourcing causes the progressive retrogradation of the starved turbiditic syn-rift system grading upsection into hemipelagic sediments. In the sediment-rich systems (WP, GC), the terrigenous systems can prograde and can be the main feeding system of the so-called sag-basins in present-day hyper extended deep-water rifted margins.

Future studies will focus to the questions of how rift evolution (migration of detachment faults), accessibility and sediment loading control the evolution and architecture of deep-water rift sequences in so-called sag basins.