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The role of inheritance in structuring hyperextended rift systems

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A long-standing question in Earth Sciences is related to the importance of inheritance in controlling tectonic processes. In contrast to physical processes that are generally applicable, assessing the role of inheritance suffers from two major problems: firstly, it is difficult to appraise without having insights into the history of a geological system; and secondly all inherited features are not reactivated during subsequent deformation phases. Therefore, the aim of our presentation is to give some conceptual framework about how inheritance may control the architecture and evolution of hyperextended rift systems.

We use the term inheritance to refer to the difference between an "ideal" layer-cake type lithosphere and a "real" lithosphere containing heterogeneities and we define 3 types of inheritance, namely structural, compositional and thermal inheritance. Moreover, we assume that the evolution of hyperextended rift systems reflects the interplay between their inheritance (innate/"genetic code") and the physical processes at play (acquired/external factors). Thus, by observing the architecture and evolution of hyperextended rift systems and integrating the physical processes, one my get hints on what may have been the original inheritance of a system.

Using this approach, we focus on 3 well-studied rift systems that are the Alpine Tethys, Pyrenean-Bay of Biscay and Iberia-Newfoundland rift systems. For the studied examples we can show that:
1) strain localization on a local scale and during early stages of rifting is controlled by inherited structures and weaknesses
2) the architecture of the necking zone seems to be influenced by the distribution and importance of ductile layers during decoupled deformation and is consequently controlled by the thermal structure and/or the inherited composition of the curst
3) the location of breakup in the 3 examples is not significantly controlled by the inherited structures
4) inherited mantle composition and rift-related mantle processes may control the rheology of the mantle, the magmatic budget, the thermal structure and the localization of final rifting
Conversely, the deformation in hyperextended domains is strongly controlled by weak hydrated minerals (e.g. clay, serpentinite) that result form the breakdown of feldspar and olivine due to fluid and reaction assisted deformation and is consequently not inherited but the result of rift induced processes.

These key observations show that both inheritance and rift-induced processes play a significant role in the development of magma-poor rift systems and that the role of inheritance may change as the physical conditions vary during the evolving rifting and as rift-induced processes (serpentinization; magma) become more important. Thus, it is not only important to determine the “genetic code” of a rift system, but also to understand how it interacts and evolves during rifting. Understand how far these new ideas and concepts derived from the southern North Atlantic and Alpine Tethys can be translated to other less explored hyperextended rift systems will be one of the challenges of the future research in rifted margins.