EXTREME CRUSTAL THINNING AND MANTLE EXHUMATION IN DEEP-WATER RIFTED MARGINS: THE LESSONS FROM THE IBERIA-NEWFOUNDLAND AND ALPINE TETHYS MARGINS AND APPLICATIONS TO THE PRE-SALT SAG BASINS OF THE S-ATLANTIC

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RESUMO: Research into the formation of passive rifted margins is incontestably undergoing a paradigm shift. The discovery of exhumed mantle and hyper-extended crust overlain by shallow marine sediments is proving fundamental in defining the controls and processes that thin continental lithosphere, lead to continental break-up and formation of oceanic basins. However, the development of new concepts critically depends on the access to pertinent geological and geophysical data, which remains a key problem. At present, little is known about the depositional environments, sedimentary facies, the kinematics and age of structures, or the subsidence and thermal history of syn-rift sediments of deep-water rifted margins. In my presentation I will therefore review the key observations made along the Iberia-Newfoundland and Alpine Tethys rifted margins and will try to show how they may impact our thinking and understanding of the pre-salt basins of the S-Atlantic.

Along the Iberia-Newfoundland rifted margins seismic refraction and reflection seismic imaging together with the results of the Ocean Drilling Project (18 deep drill holes) showed that the transition from continental to oceanic crusts does not represent a sharp boundary, but is formed by an up to 160 km wide zone of exhumed sub-continental mantle. This observation questions the existence of a sharp and well-defined ocean-continent boundary and asks about the validity of the breakup unconformity and nature and significance of magnetic anomalies in ocean continent transitions. Recurrence of distributed tectonic extension and magmatic activity after mantle exhumation suggests that final rifting is a polyphase and complex process that can last, in magma-poor environments, over 10s of millions of years and result in hundreds of kilometres of crust that is hyper-extended.

In the Alps in W-Europe, mapping of rift structures and depositional systems of the ancient Alpine Tethys margins enabled to identify lithologies and structures similar to those drilled off Iberia. The most prominent structures observed in the Alps are top-basement detachment faults. These structures can be traced from relatively unextended continental crust across the ocean-continent transition towards embryonic oceanic crust. These faults are overlain by extensional allochthons, syn- and post-rift sediments and, further oceanwards, also by MOR-basalts. Detailed mapping of these structures shows that they are complex. They do not correspond to one single low-angle detachment fault as proposed by the Wernicke model. Detachment faults interact with decollements in ductile layers and only when the crust is thinned to less than 10 km and is completely brittle, detachment faults can cut from the surface into mantle and exhume the latter at the seafloor. Fluids are intimately linked with this process, controlling rheological and thermal evolution and, by interaction with potential reservoirs, also syn-to post-rift petroleum systems in hyper-extended margins.

The lesson from the Iberia-Newfoundland and Alpine Tethys rift systems might not explain the whole S-Atlantic, however, it may help to re-evaluate and rethink some to the concepts, the terminology and the processes that were (are) used to describe rifting and continental breakup along their margins.