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From magma-poor Ocean Continent Transitions to steady state oceanic spreading: the balance between tectonic and magmatic processes

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The evolution of magma-poor rifted margins is linked to the development of a transition zone whose basement is neither clearly continental nor oceanic. The development of this Ocean-Continent Transition (OCT) is generally associated to the exhumation of serpentinized mantle along one or several detachment faults. That model is supported by numerous observations (IODP wells, dredges, fossil margins) and by numerical modelling. However, if the initiation of detachment faults in a magma-poor setting tends to be better understood by numerous studies in various area, the transition with the first steady state oceanic crust and the associated processes remain enigmatic and poorly studied.
Indeed, this latest stage of evolution appears to be extremely gradual and involves strong interactions between tectonic processes and magmatism. Contrary to the proximal part of the exhumed domain where we can observe magmatic activity linked to the exhumation process (exhumation of gabbros, small amount of basalts above the exhumed mantle), in the most distal part the magmatic system appears to be independent and more active. In particular, we can observe large amounts of extrusive material above a previously exhumed and faulted basement (e.g. Alps, Australia-Antarctica margins). It seems that some faults can play the role of feeder systems for the magma in this area. Magmatic underplating is also important, as suggested by basement uplift and anomalously thick crust (e.g. East Indian margin). It results that the transition with the first steady state oceanic crust is marked by the presence of a hybrid basement, composed by exhumed mantle and magmatic material, whose formation is linked to several tectonic and magmatic events. One could argue that this basement is not clearly different from an oceanic basement. However, we consider that true, steady state oceanic crust only exists, if the entire rock association forming the crust is created during a single event, at a localized spreading center. The interest of that definition is that it does not restrain the term oceanic crust to a basement composition and consequently does not exclude the creation of magma-poor oceanic crust, as observed at slow spreading ridges for example. Indeed, the initiation of steady state oceanic spreading is not necessarily magmatic (e.g. some segments of the Australian-Antarctic margins). In this case, drifting is accommodated by mantle exhumation. However, in this magma-poor transition, and without clear markers of a gradual increase of magmatism, it thus appears difficult to clearly differentiate an exhumed OCT basement and an exhumed oceanic basement. Some theoretical differences can be nevertheless considered: exhumed OCT basement should display a chemical evolution toward the ocean from a subcontinental to an oceanic signature. Moreover, extensional detachment faults are probably long-lived due to the poor influence of the asthenosphere at this stage. On the contrary, exhumed oceanic basement should only display an oceanic signature. In this case, extensional detachment faults are certainly short-lived, due to the strong influence of the asthenosphere, which tends to quickly re-localize the deformation above the spreading center.