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EGU2020-20094
https://doi.org/10.5194/egusphere-egu2020-20094
EGU General Assembly 2020

Thermal record of hyperextended rifted margins: the fossil record of the Pyrenees

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The thermal architecture of late rifting to breakup along the deep passive margins is still poorly known. This is mostly because of the limited access to industry drillhole data that, anyway, calibrate topographic highs and rarely the deepest rift domains (and even less the basement). However, unravelling this evolution is a fundamental requirement to define the ultimate exploration potential of these frontier domains. An alternative way to document this thermal evolution is to describe fossil analogues onshore. In this study, we use the fossil hyperextension record of the Pyrenean belt that was sampled by orogenic deformation into the North Pyrenean None and Nappe des Marbres alpine units. Previous studies have shown that the rift came into hyperextension and recorded locally mantle exhumation. These rift domains are associated with a HT-LP metamorphism event that was shown to vary spatially within the rift basin as well as into the basement. In order to restore the late rift thermal architecture of the Pyrenean hyperextended rift, we use a new compilation of Raman Spectroscopy measurements on Carbonaceous Material (RSCM) and Vitrinite Reflectance data. This method allows to record the palaeo-maximum temperatures in the sedimentary basins spatially as well as vertically and can be superposed to geological sections. This method was applied in almost 200 samples collected all along the belt at different stratigraphic level as well as into the Paleozoic basement. When the base of the rift basin is exposed, RSCM Tmax range between 450 and 620°C below a <5km thick sedimentary pile. Western Pyrenees was shown to be an exception as RSCM Tmax are less than 300°C on the outcropping superficial part of the rift basin. However; Vitrinite Reflectance data from wells that are calibrating the deep basin demonstrate that the same thermal intensity was actually reached. These results discard any lateral variation in thermal regime and is pointing out that it is a burial function into a (very)high late rift thermal gradient that largely exceed 100°c/km. Far from being restricted to the Pyrenean case, such a thermal evolution with the same amplitude gradient within the same exhumed mantle domains were documented in the Northern Red Sea example.