



Extreme thinning of distal passive margin by lateral extraction of the continental crust and mantle exhumation. Constraints from the Pyrenean analogs.

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The pre-rift Mesozoic sequences of the Cretaceous passive margins inverted in the Northern Pyrenean belt are characterized by high temperature deformation in relation with thinning of the continental basement. Our compilation of chronological and geological data from the North Pyrenean Zone confirms a clear correlation between the distribution of the highest paleotemperatures in the pre-rift sedimentary cover and the loci of extreme crustal stretching. Geological evidences such as the occurrence of peridotite bodies directly underlying metamorphic pre-rift sediments indicate an early attenuation of the rifted continental crust. This leads us to propose a mechanism of crustal thinning involving lateral extraction of the continental crust. The boudinage of the crust occurred under thermal conditions allowing coeval ductile deformation of the Paleozoic basement and of the pre-rift sediments leading to the widening of basins devoid of large faulted blocks. This mechanism accounts for the early tectonic contact between exhumed mantle rocks and pre-rift sediments and for the ductile deformation of the pre-rift sediments under HT-LP conditions well observed along the Internal Metamorphic Zone (IMZ) of the NPZ.

We also shed light on the fact that syn-rift, Albian-Cenomanian flysch sequences were deposited synchronously with the syn-metamorphic ductile deformation of the pre-rift sequences. Moreover, we recall that all along the IMZ, the base of the flysch deposits also recorded the high-temperature tectonic event. Such a synchronicity between geological events, which are generally separated in time, is not common in mountain belts. This leads us to examine how tectonics, metamorphism and sedimentation may be active in a single basin during extension. Since the base of the flysch deposits also recorded locally the high-temperature tectonic event, we propose an original mechanism for the evolution of the basins involving continuous basal extraction of the pre-rift metamorphic sediments. This early high-temperature deformation event, which is linked to extensional tectonics under high geothermal gradient, relates to the “phase anté-Cénomanienne” described by Pyrenean geologists since 1930.

In the light of this new model, we discuss the implications on the origin and significance of the North Pyrenean granulites and the relations between flysch deposition and high temperature metamorphism of the pre-rift sediments.