CONSTRAINTS of ECORS DATA on the CRUSTAL ARCHITECTURE and EVOLUTION of the PYRENEES

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The Iberian Moho is progressively deepening towards the Axial Zone of the Pyrenees, whereas the overall thickness between the Moho and the basal Triassic or intra-Permian décollement remains about constant between the Ebro River in the south and the Nogueras in the north. In contrast, the European Moho becomes flat or gets even shallower south of the North Pyrenean thrust front. At shallower level, the basal unconformity of the Late Cretaceous flexural basin is still well preserved beneath the North Pyrenean allochthon as far south as the surface trace of the North Pyrenean Fault. This implies that the southernmost part of the European crust still records the effect of the pre-orogenic, Albian episode of stretching. Worth to mention, the northernmost allochthonous unit along the Ecors profile relates to the Arize Massif, which is made up of crystalline basement and Paleozoic series including Permian continental red beds, passing northward into Triassic evaporites and Jurassic to Lower Cretaceous platform carbonates, as well as Albian deeper water clastics which were initially deposited in a down-faulted compartment of the Cretaceous rift system. As evidenced in the present-day structural section and its restored counterpart, part of the Albian tilted blocks is still preserved in the footwall of the North Pyrenean allochthon. Instead, the distal part of the extentional system has now been entirely inverted and transported northward within the North Pyrenean allochthon, which comprises, from north to south, upper crustal fragments such as the Arize Massif and its Paleozoic to Albian sedimentary cover, lower crustal granulitic fragments such as the Castillon Massif, as well as infracontinental mantle (Lherz peridotite).

Only a few normal faults have been imaged at the base of the Mesozoic cover beneath the Tremp Basin in the south Pyrenean foreland. However, these faults do not relate to extrados fractures developing simultaneously with the flexing of the foreland lithosphere. They are instead Mesozoic in age and control progessive, lateral, northward thickness variations currently observed in the Triassic to Cretaceous platform series measured in the various tectonic units of the allochthon, as evidenced on the restored cross-sections.

The excellent quality of the Ecors Pyrenees profile has demonstrated also that a south-verging thin-skinned stair-case flat-ramp thrust system occurs in the upper crust of the Aquitaine and Ebro forelands, on both sides of the Pyrenees. Despite the fact that there is no deep well to constrain the age of the intra-Paleozoic décollement there, Silurian blackshales and Carboniferous coal measures are good canditates for such decoupling. Alternatively, the fact that the basal unconformity of the Mesozoic series (Triassic in the Ebro Basin and Cretaceous in the Aquitaine part of the Ecors profile) has not been refolded above these upper crustal structures implies that they pre-date the Mesozoic. In addition, the northernmost portion of the North Pyrenees profile displays south-dipping reflectors beneath the distal portion of the flexural basin, which have been locally reached by old bore-holes, accounting for thick asymmetric Permian depocenters. Thanks to the deep seismic imagery, it is possible here to demonstrate that the north-facing normal faults localizing the Permian depocenters are rooted on top of underlying Carboniferous thrust, providing a text-book illustration of negative inversion of Hercynian compressional structures operating during the Permian collapse of the orogen. Although the quality of the Ecors data is not as good below the Tremp Basin, the north-facing Mesozoic normal faults offsetting the basal Triassic unconformity there may have been controlled by the same type of negative inversion, coeval this time with the onset of rifting in the Tethyan and then Central Atlantic domains.

Ultimately, the northern and southern Ecors Pyrenees profiles document a strong discrepancy in the crustal thickness imaged on both the Iberian and European forelands, at a large distance from the Pyrenean orogen. Actually, the Iberian crust below the Ebro foreland basin is thicker than its counterpart below the Aquitaine foreland basin, in areas which were not directly impacted by Mesozoic rifting episodes but still preserve the same post-Hercynian signature. In contrast to the upper crustal part of the Iberian foreland which still displays approximately the same thickness as its counterpart in the Aquitaine foreland, its underlying lower crust has been obviously thickened as compared to its European counterpart during the post-Albian episodes of plate convergence. Apart of its larger thickness, the Iberian lower crust differs also from its Aquitaine counterpart by the imbricate pattern of its seismic reflectors, whereas a parallel pattern of lower crustal reflectors is observed in European below Aquitaine and other portions of the former Variscan orogen, as for instance below the Paris Basin. Because the Iberian upper crust in the Ebro Basin is only uplifted and not refolded above its over-thickened lower crust, one has to admit that a southward-propagating ductile flow of Iberian lower crust operated in the footwall of the European upper mantle buffer. Such lower crustal flow allowed the transfer of part of the deformation induced by the Europe-Africa convergence from the Pyrenean plates boundary towards the Iberian foreland, with a progressive decoupling of the Iberian crust from its upper mantle, only the later being actually subducted beneath the Axial Zone of the Pyrenees.

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