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The deep architecture of the Pyrenees: An overview of the results coming from a decade of passive imaging studies

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Imaging the deep architecture of mountain ranges is crucial to understanding the support of high relief, their seismicity, or for kinematic reconstructions, but is still challenging with conventional seismic imaging approaches. Focusing on the Pyrenees, we will present an overview of the important new insights that were brought on its global deep architecture from passive imaging studies over the last decade. These progresses were made thanks to innovative imaging approaches that build both on a more thorough exploitation of seismic signals and on new dense acquisitions.

In addition to a 2D backbone deployment of broadband sensors spaced by about 60 km, 5 dense transects were deployed across the Pyrenees, providing a unique opportunity to image the global architecture of this mountain range. The most salient feature of the emerging picture is the strong non-cylindricity of the Pyrenees, with a continental subduction observed in the Central and Western Pyrenees that is absent in the east. The crust beneath the North Pyrenean Zone in the Western and Central Pyrenees is thin ($\sim$ 20 km), with a Moho that reaches very shallow levels beneath the Mauleon basin (Western Pyrenees) and Saint Gaudens (Central Pyrenees), a pattern that is strongly correlated with the distribution of positive Bouguer gravity anomalies. Full waveform inversion of short-period teleseismic wavefields allowed us to obtain finely resolved 3D compressional and shear velocity models of the lithosphere beneath the Central and Western Pyrenees. These models confirmed the subduction of the Iberian plate beneath Eurasia down to about 70 km depth, and evidenced the presence of a serpentinized mantle body emplaced at a shallow crustal level beneath the Mauleon basin. A large-N deployment, the Maupasacq Experiment, composed of about 450 broadband, short period and geophone sensors, allowed us to obtain more detailed constraints on crustal structures beneath the Mauleon basin. Local tomography has confirmed the presence of a fast mantle body at around 8-10 km depth beneath the 6 km-thick Mauleon basin. We interpret this anomalous structure as a sampled remnant of the Cretaceous pre-orogenic hyper-extended rift. Other salient features in the local tomography model are the reduced velocities observed inside vertical cylinders located inside the Mauleon basin. They can be followed from the surface down to 6-8 km depth, taking their roots on the roof of the imaged mantle body, and presumably correspond to conduits through which geological fluids circulate.