Geophysical Research Abstracts
Vol. 20, EGU2018-10496, 2018
EGU General Assembly 2018

Crustal thickening during early stages of reactivation of a hyperextended margin: the crustal root beneath the Cantabrian Mountains

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While the architecture and tectonic evolution of mature orogenic belts have been extensively studied, the initial reactivation of rifted margins leading to subduction and eventually to mountain belts is yet little understood, partly because these systems are only preserved in rare cases.
The Pyrenean-Cantabrian orogen developed along the European-Iberian plate boundary from Late Cretaceous to Cenozoic, involving the compressional reactivation of strongly segmented Mesozoic rift systems along the southern Bay of Biscay. The collisional chain includes at present two major structural domains, showing different evolutionary stages of collision; the Pyrenees in the east, displaying a complete continent-continent collision, and the western and central North Iberian margin and the Cantabrian Mountains in the west, representing a particular and valuable setting that preserves early stages of convergence. In the western North Iberian margin, the compressional reactivation gave place to an underthrusting or incipient subduction of oceanic lithosphere, while in the central North Iberian margin, hyperextended domains have been underthrust beneath the continental platform leading to crustal thickening and the uplift of the Cantabrian Mountains onshore.
In this work, we analyse the structure of the crustal root developed beneath the Cantabrian Mountains. An integration of all the available P-wave velocity models onshore reveals that the crustal root is more than 40 km thick and extends onshore between 4ºW and 6ºW. The Cantabrian Mountains are very close to the coast on this area, which includes the summits, with the highest peak at 2648 m. Offshore, this area is bounded by two N-S trending transfer zones and represent a strongly segmented area, including the hyperthinned Asturian Basin bounding northwards by the Le Danois crustal block, and the hyperextended domains within the abyssal plain.
Towards the east, crustal thickness decreases beneath the Basque-Cantabrian Zone, varying between 30 and 40 km, where the highest peak is at 1560 m. Towards the west, crustal thickness is drastically reduced to less than 35 km, even when the highest topography is at 2100 m. The crustal root disappears quite abruptly in the vicinity of the Ventaniella Fault. From the analysis of the architecture of the North Iberian margin, we interpret this structure as an Alpine reactivation of the boundary between the proximal and the former necking domain. Thus, we propose that the crustal root developed in the necking domain and its disappearance westwards of the Ventaniella Fault was related to the presence of the thicker and thus more rigid proximal domain.
The analysis of the structure and the thermo-mechanical properties of the rifted crust can provide new insights to unravel the processes leading to crustal thickening during early stages of collision that condition the future development of the collisional belt. At the same time, the study of the spatial extent and the structure of the crustal root can bring further constraints to restore the pre-orogenic architecture of the reactivated rifted margin.