Imaging the crustal structure of the Spanish Central System

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In this work, we present lithospheric-scale model of across the Iberian Massif in western Iberia. The image comprises the Spanish Central System mountain range and, the Cenozoic Duero and Tajo basins which bound it to the N and S, respectively. The target area represents one of the most characteristics topographic features of central Iberia; the Tajo Basin has an average altitude of 450-500 m while, the Duero Basin presents higher average altitude 750-800 m. The Central System represents part of the Variscan Central Iberian Zone (southern margin of the Paleozoic Gondwana) which was reactivated and uplifted during the Alpine Orogeny. This intraplate orogen features a thick-skin pop-up and pop-down configuration formed by the reactivation of Variscan structures. Its high topography is the response of a tectonically thickened crust evidenced by 1) the geometry of the Moho discontinuity 2) an imbricated crustal architecture and/or 3) the rheological properties of the lithosphere. A research project (CIMDEF) was carried out in the area and, it includes an almost 330-km long multi-seismic profile acquired using natural and controlled source seismic data. The former consists of two months of continuous recording by an almost-linear array of 69 short-period seismic stations, which recorded earthquakes and, ambient seismic noise. The controlled source data included over 900 stations and a series of acoustic sources. The data places strong constraints on the geometry of the base of the crust. The research effort includes: seismic interferometry (using seismic noise recordings), wide-angle analysis of the controlled source data and, Global-Phase seismic imaging. The latter uses PKP, PKiKP, and PKIKP phases of earthquakes at epicentral distances > 120° and, their reverberations in the lithosphere. The selected phases are autocorrelated and stacked to construct a high-resolution pseudo zero-offset reflection image. Seismic noise interferometry uses the autocorrelation of seismic noise ambient records. These autocorrelations provide an approximation to a zero-offset reflection response of a single station. Both methods are complementary as they rely on different energy sources but are applied to the same receivers locations. The results reveal the geometry of the Moho. Further details on the lithospheric structure is provided by seismic wide-angle reflection images, which reveal a clear thickening of the crust below the Central System resulting, most probably, from an imbrication of the lower crust. Results reveal features that can be correlated in all the images. The crust-mantle boundary is mapped as a relative flat interface at approximately 10 s two-way traveltime except under the Central System, where this feature deepens towards the NW reaching more than 12 s. An intra-crustal boundary is well defined at 5 s. Reflectivity within upper-mantle depths is scattered throughout the profile, located between 13-18 s, and probably related with the Hales discontinuity.

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