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Lithospheric structure of the Iberian Peninsula from coupled geophysical-petrological inversion

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The objective of this study is to obtain robust and high-resolution estimations of the thermal, compositional and density structure of the lithospheric/sublithospheric upper mantle system beneath the Iberian Peninsula. Such a high-resolution model will provide a reliable picture of the present day lithospheric structure, a crucial constraint to understand the complex geodynamic evolution in the study area. As a first step towards a full 3D inversion, we have performed a 1D nonlinear Bayesian (probabilistic) inversion of a wide variety of data sets (surface wave dispersion curves, surface heat flow, elevation), extensively exploring the parameter space by means of a coupled geophysical-petrological inversion algorithm.

The most prominent feature in the modeled structure is the progressive northward and northeastward steepening of the lithospheric-asthenospheric boundary (LAB) below the Ebro basin, reaching > 120 km under the central and western Pyrenees. Similarly, absolute maximum values of crustal thickness are obtained in the central Pyrenees, locally exceeding 45 km. Further to the west the Moho discontinuity shallows to about 35 km beneath the Cantabrian Cordillera. A dramatic decrease in both crustal and lithospheric thickness is observed from the central towards the easternmost Pyrenees, reaching depths of about 25 km and 90 km for the Moho and LAB respectively. Average Moho depth values of about 30 km are estimated in the central Iberian Peninsula. A slightly thicker crust is predicted under the Gibraltar arc than under the Betics, consistently with the deeper LAB beneath the former, most likely reflecting the presence of a sinking lithospheric slab. For the rest of the Iberian Peninsula a rather flat topography of LAB and Moho is observed, with moderate lithospheric thinning below the central western and SE Iberian margins. Isostatic topography related to variations in predicted crustal thickness shows significant discrepancies form observed topography, thus indicating important regional contributions from dynamic and mantle source. The present-day lithospheric thermochemical structure reveals the imprints of past and ongoing processes of subduction and/or delamination.