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Geometries and structures within the Iberian lithosphere and asthenosphere beneath the Tajo Basin and Betic Cordillera revealed using magnetotellurics - Results of the PICASSO Phase I project

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The PICASSO (Program to Investigate Convective Alboran Sea System Overturn) project is enhancing knowledge about the geological setting of the Alboran Domain beneath the western Mediterranean Sea and its surrounding regions, Northern Africa and Iberian Peninsula, and through that knowledge to develop an understanding of processes related to continent-continent collision. The Iberian Peninsula was the focus of the first phase of DIAS's PICASSO efforts, and comprised a magnetotelluric (MT) profile crossing the Tajo Basin and Betic Cordillera. The overarching goal of this first phase is to reveal deep-seated features previously undetected due to the location of the Peninsula on the edge of Europe and the associated complication in deep-probing seismic tomography studies, along with the circumstance that prior MT studies were mainly focussed on regions of alpine orogeny to the north and south.

Two very different regions are present along the course of the PICASSO Phase I profile: the Betic Cordillera in the south, with its complicated three-dimensional subsurface structures originating from its complex orogeny, and the relatively levelled subsurface of the Tajo Basin in the north of the profile. Whereas the Betics have been the subject of previous magnetotelluric and other geophysical investigations, the Tajo Basin remains comparatively unexplored in terms of deep-probing investigations. Our MT data augment prior seismic results of the area enabling us to draw enhanced conclusions about the nature of subsurface features by contrasting models from the different methods.

In addition to lateral variation of the study area, the characteristics of the subsurface change significantly with depth: the crust exhibits a NW-SE geoelectric strike direction, whereas for the mantle a NE-SW direction of the geoelectric strike is defined. For this intricate case of oblique geoelectric strike direction, we attain our subsurface model through separate inversion for crustal and mantle structures. Therein, isotropic and anisotropic inversion approaches are used to derive structures at mantle depth.

The crustal model contains an electrically conductive surficial layer above a relatively resistive basement; the former is most likely due to fluid intrusion into the Tertiary and Mesozoic sedimentary layer. The most striking deep-seated feature of the model is a massive electrical resistive body observable at mantle depth and extending upwards above the crust-mantle boundary beneath the Manchega Plain. Spatially, this resistive body coincides, to a certain degree, with a seismic low velocity region. This is somehow counter-intuitive, as common causes for reducing velocities, like fluids, partial melt, and increased temperature, usually result in a commensurate decrease in electric resistivity. Only very special geological settings can accommodate a low velocity – high resistivity region, e.g. the presence of isolated fluid pockets in a resistive host medium, lowering the seismic velocity, which is sensitive to the bulk properties, whereas the electric resistivity remains high, owing to the low degree of connectivity.