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Using anisotropic approaches to realise 2D magnetotelluric inversion of a subsurface with depth-varying geoelectric strike direction - Synthetic model study and application to real data from the PICASSO Phase I project

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Two-dimensional (2D) inversions of magnetotelluric (MT) data are presently far more commonly used than three-dimensional (3D) inversions, as they significantly outperform 3D inversions in terms of speed and complexity of the subsurface, thus allowing for much better resolution of the subsurface through a larger feasible number of grid cells. The validity of 2D inversion needs to be tested though for cases where the electric resistivity structure of the subsurface is potentially 3D to some extent.

One particular case of a 3D subsurface structure consists of lateral interfaces with varying orientations at crustal and mantle depths. Such a case might emerge, for example, where crustal faulting, originating from present day tectonics, is situated above a mantle where structures are dominated by prior plate tectonic processes. Those plate tectonic processes could comprise continental collision from an oblique direction, or lattice preferred orientation in the lithosphere-asthenosphere transition zone due to an oblique relative motion between the lithosphere and asthenosphere. Whereas in 2D recovery of crustal structures can usually be achieved in a straightforward manner by confining the modelled frequency range to the crustal depths, deriving mantle structures that are not parallel to crustal ones is more complex.

The multi-disciplinary, multi-national PICASSO project (Program to Investigate Convective Alboran Sea System Overturn) intends to enhance knowledge about the geological setting of the Alboran Domain beneath the western Mediterranean Sea and its surrounding regions and through that knowledge to understand processes related to continent-continent collision. The Iberian Peninsula is the focus of the first phase of DIAS's PICASSO MT efforts, and comprised a magnetotelluric profile crossing the Tajo Basin and Betic Cordillera. Analyses of MT responses and seismic tomography data indicate varying geologic strike direction with depth and along the profile. Geoelectric strike direction in the Tajo Basin crust is approximately NW-SE, coinciding with the direction of the Iberian Range and Neogene faults, whereas at mantle depths a dominant NNE-SSW direction is determined.

Data of the PICASSO Phase I project and a synthetic 3D model are used to investigate advances of anisotropic 1D and 2D inversions in recovering the structures at mantle depth in case of oblique geoelectric strike directions.