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Geoelectrical deep structure of the Betic Cordillera (South Spain) revealed: an evidence of asthenospheric upwelling

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Contradictory geodynamic models have been proposed to explain the lithospheric structure of the Gibraltar Arc and the opening of the Alboran Sea. The convergence of the African and Iberian plates generated the Gibraltar Arc (Rif and Betic Cordilleras) since the Late Cretaceous. Different geodynamic models have been proposed to explain the lithospheric structure of this arc-shaped belt and the opening of the Alboran Basin based on Bouguer anomalies, heat flow, earthquake locations, seismic refraction, seismic tomography, geoid anomalies and elevation data. Thus, the opening of the Alboran Basin has been explained involving a convective removal of the thickened lithospheric root that caused uplift and extension, a lithospheric delamination caused by gravitational collapse of this thickened lithosphere, a westwards to southwards rollback of an oceanic slab that generated back-arc extension or a broken off piece of this lithospheric slab.

The magnetotelluric method has been proved to be a useful technique for imaging the lithospheric resistivity structure beneath plate boundaries, providing constraints to geodynamic models. Some magnetotelluric surveys had been carried out in the central Betics assuming 2D structures, which can induce wrong interpretations in complex geological areas with 3D structures. Here we present a novel 3D model of the lithospheric electrical resistivity distribution beneath the whole Betic Cordillera using broad band and long period magnetotelluric data. The dataset we present consists of 100 magnetotelluric sites located over the Betic Cordillera, 41 of them including long period data. The model depicts the lithosphere-asthenosphere boundary under SW Iberia deeper than under the Alboran Basin. The existence of a low-resistivity anomaly at lithospheric mantle depths East of the 4ºW meridian compares favorably with the lack of earthquake hypocenter locations and an observed low velocity zone. The most suitable hypothesis to explain this conductive feature is an asthenospheric intrusion due to the break-off and consequent detachment of an E-dipping teared oceanic lithosphere. This scenario supports the westward rollback of an E-dipping oceanic slab theory to explain the opening of the Alboran Basin rather than a convective removal or delamination of a thickened lithosphere. The outlining of the geometry of the lithosphere-asthenosphere boundary, located at a range of depths from 110 km (NE) to 160 km (SW), corresponds well with the ones presented by previous works, the only exception being the previously undescribed asthenospheric intrusion.