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Three-dimensional magnetotelluric imaging of crustal and uppermost mantle structures of the Atlas Mountains of Morocco

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The primary goal of TopoMed (Plate re-organization in the western Mediterranean: Lithospheric causes and topographic consequences – an ESF EUROCORES TOPO-EUROPE Collaborative Research Project) project, is to define the geometries and determine the nature of the major crustal and upper mantle boundaries, through imaging electric structures, that provide information on understanding the tectonic evolution of the Atlas Mountains of Morocco. A multi-institutional magnetotelluric (MT) experiment across the Atlas Mountains region comprises the acquisition of broadband and long period MT data along two profiles: a N-S oriented profile through Middle Atlas to the east and a NE-SW profile through Marrakech to the west. The preliminary results of two-dimensional (2-D) interpretation of the MT data collected over the first profile were presented in the paper by Ledo et al. (2011).
In this study, we present the results from three-dimensional (3-D) MT inversion using the codes WSINV3DMT (Siripunvaraporn et al., 2005) and Modular system for Electromagnetic Inversion (ModEM; Egbert & Kelbert, 2012). There is a general good agreement between the main features obtained from the 2-D models and the new results of the 3-D modelling. Models inverting for only off-diagonal tensor components showed a distinct conductivity contrast between Middle-High Atlas and Anti Atlas correlates with the South Atlas Front fault, the depth extent of which appears to be limited to uppermost mantle (approximately 55 km). The eastern Anti-Atlas is characterized by a resistive (i.e. cold) lithosphere. Beside this, a prominent conducting anomaly at the lower crust/uppermost mantle is imaged west of the profile in the junction between the High and Middle Atlas (Moulouya plain). The conductive body, which extends from northern boundary of Middle Atlas to the northern boundary of High Atlas, is interpreted as due to the presence of partial melt and/or migrated fluids. We can correlate this conductivity anomaly with a recently presented (Ayarza et al., 2012) low velocity anomaly observed at the lower crust and uppermost mantle. Considering our preliminary 3-D inversion results from the profile to the west, while Western High Atlas has a conductive signature throughout the crust, Souss and Houz Basins are mapped as a resistive crust.