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3D structures of the crust and upper mantle in Atlas Mountains of Morocco from magnetotelluric data

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As a part of the PICASSO (Program to Investigate Convective Alboran Sea System Overturn) and concomitant TopoMed (Plate re-organization in the western Mediterranean: Lithospheric causes and topographic consequences – an ESF EUROCORES TOPO-EUROPE project) projects, a multi-institutional magnetotelluric (MT) experiment across the Atlas Mountains initiated in September 2009 and ended in February 2010. The overarching objective of the project is to provide new constrains on the lithospheric structure of the Atlas Mountains, and to aid in discriminating between competing models describing the tectonics of the region. The experiment comprised acquisition of broad-band (crustal probing) and long period (mantle probing) MT data along two profiles: a N-S oriented profile crossing the Middle Atlas through the Central High Atlas to the east (profile MEK) and a NE-SW oriented profile crossing the western High Atlas towards the Anti Atlas in the west (profile MAR).

Our MT inversion results from the MEK profile (Ledo et al., 2011), assuming that the Earth can be validly represented by two-dimensional (2D) structures, reveal two major mid- to lower crustal scale conductive features. The first anomaly is stretching from the Middle Atlas southward towards the High Moulouya basin and the second one is located beneath the Anti Atlas. There is a gradual increase in mantle resistivity to the south which may indicate a thickening lithosphere beneath the Anti Atlas.

To validate the 2D inversion results, the MT data on the same profile were inverted for 3D electrical resistivity structure using both WSINV3DMT (Siripunvaraporn et al., 2005a) and ModEM (Egbert et al., 2011). We ran inversions with the full impedance tensor and also with only the off-diagonal components. Following the paper of Patro and Egbert (2011), we are testing the effect of using different length scales in the along-strike and across strike directions. As expected, the 3D inversion results provide a better fit to the data compared to the 2D results. The main features deduced from the 2D interpretation are though also present in the models obtained by 3D inversions. The distinct conductivity difference between Middle-High Atlas and Anti Atlas correlates with the South Atlas Front fault, the depth extent of which appears to be limited to the crust. Also, the inversion results reflect off-profile conductive feature in the southern end of the profile.

Work in progress includes: (i) Full 3D modelling of MT responses in MAR profile, and (ii) testing the effect of off-profile conductors on the data.