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Lithospheric-scale geometry of the Atlas Mountains of Morocco revealed by magnetotelluric surveying

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The Atlas System of Morocco is an intra-continental mountain belt extending for more than 2,000 km along the NW African plate with a predominant SW-NE trend. The System comprises three main branches: the High Atlas, the Middle Atlas, and the Anti Atlas. Our paper presents the results from a recent multi-institutional magnetotelluric (MT) experiment across the Atlas Mountains region that started in September, 2009 and ended in February, 2010, comprising acquisition of both broad-band (BBMT) and long-period (LMT) MT data along two profiles. One profile, to the east, named MEK, is oriented N-S crossing the Middle Atlas through the Central High Atlas, whereas the other, named MAR, is to the west and is NE-SW oriented crossing the western High Atlas towards the Anti Atlas. Along the two profiles 24 LMT and 44 BBMT stations were deployed, at approximately 20 km and 10 km intervals, respectively. These MT measurements are part of both the PICASSO (Program to Investigate Convective Alboran Sea System Overturn) and the concomitant TopoMed (Plate re-organization in the western Mediterranean: Lithospheric causes and topographic consequences – an ESF EUROCORES TOPO-EUROPE project) projects, aimed at determining the nature of the major crustal and upper mantle boundaries and defining electric structures that provide information on understanding the tectonic evolution of the region.
The MT data have been processed, with modern robust multi-remote reference methods, and submitted to comprehensive strike and dimensionality analysis. For the first profile, MEK, two clearly depth-differentiated strike directions are apparent for crustal (5-35 km) and lithospheric (50-150 km) depth ranges. These two orientations are approximately consistent with the NW-SE Africa-Eurasia convergence acting since the late Cretaceous, and the NNE-SSW Middle Atlas, where Miocene to recent Alkaline volcanism is present. Two-dimensional (2-D) anisotropic electrical resistivity models were derived independently for both 50o and 20o E of N strike directions. Our preliminary results from the MEK profile reveal a middle to lower-crustal conductive layer stretching from the Middle Atlas southward towards the High Moulouya basin. The most resistive (and therefore potentially thickest) lithosphere is found beneath the Central High Atlas.
The geoelectrical modelling results will be tested against other geophysical observables (i.e. topography, geoid and gravity anomalies, surface heat flow and seismic velocities) using the software package LitMod. This software combines petrological and geophysical modelling of the lithosphere and sub-lithospheric upper mantle within an internally consistent thermodynamic-geophysical framework, where all relevant properties are functions of temperature, pressure and composition.