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Electromagnetic and petro-physical investigations of the lithosphere–asthenosphere boundary in Tibet and Central Europe

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During the last decades, long-period magnetotelluric (MT) and magnetovariational (MV) data were collected and interpreted in order to accomplish two internationals projects in Tibet (INDEPTH) and Central Europe (CEMES).

We used INDEPTH MT and geomagnetic observatory data in China and Tibet to derive the MT and MV soundings responses. Then we merge available published MV responses from Lhasa geomagnetic observatory with the long period MT data from several sites from INDEPTH line 500. The selected MT transfer functions fit one-dimensional assumption and exhibit a relatively high (Niblett-Bostick) penetration depth. The final one-dimensional deep resistivity models are prepared for two groups of sites: the first one located in the Lhasa Terrane (southern part of line 500) and second one distributed on Qiangtang Terrane (northern part of line 500). For the Lhasa Terrane group the models show the existence of a high conductive layer localized at a depth more than 200 km, whereas for the Qiangtang Terrane this conductive layer appears to be seated at 100 km depth.

In the frame of the European CEMES project, five international teams were engaged in collecting long-period magnetotelluric data in eleven permanent geomagnetic observatories situated along the south-west margin of the East European Craton. The conductance distributions at the depths of the upper mantle have been derived individually beneath each observatory. By averaging the individual cross-sections, we have designed the final model of the geoelectrical structure of the upper mantle beneath the CEMES region. The results indicate a systematic difference in the deep electrical structure between the Precambrian and the Phanerozoic Europe. There is a transition zone that coincides with the Trans-European Suture Zone. Ten deep 1D electromagnetic soundings composed from MT and MV data were performed and a 3D image of the eLAB in the Central Europe was obtained. The inversion results suggest a LAB depth of 100-300 km in the Central Europe.

As an additional constrain we propose a more petro-physically driven approach to modelling MT data based on 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. In particular, LitMod is used in this work to define realistic temperature and pressure distributions within the upper mantle, and to characterize the mineral assemblages given bulk chemical compositions as well as water contents. This allows us to firstly define a bulk conductivity/resistivity model of the upper mantle based on laboratory and xenolith data for the most relevant mantle minerals and secondly to produce corresponding predicted MT responses that are compared with observed MT responses. 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 LitMod.