Three-Dimensional Lithospheric Resistivity Structure of the NE Tibetan Plateau and the Western North China Block and its Geological Significance

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This study used the data in geographical ranges of N34°-N42° and E99°-E109° collected by China University of Geosciences, Beijing with funding of the SINOPROBE project. It covers the whole AB and western part of the OB of the NCB. Data from 608 broad-band MT (BBMT) stations were collected, and 55 long-period MT (LMT) stations were also acquired out of these BBMT stations. At least 20 hours and 7 days of data were recorded for each BBMT of LMT station respectively. Thus, a period range of 0.003 ~ 3000 s was obtained for BBMT stations, and for those BBMT+LMT stations, a period range of 0.003 ~ 10 000s. The data quality was quite good as the noise level was quite low at that region.

Three south-to-north profiles were inverted with a non-linear conjugate gradients algorithm integrated in the WinGLink since major directions of strike are west-to-east. However, the results of phase tensor analysis (Caldwell et al., 2004) showed that one third of the stations can only be treated as 3-D when periods are larger than 100 s. Thus, the modular system for electromagnetic inversion (ModEM) was employed for 3D MT inversion (Egbert and Kelbert, 2012; Kelbert et al., 2014). The full impedance of 480 stations was inverted at 30 periods in a period range of 0.01 to 10 000s. Error estmates of 10% and 5% of $\left|Z_{xy} \cdot Z_{yx}\right|^{1/2}$ were assigned to diagonal and off-diagonal components of the impedance tensor respectively. The inversion started with a 100 Ωm half-space, and stopped after 400 iterations with the final RMS misfit of 1.59

A layered resistivity structure of the WQLB is shown in the 3-D resistivity model, and a W-E trending very low resistive middle and lower crust is surrounded by a high resistive upper crust and lithospheric mantle. However, the resistivity structure of the QLB is relatively complicated. The lithospheric mantle showed very high resistivity, indicating a basement of metamorphic rocks formed in the Neoproterozoic. The upper crust is also highly resistive and is interpreted as igneous rocks and granitic gneiss by comparing it with the results of geological surveys. However, the resistivity of the middle and lower crust varies rapidly from very low resistivity to high resistivity from northwest to southeast. The southeast high resistivity zone is interpreted as granulite and mafic to ultramafic rocks. As to the northwestern low resistivity area, it connects with the low resistivity middle and lower crust of the WQLB. In the north, the mostof the AB lithosphere is highly resistive and indicates the AB is a stable block. According to geological data, the high resistive upper crust is composed of Archean to Proterozoic metamorphic and igneous rocks, and the middle and lower crust and lithospheric mantle are composed of Paleo-Archean mafic to ultramafic rocks. Taking N38° as the border, the southern OB shows a highly resistive lithosphere and could be interpreted as Archean to Proterozoic crystallized basement, showing features of a stable cratonic block. In contrast, a low resistivity middle and lower crust and lithospheric mantle was discovered beneath the southern OB by the 3-D results. Therefore, the low resistivity anomalies in the middle and lower crust of the WQLB and northwestern QLB extended from the TP indicates a possible northeastward-directed channel flow and is blocked by the stable lithosphere of the AB and southern OB. The huge low resistivity anomalies beneath the southern OB are interpreted as upwelling asthenosphere which indicates the possible destruction of the cratonic block, which might have been triggered by northwestward subduction of the Paleo-Pacific Ocean or northeastward development of the TP. One more notable feature of the resistivity model is that a low resistivity layer tilted northeastward can be found between the AB and QLB, which is taken as electrical evidence that the QLB was subducted beneath the AB, driven by the sinking of the Qilian Ocean (closed in the Late Ordovician) lithosphere. Moreover, the northeastward channel flow and growth of the TP during the Cenozoic was blocked by the stable AB, which pushed the QLB down into the AB and thickened the crust of northeastern Tibet and adjacent areas.

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