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Deformation Mechanism of the Northern Tibetan Plateau as Revealed by Magnetotelluric Data

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As a unique geologic unit on the northern margin of the Tibetan Plateau, the Qaidam Basin plays a significant role in constraining the vertical uplift and horizontal expansion of the northern and northeastern Tibetan Plateau. However, due to its complex evolution history and difficult logistic condition, deformation mechanism of the lithosphere beneath the Qaidam Basin is still highly debated. To better understand the lithospheric electrical structure and deformation mechanism of the Qaidam Basin, A 250 km long, NE-SW directed Magnetotelluric (MT) profile was finished in the northern portion of the Basin, which is roughly perpendicular to the thrust fault systems on the western and eastern margins of the Basin, as well as anticlinorium systems within the Basin. The profile consists of 20 broad-band MT stations and 5 long-period MT stations. Original time series data is processed with regular robust routines. Dimensionality and regional strike direction are determined for the dataset through data analysis. Based on the analysis results, 2D inversions were performed to produce a preferred model of the lithospheric electrical structure beneath the northern Qaidam Basin. Uncertainty analysis of the 2D inversion model was also conducted based on a data resampling approach. The outcome 2D electrical model was further used to estimate the distribution of temperature and melt fraction in the upper mantle based on laboratory-determined relationships between the electrical conductivity and temperature of nominally anhydrous minerals and basaltic melt by using the mixing law of Hashin-Shtrikman's bounds. All these results suggest that: (1) the crust-mantle boundary is imaged as a conductive layer beneath the western Qaidam Basin, with its temperature estimated to be 1200-1300 °C and melt fraction 5-8%, indicating decoupling deformation of the crust and upper mantle. (2) A large-scale east-dipping conductor is imaged beneath the eastern Qaidam Basin. This conductor extends from the upper crust to the upper mantle, implying vertical coherent deformation of the lithosphere. Melt fraction of this conductive region is estimated to be as high as 10%, which might accommodates a major portion of the thrust deformation on the boundary between the Qaidam Basin and the Qilian Block. (3) Two different end-member deformation mechanisms, namely the decoupling deformation and vertical coherent deformation are both active on the northern margin of the Tibetan Plateau, and both play a significant role in controlling the uplift and expansion of the northern Tibetan Plateau.

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