

Understanding Surface Deformation in the Central Tibetan Plateau: Rheology Constrains from Magnetotelluric Data

Hao Dong^{1*}, Wenbo WEI¹, Sheng Jin¹, Gaofeng Ye¹, Jianen Jing¹, Letian Zhang¹, Chengliang Xie¹, Yaotian Yin¹

¹China University of Geosciences, Beijing, 100083, China, donghao@cugb.edu.cn

The India-Asia collision, which began about 50 Ma ago, has caused the uplift of the Tibetan plateau and more than 1000 km of crustal shortening within continental lithosphere. Aside from its great average elevation of ~4500 m, the surface of the high plateau is characterized by a series of N-S trending normal fault systems distributed across the plateau and an over 1000 km long “conjugate” strike-slip fault belt along the Bankong-Nujiang Suture zone. Despite extensive geology, geodesy and geophysics studies carried out and competing tectonic models proposed in the past decades, the actual cause of these active structures and their relative roles in the underlying geodynamic process are still hotly debated today.

In this study, we present new insights into the processes behind the complex surface deformation of the middle part of Tibetan Plateau by investigating its electrical structure of the lithosphere. With 226 densely spaced broadband and long period Magnetotelluric array stations from the SinoProbe Project, we were able to construct a three-dimensional resistivity model of the crust and uppermost mantle for the central part of the Himalaya, Lhasa and Qiangtang Blocks. As revealed in previous 2D results from INDEPTH projects, this model images widespread conductive structures in the mid-to-lower crust of the Tibetan Plateau. However, the conducting features are not uniform as suggested by earlier studies, but show rather complex geometries. To the south of ~31°N, our new high-resolution model images a relatively continuous and highly conductive mid/lower crust, with a gently north-dipping fashion, which could have resulted from high level partial melting of the underplated India crust beneath the Tibetan crust. This is also consistent with the regional distribution of crustal-source Helium isotope and ultra-potassic volcanic rocks with an Indian crustal signature. On the other hand, a distinct N-S aligning pattern of conductive structures in the uppermost mantle are revealed to the north of 31°N, which also coincide with the region with an absence of a continuous Mohorovicic discontinuity from previous seismic receiver function research. Together this may indicate a decoupling of the subducting Indian lower crust and upper mantle beyond that point, which may also suggest a transition to a steeper subduction to the north. The conductive N-S aligning features, which spatially coincide with the conjugate strike-slip fault belt, have a much deeper upper boundary than its southern counterpart. This might indicate a contrasting crustal rheology between the southern and northern part of our study region. As suggested by the numerical simulations, a thin brittle upper crust, combined with weak mid/lower crust, could introduce localized extension of the crust under a N-S compressing stress, which further gives rise to E-W opening of the N-S aligned rift systems. On the other hand, a thicker and possibly stronger upper crust might result in a shear failure under a similar stress, creating the conjugate strike-slip fault system around BNS.