Crust and Mantle Structure of the Tibetan Plateau Down to 700 km Depth as Derived from Seismological Data

J. Mechie[1], R. Kind[1], J. Saul[1]

[1] Deutsches GeoForschungsZentrum – GFZ, Sections "Geophysical Deep Sounding" and "Seismology", Telegrafenberg, 14473 Potsdam, Germany, jimmy@gfz-potsdam.de

We have constructed a seismic velocity cross-section of the crust and mantle down to 700 km depth beneath the Tibetan plateau. The cross-section is based on the many controlled and passive source seismological experiments and studies which have reported results within an 800-km swath centered on the main Lhasa-Golmud transect. Beneath the 2.5-7 km thick cover layer, the upper crust down to 15-25 km depth has compressional (P) wave velocities of 5.8-6.1 km/s and low Poisson's ratios of 0.21-0.23, indicative of felsic rocks rich in quartz in the α state. There are many observations e.g. bright spots in seismic reflection records, low-velocity regions in shear (S) wave models derived from receiver-function analysis, seismicity drop off and high electrical conductivity which indicate that below 15-25 km depth, temperatures are high enough such that ductile flow and partial melting can occur.

One of the main results of our study is the recognition of a boundary at 30-40 km depth. From the velocity values above and below this boundary it is suggested that it marks the interface between the felsic upper crust and the more mafic lower crust. Within the swath, crustal thickness is greatest (approx. 74 km) beneath the southern part of the plateau south of about 31.5°N, where Indian lower crust forms the basal crustal layer. To the north crustal thickness decreases to about 66 km beneath the southern Qiangtang terrane around 33°N, before again increasing to about 70 km beneath the northern part of the plateau south of the Kunlun mountains. As the Kunlun mountains are crossed the crust thins dramatically to about 54 km beneath the Qaidam basin.

Beneath the crust, high-velocity, dense and cold Indian lithospheric mantle extends northwards within the swath until about the Banggong-Nujiang suture, where it downwells to at least 350-400 km depth in a zone about 100-200 km wide centred at about 31.2°N. To the north, low-velocity, less dense and warm Asian lithospheric mantle is present. The lithosphere-asthenosphere boundary occurs at 160-225 km depth under the plateau.

The 410 and 660 km discontinuities, at the top and base of the mantle transition zone respectively, produce prominent seismic phases beneath the whole plateau in receiver-function images, implying that no subducting slab penetrates the mantle transition zone under the plateau. This is, however, at variance with a recent tomographic image which suggests that Indian lithospheric mantle does penetrate into the mantle transition zone. The observation that the 410 and 660 km discontinuities run parallel to each other implies that temperature variations in the mantle transition zone are negligible. On the other hand, the apparent northwards deepening by about 20 km of both discontinuities implies that the upper mantle beneath north Tibet is slower, less dense and warmer than under south Tibet, in agreement with the observed uppermost mantle velocities. This, in turn, could provide some of the isostatic support for the high elevations in the northern part of the plateau where the crust is somewhat thinner than in the southern portion of the plateau.

Cite as: Mechie, J., Kind, R. and Saul, J., 2010, Crust and mantle structure of the Tibetan Plateau down to 700 km depth as derived from seismological data, *in* Leech, M.L., and others, eds., Proceedings for the 25th Himalaya-Karakoram-Tibet Workshop: U.S. Geological Survey, Open-File Report 2010-1099, 1 p. [http://pubs.usgs.gov/of/2010/1099/mechie/].