Growing the Tibet plateau: insights from crustal and Moho structure at the plateau margins

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The Tibet plateau margins host large destructive earthquakes, e.g. the Ms 8.0 Wenchuan earthquake in 2008. Thus how the plateau deforms and grows at its margins is an important question. Following the Wenchuan earthquake, deep drilling, seismicity studies and industry seismic reflection profiles have been used to build a picture of how the upper crust deforms across the Longmenshan at the eastern margin of the plateau. In this region, thrusting and strike-slip motion along discrete fault planes play an important role in upper crustal deformation. Controlled- and passive-source seismic studies have been used to obtain images of the deeper crust and Moho across the plateau margins. At the northeast margin of the plateau, all projects have found a significant decrease in crustal thickness of about 20 km when going from the Songpan-Ganzi terrane of the high plateau across the Kunlun Shan to the Qaidam basin. Major results from the two INDEPTH (International Deep Profiling of Tibet and the Himalaya) experiments which examined the deep structure of the northeast margin, include the recognition of Moho overlap beneath the southern Qaidam basin and the top of the currently subducting Asian lithospheric mantle beneath the Qilian Shan, Qaidam basin and high plateau. The crustal material between the Moho overlap beneath the southern 50 km of the Qaidam basin may represent Songpan-Ganzi lower crust underthrusting or flowing northward beneath the Qaidam basin Moho. This process is facilitated by the underthrusting and subduction of Asian lithospheric mantle beneath north Tibet. As the frontal thrust and mantle suture at the northeast margin of the plateau move north through time, the Songpan-Ganzi lower crust can flow out from beneath the high plateau. Thus the high Tibetan plateau may be thickening northward into south Qaidam as its weak, thickened lower crust is injected beneath stronger Qaidam crust. At the eastern margin of the plateau there is also a significant decrease in crustal thickness of 15-20 km in going from the Songpan-Ganzi terrane across the Longmenshan to the Sichuan basin. Here, however, controlled-source experiments have tended to show a more gradual change whereas passive-source experiments have tended to show a sharp step in the Moho. A P receiver function analysis of the data from an array of 80 broadband seismic stations across the eastern margin of the plateau, straddling the Longmenshan fault zone in the vicinity of the Wenchuan earthquake, shows that the Moho occurs at 40-50 km depth in the SE below the Sichuan basin and deepens to the NW to 55-65 km depth under the Songpan-Ganzi terrane. Along the trend of the Longmenshan fault zone from NE to SW the change in Moho depths exhibits a variable character and as in the case of the northeast margin of the plateau there are, in some places, indications of Moho overlap.