The Golmud Step: New Details of the 15 km Moho Offset Between the Tibet Plateau and Qaidam Basin from INDEPTH IV Seismic Results

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Zhu and Helmberger (1998) reported a 15-20 km Moho offset over a narrow 5 km range under the northern margin of the Tibetan Plateau near Golmud from anomalous double-pulse teleseismic P-wave arrivals. They proposed a hotter, more-ductile, less-dense lower crust under the Tibetan Plateau in the south abutting a cold, rigid Qaidam Basin crust to the north, the latter serving as a buttress to lower-crustal flow beneath the plateau. A subsequent teleseismic receiver-function profile in the same vicinity by Vergne and others (2002) was interpreted to indicate a similar Moho offset of about 20 km located about 100 km north of the Kunlun fault. Another teleseismic receiver-function study by Shi and others (2009) also reported a 15 km Moho offset at the southern margin of the Qaidam Basin along a transect located about 270 km to the east of Golmud.

In the summer of 2007, a N-S seismic profile was collected as part of INDEPTH IV to extend from the central Qaidam Basin in the north to the Songpan-Ganzi terrane of the Tibetan plateau in the south (Zhao and others, 2008). The 270 km long profile was anchored by 295 PASSCAL "Texan" recorders deployed at 650 km spacing, with a denser deployment of an additional 655 "Texan" at 100 m spacing adjacent to a 1000-channel Sercel multichannel system recording at 50 m spacing in the central part of this profile. This spread recorded 5 large (1-2 ton) explosive shots (KS1-KS5) as well as 100 smaller (60-240 kg) shots for reflection and refraction coverage across the southern margin of the Qaidam Basin and adjacent Kunlun mountains.

Conventional processing of the more numerous smaller shots has yielded little information on deep crustal structure. However, reflection treatment of the wide-angle recordings from the larger shots, especially KS5, provides a fresh perspective on Moho morphology across the Tibet-Qaidam boundary. Figure 1 shows the shot gather for KS5 displayed after applying an NMO correction using an average crustal Vp of 6.2 km/s. There is a clear reflection from a depth of about 48 km (below sea level) beneath the southern Qaidam basin, and a distinctive, albeit weaker and lower frequency (i.e. 2 Hz vs 5 Hz), reflection from about 63 km depth (bsl) beneath the Tibetan plateau to the south. Identifying both events with the Moho implies a 15-km offset about 40 km north of the North Kunlun Thrust along a line about 30 km to the east of Golmud. Close examination suggests that this increase in depth occurs over a zone that may be as narrow 5 km, corresponding to a 72º dip of any linking segment.

The magnitude of the offset implied by this correlation of reflectors, 15 km, is comparable with that estimated by the previous studies. The location of this offset agrees with that of Vergne and others (2002), but lies about 15 km north of the Moho offset calculated by Zhu and Helmberger (1998). We suggest that the abrupt nature of this crustal thickening implies significant strength in the lower crust at this margin of the plateau, and thus represents an important constraint on rheological models used to explain crustal thickening and uplift of the plateau.

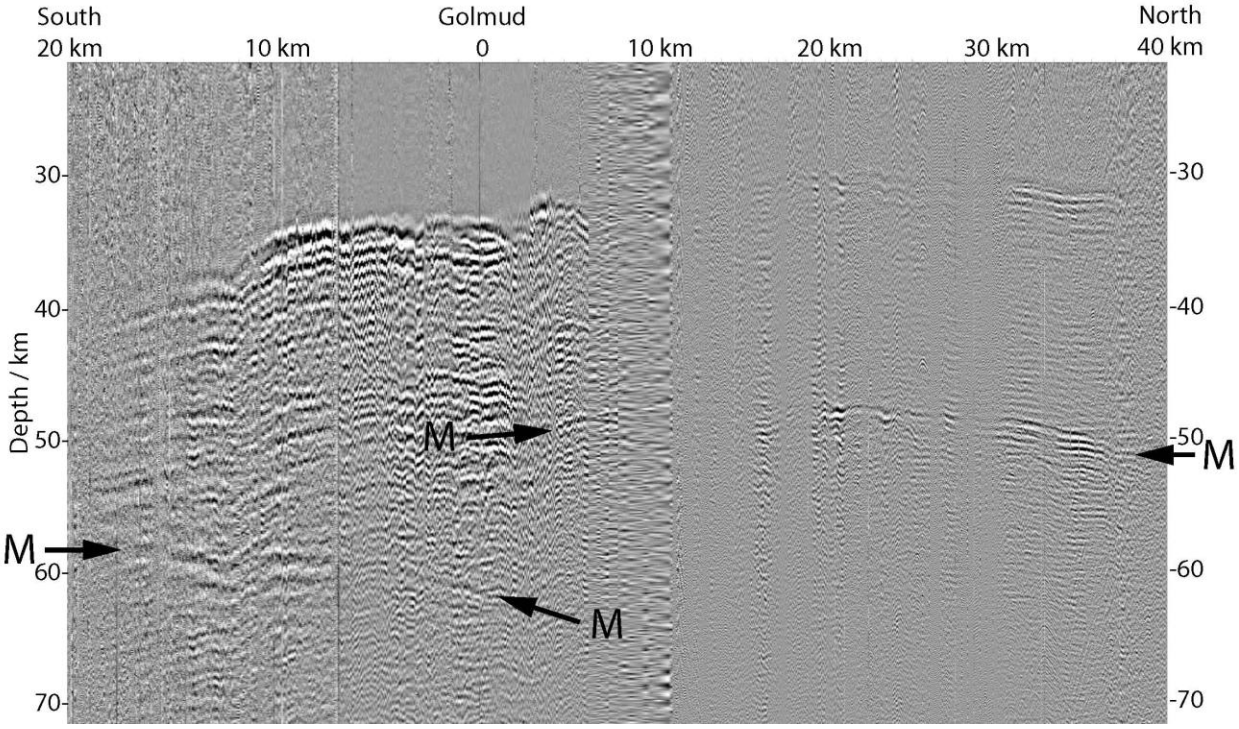

Figure 1. Shot gather for KS5 displayed as depth section. Arrows point to the Moho. Distance of reflection points from Golmud indicated along the top of the section. Energy arriving before the Moho reflections corresponds to direct P phases (Pg) and associated multiples.

References

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