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Crustal structure and composition beneath the northeastern Tibetan plateau from receiver function analysis

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ABSTRACT

We analyzed hundreds of P-wave receiver function data recorded by 53 portable seismic stations to investigate the crustal structure beneath the NE Tibetan plateau. The Moho depths identified by this study reveal that the crustal thickness decreases laterally from the Qilian Orogen (~63 km) to east Kunlun fault (EKLF) area (~44 km). The Moho depth becomes obviously deeper northeast of Songpan–Ganzi terrane and beneath the Qilian Orogen. A remarkable contrast is observed in the measured Poisson's ratio between the Qilian Orogen and EKLF area. The Qilian Orogen is characterized by lower Poisson's ratio. In general, the higher Poisson's ratios ($\upsilon > 0.30$) in the EKLF area can be considered as the evidence for dominantly mafic rocks in the crust. The measured low Poisson's ratio and the negative correlations between V_P/V_S and the crustal thickness beneath the Qilian Orogen suggest dominantly felsic crust beneath the Qilian Orogen, which is in contrast with the mid-to-lower low-velocity crustal model beneath the NE margin of the Tibetan plateau indicating that the low velocity zone terminates beneath the east Kunlun area. The seismic evidence suggests that the thickened crust is probably resulted from superposition of the successive intracrustal thrusts. Our results reveal the lateral inhomogeneity of crustal structure in this area and are inconsistent with the scenario of an inflated crust due to extrusion of lower crust material from the central Tibetan plateau.

1. Introduction

The NE Tibetan plateau has been the focus of several investigations related to continental collision resulting from the northward subduction of the Indian plate beneath the Asian plate from ~55 Ma ago, resulting in ~1500 km of crustal shortening (Molnar and Tapponnier, 1975; England and Houseman, 1989; Rowley, 1996; Yin and Harrison, 2000). Since the collision of India with Asia, the Tibetan plateau has mainly been growing toward the east and the northeast (Tapponnier et al., 2001), and hence the crustal structure and composition in the NE plateau has been of considerable interest (Herquel et al., 1995; Zhu and Helmberger, 1998; Vergne et al., 2002; Liu et al., 2006; Shen et al., 2011; Li et al., 2014a,b).

The Tibetan plateau is bounded by several continental blocks, such as the Indian plate to the south, the Yangtze block to the east, the Ordos block to the northeast, the Qaidam basin in the north, and the Tarim basin to the northwest (Fig. 1a). The geodynamic mechanism that led to the formation of the plateau has been debated through various models including slip partitioning (e.g., Chen et al., 1994; Tapponnier et al., 2001), lithospheric detachment and removal (e.g., Houseman et al., 1981; Meng et al., 2006; Li et al., 2008), subduction of the Indian mantle lithosphere beneath the plateau (e.g., Barazangi and Ni, 1982; Owens and Zandt, 1997; Kosarev et al., 1999; Tilmann et al., 2003; Kumar et al., 2006; Chen and Tseng, 2007), subduction of the Asian lithosphere (e.g., Willett and Beaumont, 1994; Kind et al., 2002), crustal shortening and thickening (e.g., Dewey and Burke, 1973; Allegré et al., 1984; England and Houseman, 1986; Meyer et al., 1998) and eastward escape through mid-to-lower crustal flow (e.g., England and Houseman, 1989; Bird, 1991; Royden, 1996; England and Molnar, 1997; Royden et al., 1997, 2008; Clark and Royden, 2000; Shen et al., 2001; Klemperer, 2006; Li et al., 2009, 2012, 2014a,b;

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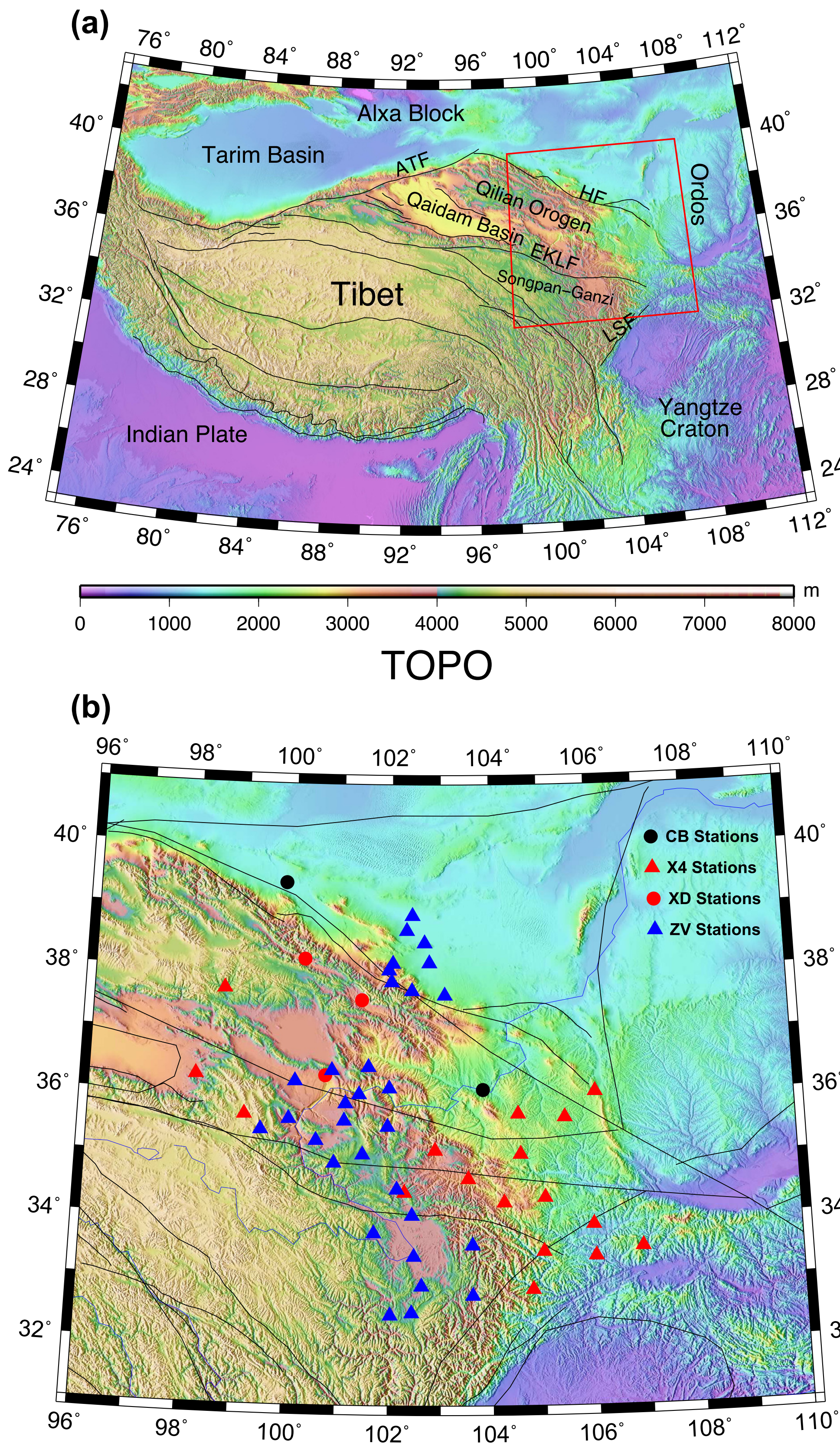

Fig. 1. Topographic relief of the Tibetan plateau and adjacent areas (a) and the distribution of seismic stations used in this study (b). The rectangle indicates the study area. The blue triangles represent seismic stations deployed by NETS experiment (Shen et al., 2008). The red triangles denote seismic stations deployed by Ascent experiment. The red dots denote the seismic stations deployed by XD experiment. The black dots denote the seismic stations deployed by CB experiment. ATF, Altyn-Tagh Fault; HF, Haiyuan Fault; EKLF, east Kunlun Fault; LSF, Longmenshan Fault.