Extreme variability of Tibetan thermal lithosphere

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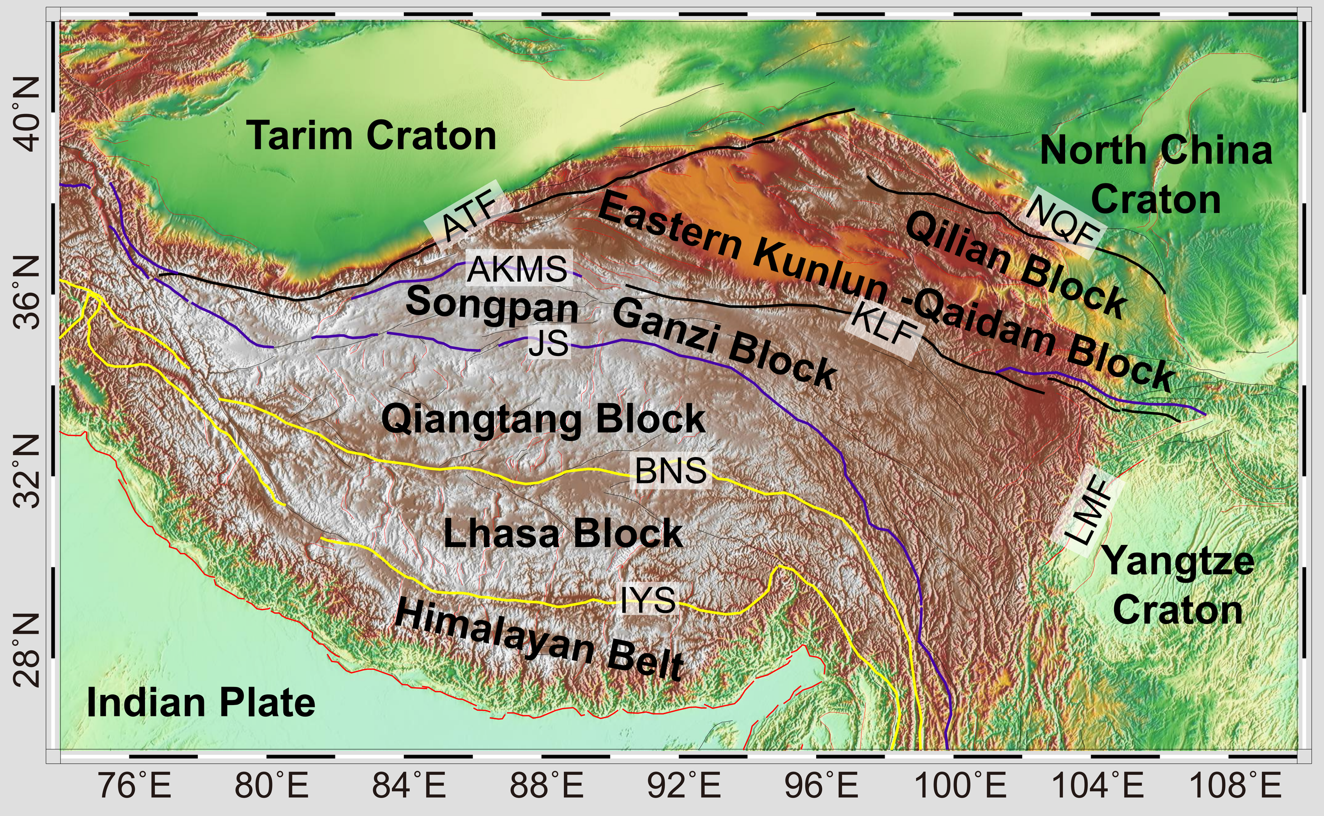
Keypoints

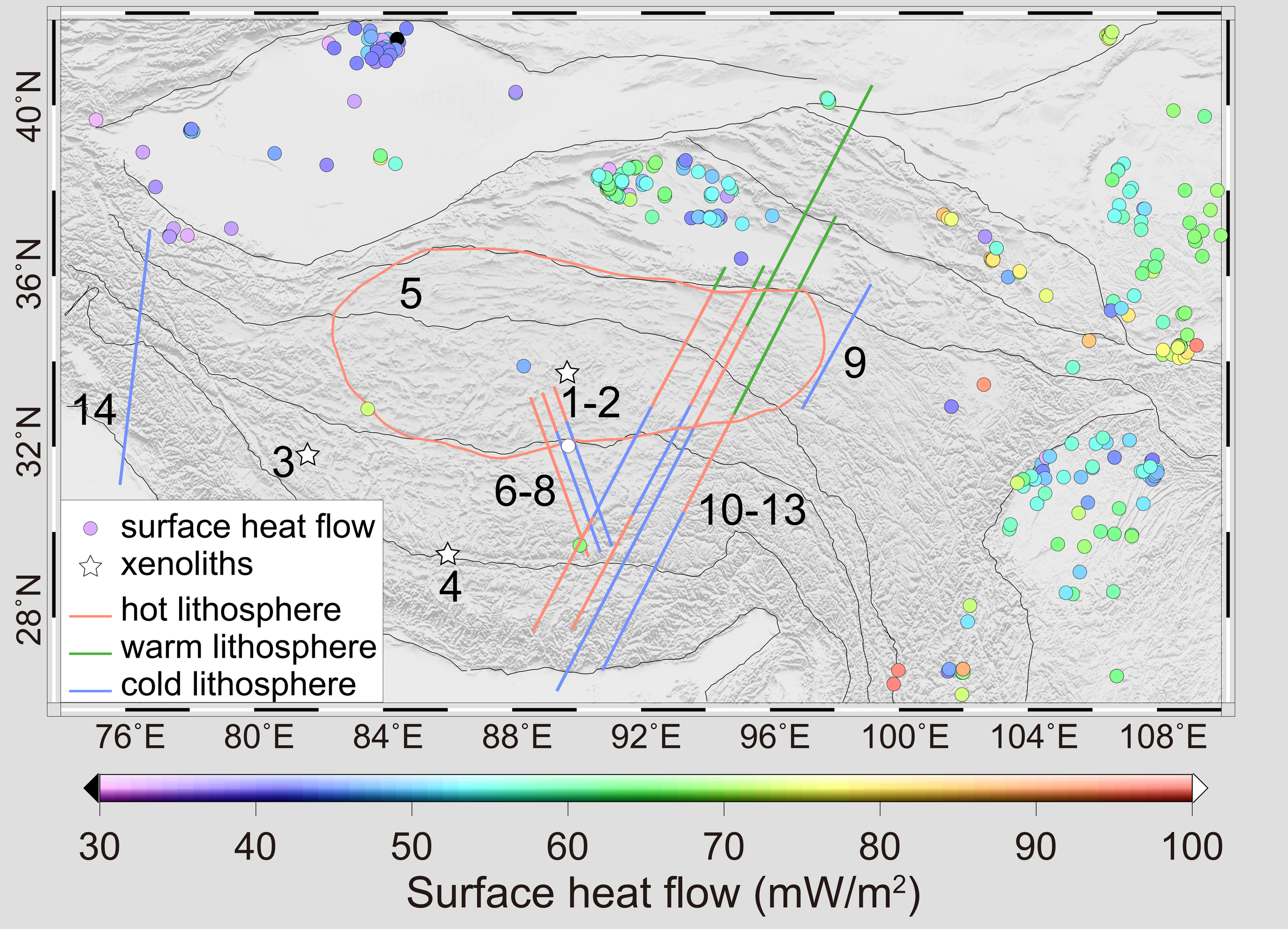
We present a thermal model for lithospheric thickness in Tibet and adjacent regions based on the new thermal-isostasy method and our compilation of Moho depth based on published seismic models. We interpret the strong heterogeneity of lithosphere thermal structure to be caused by lateral variations in the northern extent of the subducting Indian plate, the southward subduction of the Asian plate beneath central Tibet, and possible preservation of fragmented Tethyan paleo-slabs. Cratonic-type cold and thick lithosphere (200-240 km) with a predicted surface heat flow of 40-50 mW/m2 typifies the Tarim craton, the NW Yangtze craton, and most of the Lhasa Block that is likely refrigerated by underthrusting Indian lithosphere. We identify a 'North Tibet anomaly' (at 84-92 oE, 33-38 oN) with thin (<80 km) lithosphere and high surface heat flow (>80-100 mW/m2) in a region with anomalous seismic Sn and Pn. We interpret the anomaly as due to the removal of lithospheric mantle and asthenospheric upwelling at the junction of the Indian and Asian slabs with opposite subduction polarities. Other parts of Tibet typically have an intermediate lithosphere thickness of 120-160 km and a surface heat flow of 45-60 mW/m2, with patchy anomalies in eastern Tibet. The heterogeneous thermal lithosphere beneath Tibet suggests an interplay of several mechanisms as the driver of the topographic uplift.

Background



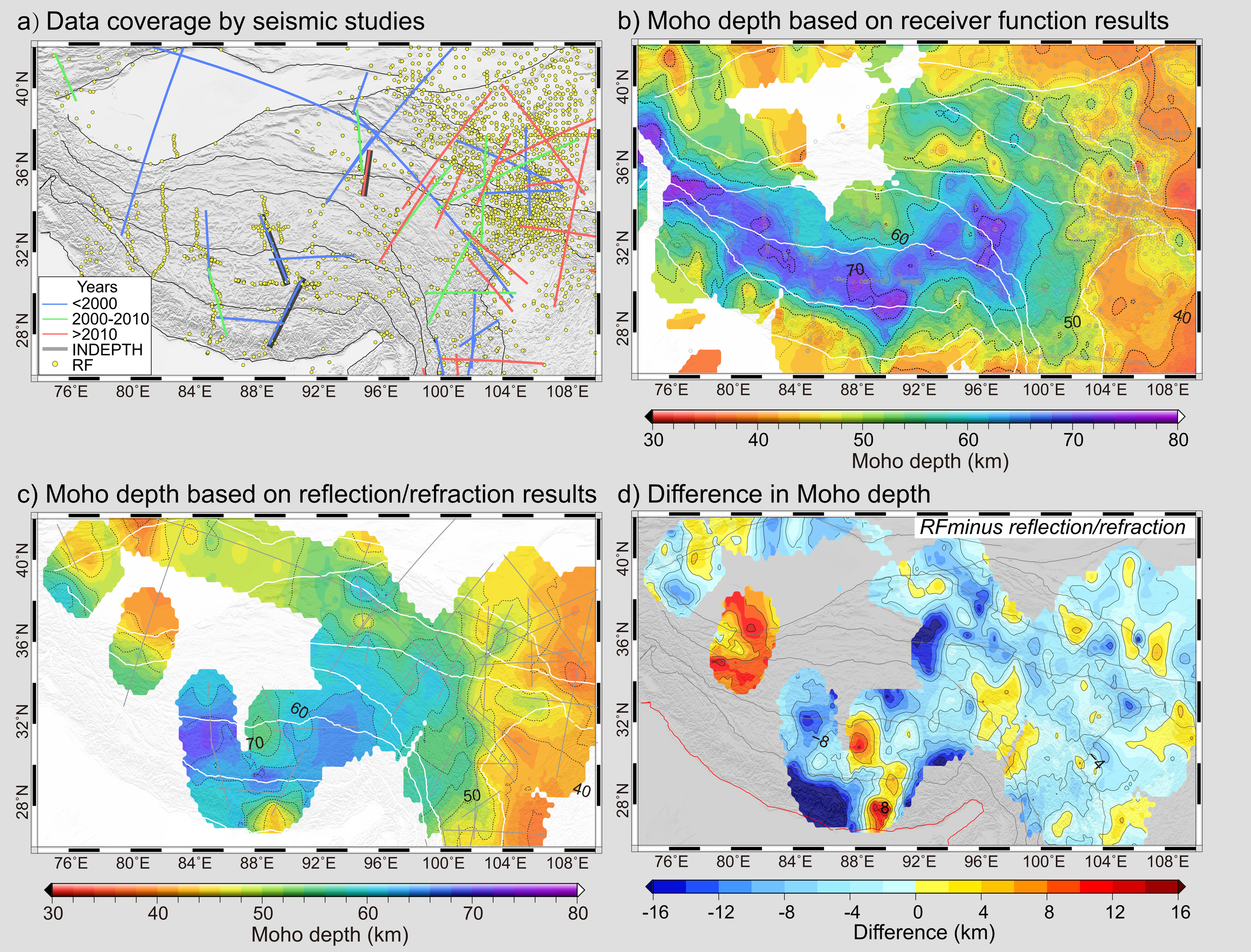
Topography and simplified tectonics of Tibet and adjacent regions. Geological boundaries modified after Styron et al. (2010). Purple and yellow lines mark the sutures from closure of Paleo-Tethys and Neo-Tethys; black lines are strike-slip faults (bold if slip > 8 mm/-year); thin red lines are normal and thrust faults.

Lithosphere thermal observations



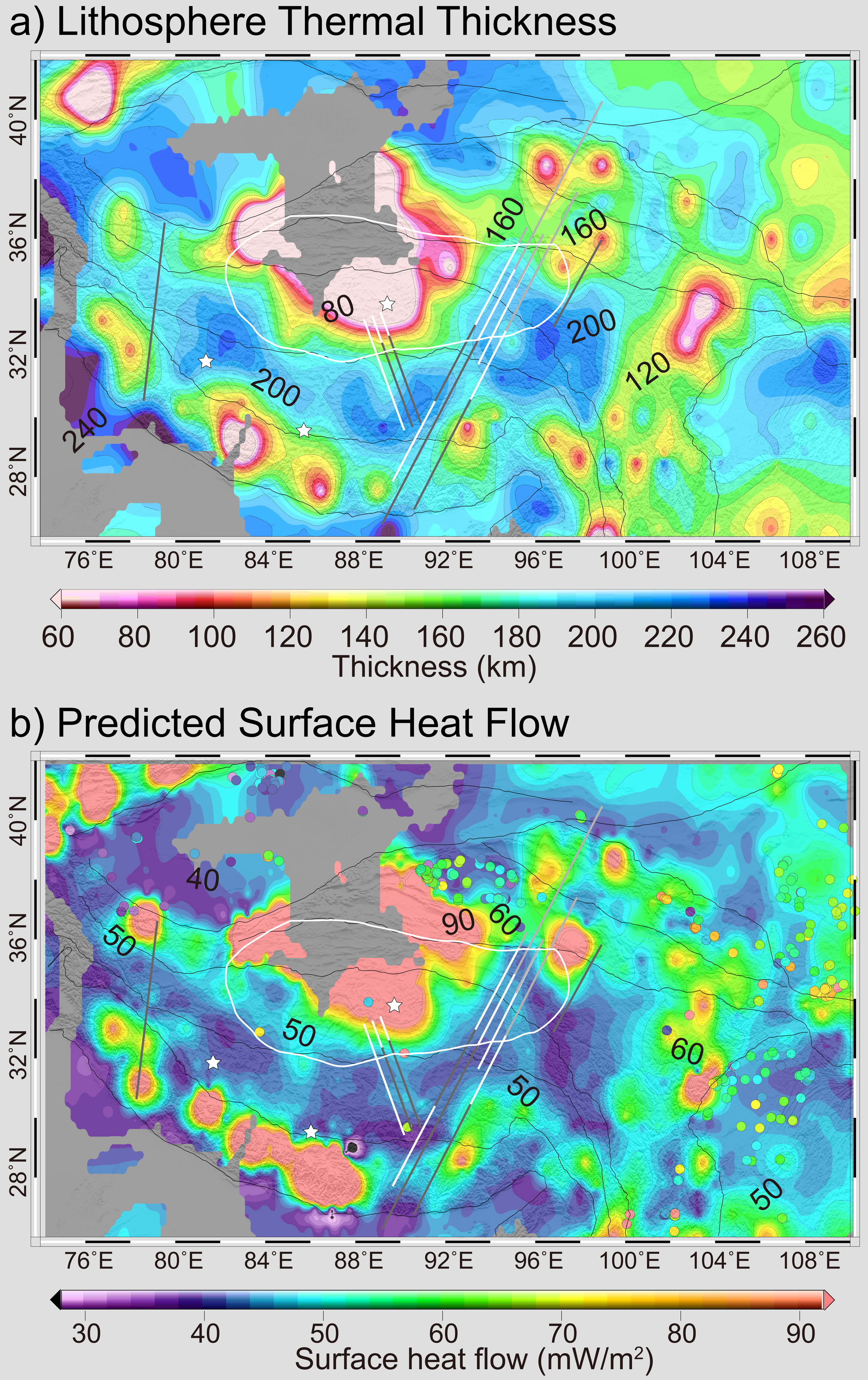
Lithosphere thermal observations based on previous studies. Colored circles – high-quality surface heat-flow measurements (Jiang et al., 2019). Red, green and blue lines – inferred thin, normal and thick lithosphere based on geophysical observations (numbers 1-14 refer to previous studies).

Crustal thickness



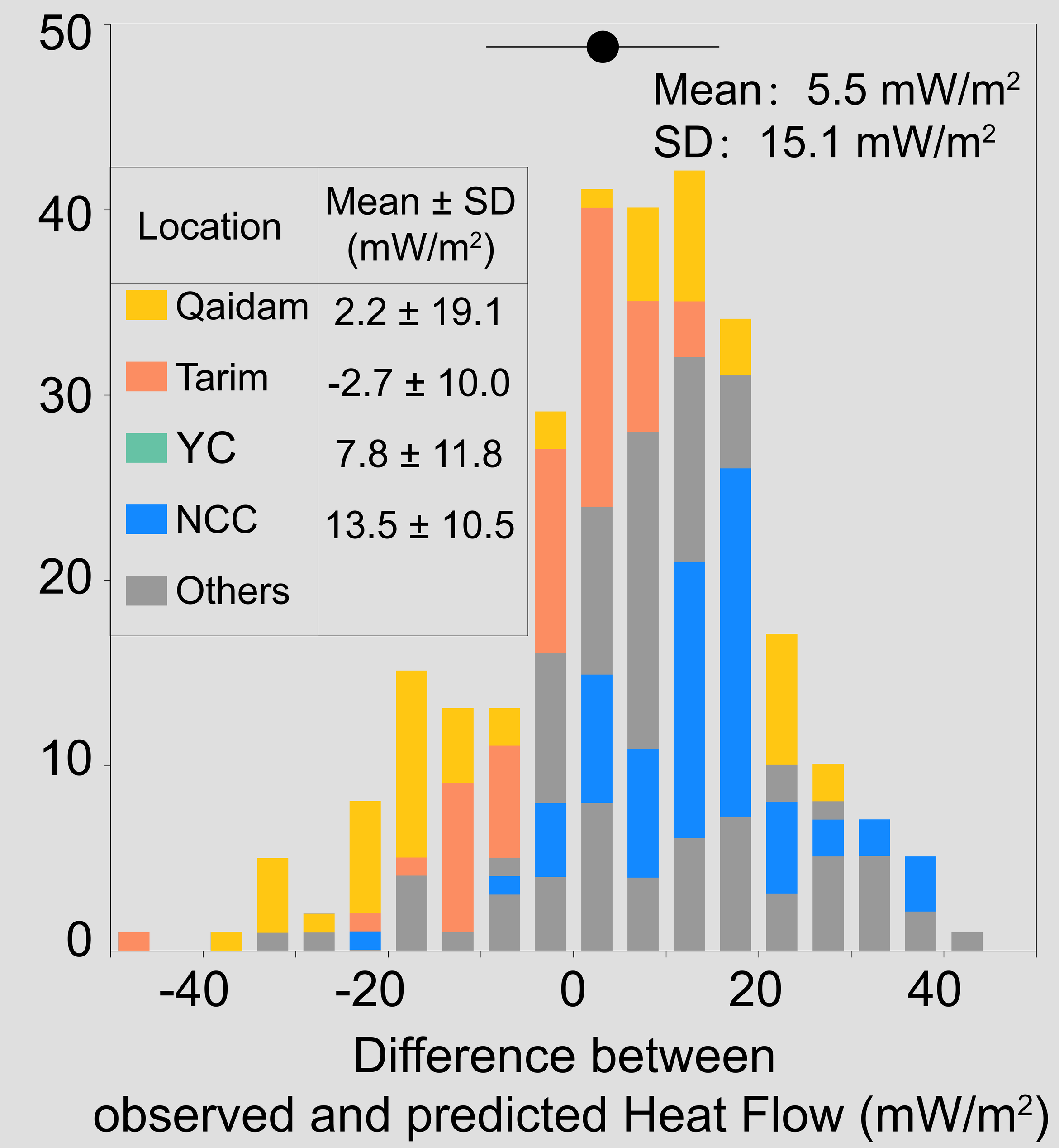
(a) Receiver functionsand seismic wide-angle reflection/refraction profiles. (b) Moho depth based on receiver function (RF) results. (c) Moho depth based on seismic wide-angle reflection/refraction profiles. (d) Difference in Moho depth between receiver function studies and wide-angle reflection/refraction studies.

Heterogeneous thermal lithosphere

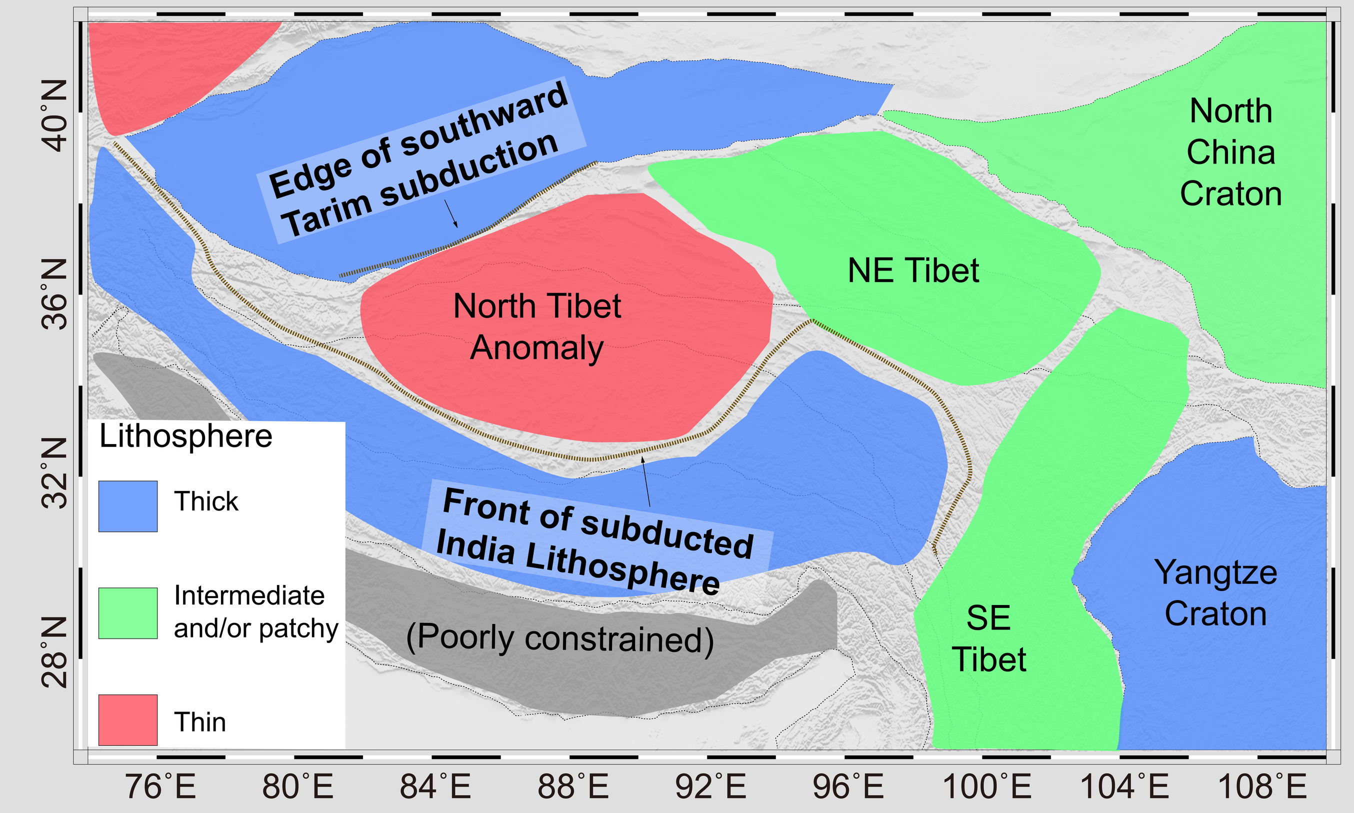


(a) Lithosphere thermal thickness calculated by thermal isostasy; (b) predicted surface heat flow overlain by measured values (colored dots); the color scales for predicted and measured heat flow are the same. Other figure elements as in Fig 1b: color lines in (b, c) show the lithosphere thermal state based on previous studies (white, light and dark gray are for hot, warm and cold lithosphere, respectively); stars are xenolith locations.

Quality Control



Simplified sketch map



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Artemieva, I.M., 2019b. Lithosphere thermal thickness and geothermal heat flux in Greenland from a new thermal isostasy method. EarthScience Reviews, 188, 469-481. doi:10.1016/j.earscirev.2018.10.015.