Deep-seated lithospheric geometry in revealing collapse of the Tibetan Plateau

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The Tibetan Plateau's enigmatic collapse, which was indicated based on extensional faulting in the interior of the plateau and large eastward-directed strike-slip faults, has inspired intensive geologic inquiry and debate. Interaction of the subducting Indian plate with the overlying Asian lithosphere is one factor that may be affecting the plateau. A more detailed image of the subducting Indian plate can help constrain its role, but regional high-resolution seismic data have not been widely available at a relevant scale. Here we present an integrated interpretation based on two types of seismic datasets: 1) three N-S oriented deep seismic-reflection profiles that cross the Yarlung-Zangbo suture, and 2) two E-W receiver function profiles that cross the Xainza-Dingjye and Nyima-Tingri rifts, respectively. These images reveal different crustal-scale structures in the dominant collision zone between the western and central regions, as well as distinctly offset Moho discontinuities across the N-S trending rift grabens in southern Tibet. These crustal variations, combined with previous tomographic studies in Tibet, outline an easterly tilt of the subducting Indian slab, along which crust-mantle decoupling occurred. Together with the spatio-temporal distribution of synchronous Miocene potassium-rich volcanics exposed within the grabens in southern Tibet, this offset Moho structure beneath the grabens lends support to the hypothesis that eastward steepening of the subducting Indian slab was accompanied by slab tearing beneath each north-south striking rift. This overall crustal geometric variation suggests a stepwise flattening of the torn Indian slab from west to the east, a process that brought easterly migration of gravitational instability to the overriding Tibetan crust that drove collapse of the Tibetan Plateau once gravitational instability reached a critical level to the east.