The Tibet-Himalaya Accommodation Zone and the Nature of Orogenic Plateau Margins

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Geodetic studies have established the existence of a profound discontinuity in modern surface strain between the Tibetan Plateau and the Himalaya. To the north, the surface strain field of southern Tibet is one of essentially E-W extension expressed as N-S–striking normal fault systems and NW-SE–striking and NE-SW–striking transcurrent fault systems. To the south, the modern surface strain of the Himalaya is characterized by N-S contraction by deformation on active, N-S–striking, S-vergent thrust fault systems. This discontinuity persists at least as far back in time as the initiation of N-S graben systems of southern Tibet in Middle-Late Miocene time.

Precisely how these two surface strain fields interact is one of the most poorly understood facets of the active tectonics of the Himalayan-Tibetan orogenic systems. In a 2001 *Tectonics* paper with José Hurtado (Hodges et al., 2001), we hypothesized that active, discrete, N-dipping detachments of the South Tibetan fault system (STFS) may maintain strain compatibility between the Himalayan and Tibetan Plateau regimes. In our model, these detachments projected northward into the middle crust beneath southern Tibet and served as modern manifestations of the upper bounding faults of a Miocene-Recent, southward extruding channel of reprocessed crust of Indian Plate affinity (see also Beaumont and others, 2001; Hodges, 2006). This idea derived from geologic observations in the Kali Gandaki drainage in the Annapurna-Dhaulagiri Himalaya of central Nepal (~28˚40’N; 83˚36’E), where the N-S–trending Thakkhola graben appears to truncate abruptly at the surface trace of a prominent STFS detachment (Hurtado et al., 2001). While few other segments of the STFS had been scrutinized by 2001 for evidence of neotectonic activity, we also noted that the strain transition from southern Tibet to the Himalaya was roughly coincident with mapped traces of the STFS, with a major physiographic transition from the plateau to the main Himalayan ranges, and with knick points and drainage divides on large trans-Himalayan rivers as they flowed off the plateau. To us, these provided additional (albeit indirect) evidence of recent slip on the STFS.

Since 2001, our research group has conducted additional studies along the southern boundary of the Tibetan Plateau in Bhutan, Nepal, and Tibet and it is now clear that the transition between the Himalayan and Tibetan strain fields – which we refer to here as the *Tibet-Himalaya Accommodation Zone* (THAZ) – is more complicated than a single array of detachments along the trace of the STFS. In detail, THAZ (most easily defined as the southern limit of N-S–striking normal faults) sometimes lies near the trace of major Miocene detachments of the STFS or the Himalayan range crest but sometimes does not. For example, in the Dhaulagiri Himalaya (~28˚37’N; 83˚15’E), it is marked by a series of oblique-slip faults that express as N-dipping fault scarps and lineaments cropping out south of the trace of the STFS and not far north of the trace of the Main Central thrust. In the upper Arun drainage (~28˚06’N; 87˚22’E) and at the Yadong cross-structure (~27˚48’N; 89˚12’E), THAZ corresponds in part to ~N-S–striking normal faults that bound major transverse ranges or extensional graben. In some poorly mapped regions, the position of THAZ can be estimated only approximately and is not marked by faults that are obvious in remote sensing imagery. Thus, it appears that the southern boundary of the Tibetan Plateau is marked by active, surface-breaking faults in some places and a steep topographic gradient, presumably developed over blind structures, in others.

We hypothesize that active structures of THAZ root northward to form a décollement at the top of the modern seismic low-velocity zone in the middle crust of southern Tibet (e.g., Nelson et al., 1996). In this model, THAZ is a detachment separating the upper crust of southern Tibet (which is undergoing E-W extension) from deeper structural levels that experience N-S contraction directly related to the continued northward subduction of the Indian Plate. If correct, this implies that the upper crust of southern Tibet is essentially delaminated from the middle crust and that the observed surface strain field in southern Tibet may be quite different from the strain field in the middle and lower crust below.

The nature of the southern boundary of the Tibetan Plateau, characterized by a strain accommodation zone that dips toward the plateau and in the same direction as the main subduction zone of the Himalayan-Tibetan orogen (currently the Main Himalayan thrust system), is markedly different from the western boundary of the Andean Plateau in South America. The boundary there is marked instead by a combination of steep homoclines, minor thrust faults, and – at least in Southern Peru (~16˚S; 72-73W; Schildgen and others, 2009) – steep normal faults that dip away from the plateau and in the opposite direction as the main subduction zone of the Andean orogen (the Peru-Chile trench). The differences in these margins are interesting because the western Andean Plateau and the southern Tibetan Plateau share a variety of physiographic and geodynamic characteristics, including the likelihood of there being a fluid middle crust beneath each that is susceptible to lateral flow under the influence of gravity. Unlike the southern margin of the Tibetan Plateau, where channel flow may be responsible for recycling of accreted Indian crust to the Himalayan range front, the western margin of the Andean Plateau exhibits no evidence for the return flow of lower plate material toward the range front by an extruding channel. This may simply be a difference between continent-continent convergence and ocean-continent convergence, but it is noteworthy that the western Andean front has an arid to hyperarid climate whereas the Himalayan front experiences a monsoon climate with up to 5m/yr rainfall. Comparative studies of the much wetter (Amazonian) eastern margin of the Andean Plateau with the southern margin of the Tibetan Plateau, as well as the dry northern margins of the Tibetan Plateau with the dry western margin of the Andean Plateau, may yield a better understanding of the role of climate in the evolution of plateau margins.

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Cite as: Hodges, K.V. and Whipple, K.X. 2010, The Tibet-Himalaya Accommodation Zone and the Nature of Orogenic Plateau Margins, *in* Leech, M.L., and others, eds., Proceedings for the 25th Himalaya-Karakoram-Tibet Workshop: U.S. Geological Survey, Open-File Report 2010-1099, 2 p. [http://pubs.usgs.gov/of/2010/1099/hodges/].