Late Cenozoic Exhumation of the Eastern Margin of the Tibetan Plateau: New Constraints from Age-Elevation Transects in the Longmen Shan

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The eastern margin of the Tibetan Plateau adjacent to the Sichuan Basin is characterized by one of the steepest escarpments on the continents – the Longmen Shan belt. Mean relief across this margin of the plateau exceeds ~ 4 km relief over a distance of ~ 50 km. The mechanisms by which this spectacular topography developed and is sustained is an ongoing debate and carries implications for the geodynamic evolution of the Tibetan Plateau (e.g., Royden and others, 1997; Clark and Royden, 2000; Kirby and others, 2002; Godard and others, 2009a). A number of recent studies used low-temperature thermochronology to decipher late Cenozoic thermal and exhumation evolution of the this region; collectively, these suggest that rapid cooling in the Late Cenozoic (e.g., 20 – 8 Ma; Arne and others, 1997; Kirby and others, 2002; Godard and others, 2009b) heralds the development of high topography. However, the rugged and inaccessible terrain has hindered attempts to collect dense age-elevation transects that cover the entire range of exposed rock.

Here we present preliminary results of low-temperature thermochronology (apatite fission-track and (U-Th)/He from zircon) from two age-elevation transects collected in the immediate hanging wall of the thrust that ruptured during the 2008 Sichuan Earthquake ($M_w = 7.9$). Both transects are from Proterozoic basement rocks of the Pengguan Massif; the apatite fission-track (AFT) transect spans the entire region of granitic rocks (1160 – 4174 m), whereas the zircon He data span a more limited range of relief (1100 – 2000 m). AFT ages are systematically younger at lower elevations and range from 15 – 56.5 Ma. In contrast, zircon (U-Th)/He ages range from 7.3 – 14.3 Ma. Thus, for samples with the same elevations, AFT ages are older than the zircon (U-Th)/He ages. This discrepancy may reflect spatial variability in the thermal structure beneath the Longmen Shan, perhaps as a consequence of: 1) topographic relief across the plateau margin; 2) lateral cooling across the range-bounding thrust; or 3) structural deformation (folding) of isotherms during shortening at the plateau margin. We are currently exploring these questions using simple thermal models, as well as collecting additional apatite and zircon (U-Th)/He data. Collectively, our results may suggest that exhumation began in Longmen Shan region somewhat earlier than previously thought (Kirby and others, 2002) but a definitive answer to this question awaits assessment of the effects of variations in the thermal structure beneath the eastern margin of the Tibetan Plateau.

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