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Geometry and kinematics of the Main Himalayan Thrust and Neogene crustal exhumation in the Bhutanese Himalaya derived from inversion of multi-thermochronologic data

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Both climatic and tectonic processes affect bedrock erosion and exhumation in convergent orogens, but determining their respective influence is difficult. A requisite first step is to quantify long-term (~10ˆ6 yr) erosion rates within an orogen. In the Himalaya, past studies suggest long-term erosion rates varied in space and time along the range front, resulting in numerous tectonic models to explain the observed erosion rate distribution. Here, we invert a large dataset of new and existing thermochronological ages to determine both long-term exhumation rates and the kinematics of Neogene tectonic activity in the eastern Himalaya in Bhutan. New data include 31 apatite and 5 zircon (U-Th)/He ages, and 49 apatite and 16 zircon fission-track ages along two North-South oriented transects across the orogen in western and eastern Bhutan. Data inversion was performed using a modified version of the 3-D thermo-kinematic model PECUBE, with parameter ranges defined by available geochronologic, metamorphic, structural and geophysical data. Among several important observations, our three main conclusions are: (1) Thermochronologic ages do not spatially correlate with surface traces of major fault zones, but appear to reflect the geometry of the underlying Main Himalayan Thrust; (2) our data are compatible with a strong tectonic influence, involving a variably dipping Main Himalayan Thrust geometry and steady-state topography; and (3) erosion rates have remained constant in western Bhutan over the last ~10 Ma, while a significant decrease occurred at ~6 Ma in eastern Bhutan, which we partially attribute to convergence partitioning into uplift of the Shillong plateau.