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Large Spatial and Temporal Variations in Himalayan Denudation

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In the last decade growing interest has emerged in quantifying the spatial and temporal variations in mountain building. Until recently, insufficient data has been available to attempt such a task at the scale of large orogens such as the Himalaya. The Himalaya accommodates ongoing convergence between India and Eurasia and are a focal point for studying orogen evolution and hypothesized interactions between climate and tectonics. Here we integrate 1126 published bedrock mineral cooling ages with a 1D Monte-Carlo thermal-kinematic erosion model to quantify the denudation histories along ∼2700 km of the Himalaya. The model free parameter is a temporally variable denudation rate from 50 Ma to present. Thermophysical material properties and boundary conditions were tuned to individual study areas. Monte-Carlo simulations were conducted to identify the range of denudation histories that can reproduce the observed cooling ages. Results indicate large temporal and spatial variations in denudation that can only partially be explained by modern and paleo erosion. More specifically, across >1000 km of the southern Greater Himalaya denudation rates were highest (∼1.5-3 mm/yr) between ∼10-2 Ma and lower (0.5-2.6 mm/yr) over the last 2 My, most robustly seen in the NW-Himalaya. In contrast to this, across the ∼2500 km length of the northern Greater Himalaya denudation rates vary over length scales of ∼300-1700 km. Slower denudation (<1 mm/yr) occurred between ∼10-4 Ma followed by a large increase (1.2-2.6 mm/yr) in the last ∼4 Ma. We find that only the southern Greater Himalayan Sequence supports a co-evolution of tectonics, climate, and denudation whereas the higher elevation northern Greater Himalaya denudation history might revile variations in exhumation due to ramp-flat geometry in the main basal decollemente and/or recent glacial and/or fluvial enhanced erosion.