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Spatiotemporal Evolution of Denudation across the Himalaya

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Quantifying spatial and temporal variations in denudation rates across orogenic belts are essential for understanding potential linkages between tectonics, and climate. The 2500 km long Himalayan Arc offers and ideal location to study spatial and temporal variations in denudation across an orogen. In this study, we address the following questions: (1) what are the variations in denudation rates across the Himalayan arc over the last ∼25 Myr? (2) how do denudation rates across the central Himalayan front compare with the syntaxes? and (3) what are the spatiotemporal variations in exhumation along transects perpendicular to the arc that traverse multiple tectono-morphic units.

Methods used in this study include a compilation of ∼850 previous published mineral cooling ages obtained along the 2500 km long Himalayan belt. We interpret apatite (AFT) and zircon fission track (ZFT) as well as $^{40}Ar/^{39}Ar$ white mica cooling ages using a thermo-kinematic model to quantify the spatiotemporal evolution of denudation and arc formation. Results from our study include the following. First, along strike variations are analyzed using variations in denudation across the High or Greater Himalaya, the tectono-morphic unit, which comprise crystalline and high elevated regions of the orogen. We obtain strong spatiotemporal variations in exhumation along the southern Himalayan margin since the early Miocene. Rates vary between ∼0.2 and 3 mm/yr between ∼23 Ma and present day. Second, in contrast, the Himalayan Syntaxes of Nanga Parbat and Namache Barwa have denudation rates that are around a factor of two higher (∼5-6 mm/yr for at least the last 5 Myr) than the central part of the orogen. Third, denudation rates along two orogen perpendicular (∼ N-S) tran-

sects in central Nepal and NW India suggest large denudation magnitudes are not only focused along the southern mountain front, but also occur 100-150 km to the north along the southern margin of the physiographic High Himalaya today exposing the Lesser Himalayan Crystalline. Taken together, these results demonstrate that exhumation is focused within a narrow ($\sim$40-80 km) wide belt that covers most along strike regions of the High Himalaya. Furthermore, we find large major temporal variations in denudation in the Early, Mid Miocene and at Pliocene/Quaternary transition, respectively. Most notably, denudation rates for the internal compartments of the High Himalaya to the north were highest between $\sim$23-17 Ma and 3-0 Ma, with a deceleration in rates noted between 17-3 Ma. Contemporaneously, to the south, however, where today rocks related to Lesser Himalayan Crystalline are exposed, we obtain consistent high denudation rates of 1 to 2 mm/yr throughout the Miocene.