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Coupling denudation rates and topographic development in the rainiest place on earth: Reconstructing the Shillong Plateau uplift history with cosmogenic 10Be

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The Shillong Plateau in northeastern India is a prominent feature located between the Bengal floodplain and the heights of the Himalayas. Its' surface uplift has had a significant impact on strain partitioning, the path of the Brahmaputra River and regional precipitation patterns. Today, the plateau receives the highest measured yearly rainfall in the world: the Meteorological Observatory in Cherrapunji registers regularly 12 m/yr rainfall, and all along the plateau margin, the mean annual precipitation from TRMM satellite data is $\sim$ 7 m/yr. Despite the unique tectonic and climatic setting of the plateau, its exhumation and surface uplift history are poorly constrained.

We collected 14 detrital sand samples and 3 exposed bedrock samples from which we obtained cosmogenic 10Be-derived denudation rates. The calculated bedrock denudation rates range from 2.7 $\pm$ 0.2 to 6.7 $\pm$ 0.6 m My^{-1}, whereas catchment averaged denudation rates range from 64.8 $\pm$ 4.9 to 232 $\pm$ 18 m My^{-1}. These results are significantly lower than cosmogenic-derived denudation rates in nearby Bhutan (Portenga et al., 2015). Relatively slow denudation rates are intriguing in a setting with extreme rainfall and high-relief topography; however, they corroborate previous observations that denudation rates in tropical settings might have low sensitivity to rainfall amount. To determine the onset of surface uplift, we couple catchment average erosion rates with topographic analyses of the plateau's southern flank. We interpolated an inclined, pre-incision surface from minimally eroded remnants along the valley interfluves and calculated the missing volume from the carved valleys. The missing volume was then divided by the volume flux expected from cosmogenic denudation rates to infer the onset of uplift. Our results, ranging from 2.9 to 4.5 Ma for individual valleys (or a mean onset of 4.0 to 4.15 Ma), are consistent with several lines of stratigraphic evidence from the Brahmaputra and Bengal basin (Najman et al., 2015) that constrain the onset of surface uplift.

Ultimately, our combination of topographic and cosmogenic nuclide analyses, together with a reassessment of published thermochronological data from the Shillong Plateau, allows us to propose a more detailed reconstruction of the plateau's exhumation and surface uplift history, which comprises a unique interplay between tectonic, climatic, and erosional processes.

References

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