

Giant collapses of high Himalayan peaks and their impact on the Himalayan landscapes

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Abstract:

Although the topographic evolution and erosion dynamics of the Himalayan range have been extensively documented, it is not known how the very high Himalayan peaks erode. Some conceptual models assume that intense periglacial processes involve regressive erosion of high peak headwalls at rates dictated by valley-floor downcutting of glaciers. However, recent data indicate that frost-cracking intensity decreases with elevation, suggesting instead that the highest Himalayan peaks are nearly free of erosion, raising the question of their long-term evolution. Here, we report geological evidence for two Holocene giant rockslides that occurred in the Annapurna Massif (central Nepal), involving total rock volumes of approximately 23 and 18 km³, respectively, and that decapitated high paleosummits, most probably culminating above 8000 m for the first one. Our data demonstrate that the main mode of high-altitude erosion could be catastrophic mega-rockslides, leading to the sudden reduction of high peaks by several hundred meters and ultimately preventing the Himalayan summits from growing indefinitely (Lavé et al., 2023). This erosion mode, associated with steep slopes and high relief, arises from a higher mechanical strength of the high-peak substratum, probably due to the presence of permafrost at high altitude and the absence of bedrock weathering. In addition to their direct impact on the evolution of the High Himalayan landscape and ridgeline, giant rockfalls can also have major implications for the evolution of downstream rivers and natural hazards through massive sediment supply, though this effect mainly depends on the rockfall location within the range.

Keywords: Giant rockslides, high Himalayan summits.

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