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High peaks on thin crust – a global climatic signal?

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Distribution, height and steepness of peaks in mountain ranges worldwide are inseparably linked to Quaternary climate modulations. There is evidence that periods of intense glacial occupation resulted in increased erosion rates in mountain belts. It has been proposed that localized erosion and uplift induced by isostatic rebound promote an increase of peak elevation by a concurrent reduction of mean elevation. Contrarily, it has also been proposed that periods of increased erosivity cause a reduction of mountain height and relief. In particular, focused glacial erosion near the long-term snowline seems to restrict the maximum height of mountain belts.

Here we present the first global analysis of the morphology and distribution of more than 16,000 peaks. We focus on the spatial correlation of peak height and steepness, mean elevation and crustal thickness. Our analysis reveals that the steepness of peaks increases with altitude. Comparing peaks of similar altitude, the steepness of peaks increases towards high latitudes, while the crustal thickness supporting these peaks decreases. This suggests a progressive crustal thinning with intensity and duration of glacial occupation transforming mountain belts from a fluvial towards a glacial topography. Due to the characteristic glacial landscape geometry with very steep peaks separated by spacious glacial valleys, even a relatively thin crust suffices to support very high peaks.

The question arises whether extraordinary high peaks at high latitudes (e.g. Denali) are (a) relics of the preceding fluvial topography, (b) characteristic features evolving during the topographic transition from fluvial to glacial conditions or (c) even representative landforms featured by a glacial steady-state topography.