Erosion Rates at the Crest of the Himalaya: Slow or Fast?

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The tempo of erosion in the Himalaya has been studied extensively because of the broad interest in the rich interactions between tectonics, topography and climate that govern the development of this and other mountain ranges. Rates of exhumation at lower elevations have been examined in a multitude of studies by a number of research groups using diverse approaches. For example, Thiede and Ehlers (work in progress) have compiled from these studies ~950 mineral cooling ages obtained from in-situ samples across the entire Himalaya. They include the syntaxial regions at both ends of the range where erosion is clearly linked to the spatial pattern and rate of crustal deformation (e.g., Zeitler and others, 2001a; Koons and others, 2002; Sol and others, 2007; Finnegan and others, 2008).

Little is known, however, about contemporary rates of erosion at the crest of the Himalaya where glacial and periglacial processes dominate. Currently, there is not even consensus in the most recent literature on whether glaciers accelerate or impede erosion in the Himalaya, and contradictory assumptions are being made in the current literature about the role of glaciers and glaciations in shaping the range, and by inference, other mountain belts that are or were glaciated. For example, Rahaman and others (2009), who report on climate control on the distribution of erosion over the Himalaya during the past ~100 ka, claim that sediment yields decreased during periods of more extensive glacial cover in the Higher Himalaya. On the other hand, Gabet and others (2008) reporting on their work in the northern Marsyandi catchment make the common assumption that glacial erosion is, in general, relatively fast and argue that high rates of erosion during periods of glaciation compensate for the low rates during interglacials. Actual data on glacial erosion rates for the Himalaya are indeed very sparse, consisting of only two studies, one of Raikot Glacier,in the Nanga Parbat region (Gardner and Jones, 1993) and another in the Annapurna Range (Heimsath and McGlynn, 2008). This sets the stage for our impending research on erosion rates in the Mt. Everest area.

Are the high peaks eroding fast or are they relatively immune to erosion? The well known occurrence of marine sediments on Mount Everest shows clearly that the amount of exhumation at the crest of the range has been small relative to many areas where igneous and high grade metamorphic rocks have been exhumed from great depth (e.g. Burg and others, 1997; Zeitler and others, 2001b). This does not require erosion to be slow, however, because the Everest massif may be rising and eroding rapidly, but has only done so in the recent geologic past; little is known about the exhumation and uplift history of the region.

Slow erosion is consistent with the notion, which emerged early in the literature (Griffiths, 1952), that high peaks could be relatively resistant to erosion. Indeed, the high peaks and great relief characteristic of the core of high mountain ranges suggest that glacial and periglacial processes are relatively ineffective at the highest elevations. Contributing factors include the limited moisture carried in cold air, increased snow armoring of slopes, snow avalanching off the steep slopes of the "Teflon peaks" (Anderson, 2005), as well as high rock strength of the crystalline-cored peaks and the extremely low temperatures that impede freeze-thaw processes as well as glacial erosion (Koons, 1989; Foster and others, 2008).

Erosion is fast, however, for at least one major mountain in the Himalaya in the eastern most Himalaya (Figure 1). Detrital zircons from a stream draining the cirque glacier incising the north flank of Namche Barwa, analyzed by R.S. Stewart (sample #NB0904), yielded a population of extremely young ages characterized by a number of peaks, the youngest of which is 0.3 Ma and accounts for 35% of the 81 grains analyzed; the oldest grain in this entire sample is 3.6 Ma. The cooling ages for Namche Barwa north-west flank samples indicate extremely rapid erosion; they are comparable to those found in the Siang river at Pasighat, India (dotted line with beige infilling) that most probably originate from a ~3300 km^2 area where exhumation rates by fluvial incision by the Tsangpo/Siang River (Brahmaputra) range from 7 to 21 mm yr^{-1} (Stewart and others, 2008).

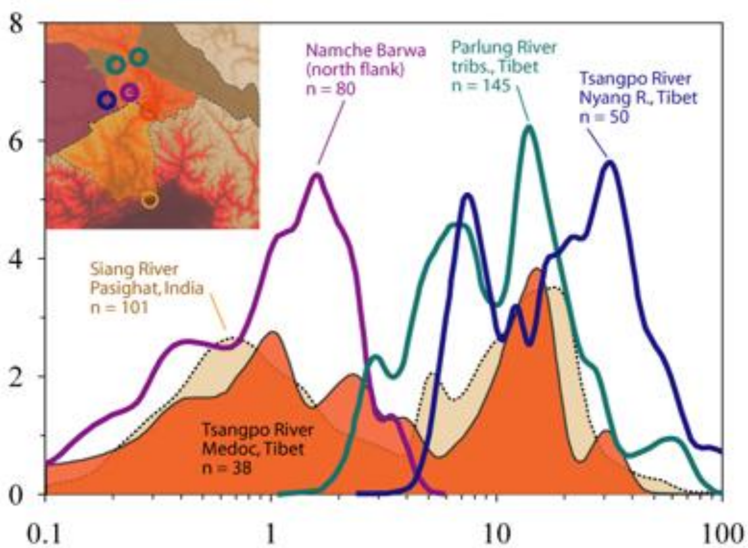

Figure 1. Frequency (vertical axis, in %) of cooling ages (horizontal axis, in Ma) from fission tracks in detrital zircon grains from the easternmost Himalaya. Zircons from the north flank of Namche Barwa (magenta color) have cooled as quickly, and by inference have been exhumed as rapidly, as those from Brahmaputra River as it slices through the Himalaya (labelled by the regional name of the river: the Siang and Tsangpo shown with the beige and orange infilling, respectively). The green and blue curves delineate frequency distributions of material for more slowly eroding drainages of SE Tibet.

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