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Quantifying erosion and provenance variability in the modern sands of the Central Himalayan rivers: a comparison of provenance methods.

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The sediments transported by mountain rivers can potentially bring very useful and unexpensive information to estimate mean erosion rates or spatial distribution of the erosion at the scale of a watershed. Similarly, during the erosion of mountain belts, the eroded sediment deposited in adjacent basins preserve a detrital record of the orogenic growth. Such diagnostic is in particular possible if the different parts of the contributing watershed have contrasted signature in terms of either lithology, mineralogy, geochemistry, or thermochronologic closure ages. In latest years, the Marsyandi and Narayani catchments in central Nepal have become a privileged natural laboratory in which numerous distinct studies on sediment provenance and signature have been applied. These studies include sediment budget, water and sediment chemistry on suspended and sand fractions, sand mineralogical composition, gravel bedload lithologic composition, sediment provenance using geochronological techniques like Ar/Ar on detrital muscovite, and U/Pb on detrital zircons, or cosmogenic radionuclides in sand fraction. Such large data set offers therefore an unprecedented opportunity to compare these different methods and test their accuracy. Rates and patterns of erosion inferred from these different techniques diverge widely. Whereas a majority of studies support focused erosion of the Greater Himalaya [Galy et al. 1999; Attal & Lavé, 2006 ; Garzanti et al. submitted], recent analyses suggested instead erosion rates up to three-times faster in the Upper Lesser Himalaya [Amidon et al. 2005a,b]. On the other hand, cosmogenic radionuclides indicate mean denudation rates between 0.2 and 0.5 mm/yr on the southern front of the High Himalaya [Wobus et al., 2005], whereas others long term estimate as well as suspended load measurements suggest much higher rates of

2-3 mm/yr [Burbank et al., 2003; Lavé and Avouac, 2002]. The reasons of such discrepancies can arise from several process occurring on the hillslopes or during the fluvial transport that are usually not taken into account : heterogeneous distribution of minerals in source rock, mineral survivability during soil formation or fluvial transport, analysed grain size distribution, hydraulic sorting or temporal variability may bias the initial source signal. These processes, and the bias they can induce, will be discussed to the light of the Himalayan example and of experimental results.