Sand petrology and focused erosion in collision orogens: the Brahmaputra case

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Abstract

The high-relief and tectonically active Himalayan range, characterized by markedly varying climate but relatively homogeneous geology along strike, is a unique natural laboratory in which to investigate several of the factors controlling the composition of orogenic sediments. Coupling of surface and tectonic processes is most evident in the eastern Namche Barwa syntaxis, where the Tsangpo–Siang–Brahmaputra River, draining a large elevated area in south Tibet, plunges down the deepest gorge on Earth. Here composition of river sands changes drastically from lithic to quartzofeldspathic. After confluence with the Lohit River, draining the Transhimalayan-equivalent Mishmi arc batholiths, sediment composition remains remarkably constant across Assam, indicating subordinate contributions from Himalayan tributaries. Independent calculations based on petrographical, mineralogical, and geochemical data indicate that the syntaxis, representing only \(\sim 4\%\) of total basin area, contributes \(35 \pm 6\%\) to the total Brahmaputra sediment flux, and \(\sim 20\%\) of total detritus reaching the Bay of Bengal. Such huge anomalies in erosion patterns have major effects on composition of orogenic sediments, which are recorded as far as the Bengal Fan. In the Brahmaputra basin, in spite of very fast erosion and detrital evacuation, chemical weathering is not negligible. Sand-sized carbonate grains are dissolved partially in mountain reaches and completely in monsoon-drenched Assam plains, where clinopyroxenes are selectively altered. Plagioclase, instead, is preferentially weathered only in detritus from the Shillong Plateau, which is markedly enriched in microcline. Most difficult to assess is the effect of hydraulic sorting in Bangladesh, where quartz, garnet and epidote tend to be sequestered in the bedload and trapped on the coastal plain, whereas cleavable feldspars and amphiboles are concentrated in the suspended load and eventually deposited in the deep sea. High-resolution petrographic and dense-mineral studies of fluvial sands provide a basis for calculating sediment budgets, for tracing patterns of erosion in mountain belts, and for better understanding the complex dynamic feedback between surface processes and crustal-scale tectonics.

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