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Quaternary Indus River Terraces as Archives of Summer Monsoon Variability

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If we are to interpret the marine stratigraphic record in terms of evolving continental environmental conditions or tectonics, it is essential to understand the transport processes that bring sediment from mountain sources to its final marine depocenter. We investigate the role that climate plays in modulating this flux by looking at the Indus River system, which is dominated by the strong forcing of the Asian monsoon and the erosion of the western Himalaya.

Lake, paleoceanographic, and speleothem records offer high-resolution reconstructions of monsoon intensity over millennial timescales. These proxies suggest the monsoon reached peak intensity at ∼9–10 ka in central India, followed by a steady decline after ∼7 ka, with a steep decline after 4 ka. New lake core records (Tso Kar and Tso Moriri), however, suggest a more complex pattern of monsoon weakening between 7–8 ka in the Greater Himalayan region, which contrasts with a time of strong monsoon in central India. This indicates that the floodplains of the major river systems may not experience the same climatic conditions as their mountain sources, resulting in different geomorphologic responses to climate change. Earlier research has established that the northern part of the Indus floodplain adjacent to the mountains experienced incision after ∼10 ka. Incision and reworking is even more intense in the Himalayas but its timing is not well-constrained.

High altitude river valleys, at least north of the Greater Himalaya, appear to be sensitive to monsoon strength because they lie on the periphery of the Himalayan rain shadow. These valleys may be affected by landslide damming during periods of strong monsoonal precipitation, such as slightly after the monsoon maximum from 9–10 ka. Damming of these river valleys provides sediment storage through valley-filling and later sediment release through gradual incision or dam-bursting. Terraces of a major tributary to the Indus, the Zanskar River, indicate valley-filling prior to ∼10 or even ∼30 ka, and suggest periods of strong summer rains; although existing dates on these landslide-dammed terraces are sparse. New OSL ages help constrain the timing of valley-filling events and the timing of river incision when this sediment was released to the Indus river and thus to the delta. Initial work suggests that sediment storage in mountain terraces may be the greatest source of sediment (∼80%) to the post-glacial Indus, and that the timing of sediment release may be modulated by periods of strong precipitation . In order to interpret the marine erosional archive as an environmental record, it is fundamental to understand how this sediment is stored on the continent and released to the ocean.