When Did the Himalayas Get High?

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Millions of years of erosion from the Himalayas have created a huge sedimentary structure in the Bay of Bengal, known as the Bengal Fan. The Bengal Fan is the world's largest sediment accumulation, and its volume is estimated to be 5-10 times the volume of the portion of the Himalayas presently above sea level. ODP Leg 116 recovered sediments from the Bengal Fan representing 20 million years of deposition, providing a uniquely valuable archive of Himalayan uplift and erosion and weathering processes.

These ODP data can be used to test hypotheses about the formation of the Himalayan mountain belt and the impact of weathering fluxes on ocean chemistry. Cores revealed that the Himalayas were uplifted at least 20 million years ago, 10 million years earlier than scientists originally projected.

One of the most intriguing sediment intervals recovered by ODP Leg 116 was deposited during latest Miocene to Pliocene times, approximately 7.4 million years ago (Ma). Coupled changes in sedimentation rate, clay mineralogy, the $^{87}Sr/^{86}Sr$ ratio of pedogenic clays, and the d^{13}C of organic carbon all imply significant environmental change in the Himalayan region at this time.

The cores indicate that a sequence of rocks known as the High Himalayan Crystalline series (HHC) has been the dominant source of the sediment to the Bengal Fan since the early Miocene. The cores show a period of increased weathering intensity that appears to be related to decreased sediment delivery. The weathering took place mostly in the low elevation floodplain of the Ganges system.

The rapid accumulation of sediment in the Bay of Bengal results in the storage of large amounts of organic matter, most of which is derived from terrestrial sources. Since the late Miocene, a significant fraction has been derived from C4 grasses in the floodplain region. This grass carbon is closely associated with the highly weathered clays, and it appears that the enhanced weathering occurred in the newly developed grasslands of the foreland basin. A picture emerges of decreased sediment flux and longer residence time in the foreland, under conditions of increasing seasonality. Although work on other ODP sites from the Arabian Sea suggests increasing monsoon intensity and a possible connection to uplift, the Bengal Fan records decreased sediment transport but more intense chemical processing of this material in the foreland. Not until millions of years later do high flux rates and low weathering intensity recur.

Figure 1. Data from Bengal Fan sediment recovered in Hole 717C. From left to right: **1)** Sediment accumulation rate and **2)** clay mineralogy show decreased erosion but increased weathering from 7.4 to 1 Ma. However, **3)** neodymium isotopic composition of bulk sediment and individual minerals shows little variation, indicating that the HHC remained the main source of sediment since before 18 Ma. **4)** Strontium isotopic composition from clay interlayer sites record changes in the weathering environment associated with changing clay formation, which occur at the same time as **5)** shifts in carbon isotopic composition of buried organic carbon indicate a change from trees and shrubs as the dominant carbon source to grasslands. The coupled changes in clay mineralogy, strontium and carbon isotope ratios indicate an increase in the importance of floodplain processes that may have been aided by decreased sediment flux.