

Uplift of Himalaya and its implications on the evolution of Indian monsoon

S. Singh^{1,2*}, B. Parkash¹ and A.K. Awasthi^{1#}

¹ Deptt. of Earth Sciences, Indian Institute of Technology Roorkee, India

² Centre for Earth Sciences, Indian Institute of Science, Bangalore, India

Presently at Department of Petroleum Engineering, Graphic Era University, Dehradun, India

*geoseema05@yahoo.co.in

The Himalayan orogen underwent multiple tectonic upheavals since its evolution and though researchers linked intensification of Asian monsoon climate with its emergence, none of them explained that Cenozoic upheaval which forced Himalayas to such a critical height so as to set-up monsoon climate and subsequently brought changes in flora and fauna. We combine information from our isotopic, sedimentological and pedological data along-with other geological evidences to prove that specifically, late Miocene (10±1Ma) tectonic upheaval not only forced Himalayas to great elevation, perhaps to its highest since evolution, to initiate monsoon climate but also the Indian monsoon was strongest at that time and since then, there is progressive long-term decrease in monsoon strength. Herein isotopic, sedimentological and pedological data from a total of four Siwalik sections, across a lateral stretch of ~ 170 Km, have been coherent to deduce palaeoprecipitational history of the region during the late Cenozoic Himalayan orogenesis.

Stable oxygen isotope analyses of a total of 195 pedogenic carbonates, ranging in age between ~13 Ma to 0.4 Ma, indicate a progressive increase in aridity except for short term increases in rainfall or monsoon intensity at around 10 Ma, 5 Ma and 1.8 Ma. Furthermore, present results are in conformity with patterns of changes in precipitation documented by similar isotopic studies in other parts of Himalayan foreland basin. The $\delta^{18}\text{O}$ values on average, except for the periods of highly negative values at around 10 Ma, 5 Ma and 1.8 Ma, become ~ 2 ‰ positive from the sediments pre-8 Ma to post-8 Ma which implies ~ 3 °C increase in mean annual air temperature [1]. The average $\delta^{18}\text{O}$ values at ~ 10 Ma, 5 Ma and 1.8 Ma are -11.23 ‰, -9.72 ‰ and -8.74 ‰ respectively. This means there is an increase of 2.5‰ in $\delta^{18}\text{O}$ values from analyzed oldest ~10 Ma to the recent 1.8 Ma rainfall/monsoon event and hence a long-term decrease in monsoon strength of about 167 mm from the ~10 Ma to 1.8 Ma rainfall event. Likewise, degree and nature of pedogenesis and sedimentological attributes show similar patterns of changes in the evolution of monsoon [2].

Interestingly amongst several upheaval phases of the Himalaya, rapid increase in mean sediment accumulation rates [3, 4, 5] and lowest eustatic level [6] during late Miocene, significantly indicate its fastest and highest uplift at that time (10±1Ma). Also, amongst various tectonic pulses during Himalayan orogenesis, rate of uplift during late Miocene was the most intense and fastest [7]. Whether the uplift of the Himalayas was controlled by tectonics or climate, it surely forced the Himalayan orogen to significant height so as to act as orographic barrier to the SW moisture laden winds of the Arabian sea, thereby having then strongest monsoonal rains.

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