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Reconstructing Indian Summer Monsoon Variability and Assessment of Organic Matter Sources from Anshupa Lake, Core Monsoon Zone, India: Records from n-alkane Distribution and Stable Isotopic Composition

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This study meticulously reconstructs the variability of the Indian Summer Monsoon (ISM) over the past 6000 years. The Multi-proxy records of lipid biomarkers and stable isotope values helped in a detailed analysis of an 11.70 m long sediment core from the Anshupa Lake located in the Core Monsoon Zone (CMZ) in India. The research measures elemental composition (TOC, TN and C/N) and stable isotopic ($\delta^{13}C_{OM}$ and $\delta^{15}N$) values. Additionally, n-alkane (n-C14–C35) concentrations and relevant indices, including the CPI, Paq, ACL and TAR, along with compound-specific δD and $\delta^{13}C_{C29}$ values to disentangle organic matter (OM) sources and assess their utility for paleo-environmental reconstructions. The results indicate that the OM in the sediments is derived from a mix of autochthonous aquatic sources and allochthonous terrestrial plants. The distribution of n-alkanes in catchment sediments shows a strong odd-over-even predominance, characterised by higher chain lengths (n-C27 to n-C33). The study demonstrates the effectiveness of δD and $\delta^{13}C_{C29}$ isotope approaches in distinguishing changes in precipitation and vegetation patterns in and around the lake. From the mid-Holocene (~6000 cal yr BP) to the Present, a gradual decrease in $\delta^{13}C_{OM}$ and $\delta^{13}C_{C29}$ values, indicating a corresponding decline in temperature and precipitation, marked by significant fluctuations. This trend reflects a continued weakening of the ISM and a shift from predominantly C3-type vegetation to C4-type vegetation. Organic geochemical proxies (C/N) recorded the pronounced 4.2 ka drought event with other significant wet and dry phases. These findings shed light on the complex interplay between monsoon activity and regional ecological balance, emphasising the importance of paleoclimate records in reconstructing historical climatic shifts.