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Palaeovegetational reconstruction in Late Miocene: A case study based on early diagenetic carbonate cement from the Indian Siwalik

Prasanta Sanyal [a,*], S.K. Bhattacharya [a], Rohtash Kumar [b], S.K. Ghosh [b], S.J. Sangode [b]

[a] *Physical Research Laboratory, Ahmedabad-380 009, India*
[b] *Sedimentology Group, Wadia Institute of Himalayan Geology, Dehra Dun-248001, India*

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Abstract

Carbon isotope ratio of early diagenetic carbonate cement (EDCC) from sandstones was measured from Mohand Rao (age: 9 to 4.5 Ma) and Haripur Khol (6 to 1.8 Ma) sections of Siwalik Group of India to reconstruct palaeovegetation. The $\delta^{13}C$ of cement from Mohand Rao section varies from −10.5‰ to −0.2‰ with progressive increase in values from 9 to 7.3 Ma indicating gradual change of existing C_3 type vegetation to C_4 type vegetation. Post 7.3 Ma, the $\delta^{13}C$ value is anchored around zero per mil indicating mixed C_3–C_4 environment with C_4 dominating the ecosystem. In Haripur Khol section, the $\delta^{13}C$ value of EDCC from sandstone indicates presence of both C_3 and C_4 type of plants with dominance of C_4 in the ecosystem, which corroborates the results of our previous study based on carbon isotope ratio of soil carbonates.

The oxygen isotope ratio of EDCC from sandstones does not show any systematic variation with time. The $\delta^{18}O$ values of EDCC from Mohand Rao section ranges from −8.9‰ to −13.6‰ and in Haripur Khol section, from −9.9‰ to −13.6‰. At a given stratigraphic level, the average $\delta^{18}O$ value of EDCC of sandstones is lower (up to 4‰) compared to the average $\delta^{18}O$ of soil carbonate from the same or adjacent level (using our earlier published data from Haripur Khol section). The depletion in ^{18}O of EDCC may be due to contribution of contemporary river water infiltrating the groundwater system in the post-monsoon period.

Carbon and oxygen isotope ratio of soil carbonate nodules and carbon isotope ratio of associated organic matter from the same nodules were also measured from the Mohand Rao section in a few cases ($n=9$). From 9 to 8 Ma, the carbon isotope ratio of soil carbonates varies from −10.8‰ to −7.8‰ indicating dominance of C_3 type vegetation in the flood plain. In contrast, from 5.4 to 4.8 Ma, the $\delta^{13}C$ ranges from 0.1‰ to −4.3‰ indicating that the vegetation consisted of mixed C_3–C_4 plants with C_4 dominating the ecosystem. The carbon isotope ratio of the organic matter from the same soil carbonate nodules ranges from −25.2‰ to −24.4‰ (from 9 to 8 Ma) and −17.4‰ to −24.6‰ (from 5.4 to 4.8 Ma) corroborating the above results. The average $\delta^{18}O$ value of soil carbonate nodules for the time period 9 to 8 Ma is −8.8‰; for 5.4 to 4.8 Ma, the value is −7.9‰.

* Corresponding author.
E-mail address: psanyal@prl.ernrt.in (P. Sanyal).

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These average $\delta^{18}O$ values are comparable with previously published oxygen isotope results of soil carbonates from Haripur Khol and Kangra valley.

Keywords: Diagenesis; Cement; Soil carbonate; C_4 plants; Indian Siwalik

1. Introduction

The deposits in the Himalayan Foreland Basin known as Siwalik sediments are derived from erosion of rocks from the higher reaches of Himalayan region. These formed over the time span of last ~18 Myr (Johnson et al., 1985) and can be divided into three subgroups: Lower, Middle and Upper Siwalik based

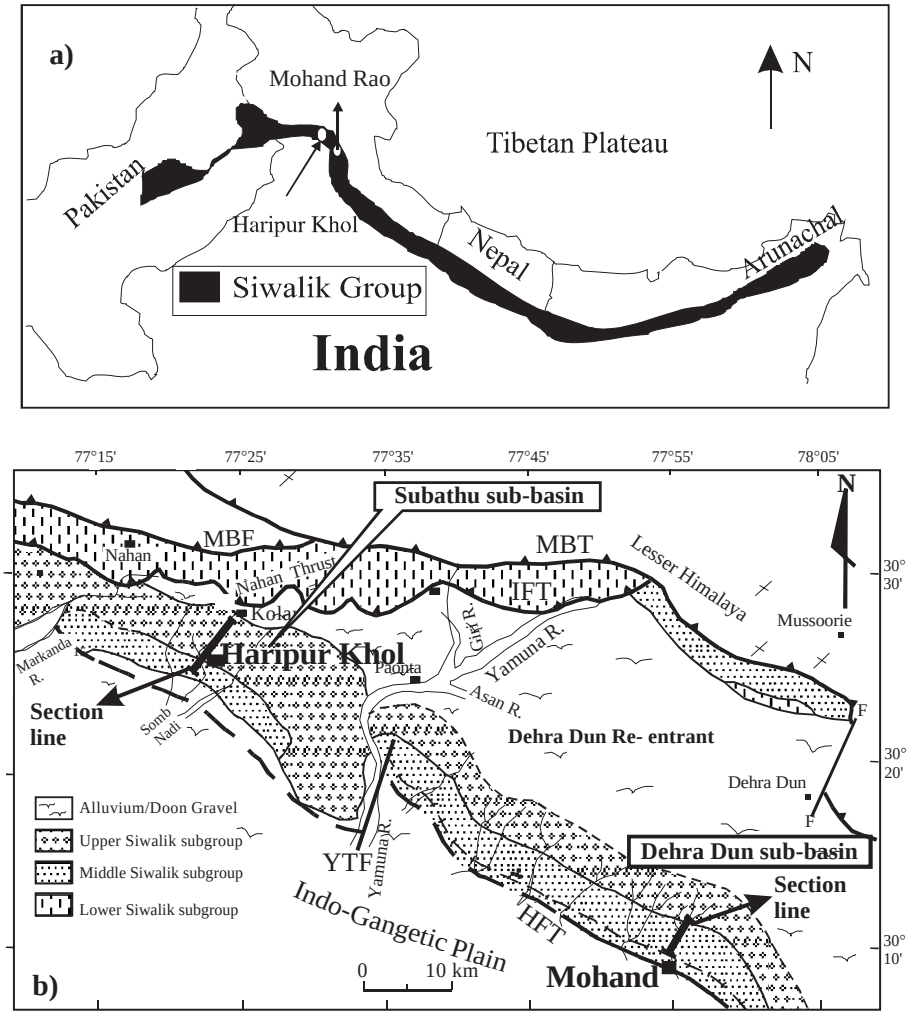

Fig. 1. a) Schematic of the geographical extension of the whole Siwalik Group across the northern part of Indian sub-continent and location of Haripur Khol and Mohand Rao sections. b) Geological map of the Dehra Dun sub-basin and Subathu sub-basin. Samples were collected from Mohand Rao section of Dehradun sub-basin and Haripur Khol section of Subathu sub-basin along section line. MBT = Main Boundary Thrust; YTF = Yamuna Tear Fault; HFT = Himalayan Frontal Thrust; IFT = Intra-foreland Thrust; MBF = Main Boundary Fault.