Organic geochemical study of continuous lacustrine sediments obtained from Kathmandu Valley, central Himalaya: interpretation of paleoenvironmental changes in the late Quaternary using bulk organic matter analyses

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The climate of East and South Asia is under strong control of monsoonal climatic system. The Asian monsoon climate has been developed with the uplift of the Himalaya-Tibet orogen since the collision of Indian subcontinent with Asian continent. The timing of initiation of the monsoon and related important tectonic events have been reported, but a problem how monsoon has changed in the past, particularly in glacial-interglacial period in Quaternary, is still uncertain. It is important to clarify changes of paleomonsoon climate on land, and it would contribute to understand present monsoon climate and to estimate future monsoon climate.

The Kathmandu Valley is an intermontane basin, located on the southern slope of the central Himalaya under direct influence of Indian monsoon. The valley is filled with thick lacustrine and fluvial sediments of the late Pliocene to Quaternary. Therefore, it is expected that these sediments record a long-term paleoenvironmental changes in this region. Fujii and Sakai (2002) reported that seven cycles of warm-and-wet and cold-and-dry climate were recognized since 0.9 Ma, which reflect global glacial-interglacial cycles. However, in that study there were several problems: the samples were not continuous and ages were not directly determined. Therefore, we carried out core drilling for academic purpose in the Kathmandu Valley, and could have obtained 218 m-long drill-core. In this study, we analyzed sediment core (RB core) obtained at Rabibhawan in the western central part of the Kathmandu Valley. The RB core is composed mainly of continuous muddy lacustrine sediments. The sediments are rich in organic matter, and yield many fragments of plants and animals.

Organic components preserved in lacustrine sediments were originated in terrestrial plants and aquatic organism. Variety and productivity of the organisms are controlled by environmental factors such as temperature and precipitation. Therefore, it is important to study organic matter in lacustrine sediments, in order to reconstruct paleoenvironmental changes.

In this study, we carried out analyses of total organic carbon (TOC), total nitrogen (TN) and isotopic composition of bulk organic matter ($\delta^{13}C$) in the Paleo-Kathmandu Lake sediments and reconstructed paleoenvironment in the Kathmandu Valley during the late Quaternary. This is the first organic geochemical report of paleoenvironmental and paleoclimatic study in this region.

The sediment samples were analyzed at 1 m intervals from 10 m to 180 m below the surface. At depth of 83-89 m, samples were absent due to sand bed.

Vertical profiles of the TOC concentrations, TOC/TN ratios (C/N ratios) and $\delta^{13}C$ values in sediment are shown in **Figure 1**. The TOC concentrations range from 2 to 7 % and C/N ratios change between 7 and 20. The $\delta^{13}C$ values of total organic carbon change between -29 to -20 ‰ with the averaged value of -24 ‰, and change periodically. The TOC concentration and C/N ratio also change periodically and their oscillations correlate well. The $\delta^{13}C$ values were inversely correlated with the TOC concentrations and C/N ratios.

Based on the cyclic changes of $\delta^{13}C$ values, the muddy section of the core was divided into fourteen zones. In the zones, showing high $\delta^{13}C$ and low TOC and C/N ratio, it is inferred that the proportion of C4 plants of total organic matter was increased, while the proportion of the terrigenous organic matter to the total organic matter was decrease. The paleoenvironment of these zones indicates that C4 plants are predominant in land, and grasses proliferated in this area. In the other zones with the low $\delta^{13}C$, it is infered that the terrigenous organic matter was increased and the contribution of C4 plants was not significant. Accordingly, the paleoenvironment of the low $\delta^{13}C$ zones reveal that C4 plant was expelled, and arboreal plants were vigorous.

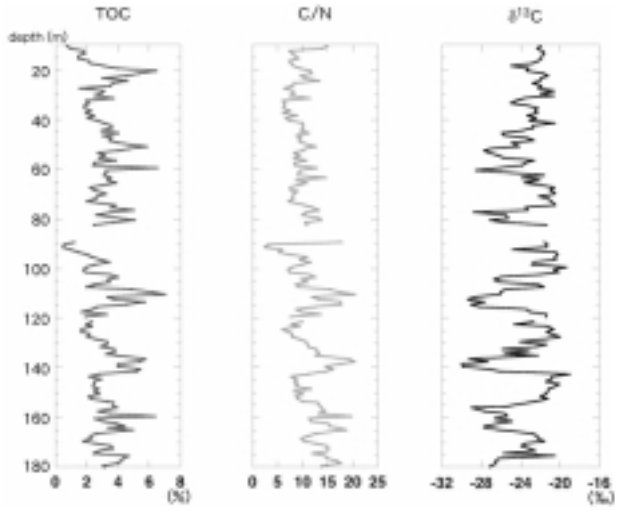

FIGURE 1. TOC concentrations, C/N weight ratios and $\delta^{13}C$ values in RB core from Kathmandu Valley, Nepal

The previous studies using Kathmandu basin sediments proposed that a dry and wet climate prevailed during the glacials and interglacials in Kathmandu area, respectively. In addition, it is commonly known that C4 plant an advantage over C3 plant in the arid climate except in the high latitude area. From these facts, it is concluded that the high $\delta^{13}C$ zones corresponded with cold and arid climate; therefore, the cyclic changes of the $\delta^{13}C$, TOC and C/N ratio reflect the paleoclimate changes, i.e., repetition of cold-arid and warm-humid climate. ^{14}C dating and paleomagnetic studies suggest that the age of the core was about 0.68 Ma-12Ka.

The present zonation with the estimated time-scale was compared to the SPECMAP stack. As a result, it is found that the cyclic changes in the paleoclimate in Kathmandu area are in good agreement with the global climate changes represented by the ice volume changes during the late Quaternary. Therefore, we conclude that paleoclimatic changes during at least 0.7 Ma in Kathmandu area were influenced mainly by the glacial-interglacial cycles and Paleo-Kathmandu Lake sediments have a high potential to provide a high-quality and high-resolution record of the Quaternary monsoonal climatic changes in the continental interior of South Asia.

References

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