Behavior of minerals with Paleoclimate and paleoenvironment changes of the Kathmandu Valley, Central Nepal

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The Kathmandu Basin is the best target for clarifying the variability of the Asian monsoon climate and its linkage to the uplifting of the Himalayan-Tibetan orogen, since it is located on the southern slopes of the central Himalayas and filled with thick sediments from late Pliocene to Quaternary. Our group has proceeded on a Japan-Nepal collaborative project, Paleo-Kathemandu Lake (PKL) Project. In the project, we have carried out core drilling within the Kathmandu Basin and have investigated on the cores and surface exposures from various viewpoints and methods.

Clay minerals in the Kathmandu Basin sediments contain good information on the paleoclimate and paleoenvironment in this area, because they are directly formed through the weathering or hydrolysis process from the parent minerals, feldspars and micas, in both gneiss and granite of the Shivapuri injection complex and weakly metamorphic rocks of the Phulchauki Group. In order to reconstruct the paleoclimatic and paleoenvironmental changes, we examined the estimation of the amount of the clay size fraction, the relative amounts of individual clay and non-clay minerals, and the crystallinity of illite in the drill-core sediments by using the decomposition procedure of X-ray diffraction (XRD) patterns and the mineral reference intensity (MIF) method. Here we report the paleoclimatic and paleoenvironmental information in the Kathmandu Basin deduced from their mineralogical data.

We used for mineral analysis RB core, which was drilled at Rabibhawan in the western central part of the Kathmandu Basin and is 218 m long. The clay fraction under 2um was separated from each sediment sample by gravity sedimentation. About 200 mg of this fraction was collected by the Millipore filter transfer method to provide an optimal orientation. Non-clay samples were ground to powder in agate mortar, and then 10 wt% of ZnO was added to the individual powder samples as an internal standard for the quantitative analysis. All XRD data were collected on a Rigaku X-ray Diffractmeter RINT 2100V.

The amount of clay size fraction varied about 0.5 to 35 wt%. The constituent clay minerals were illite, illite-smectite mixed layer minerals (smectite), illite-chlorite mixed layer minerals, chlorite, vermiculite, and kaolin minerals. The main clay minerals were illite and kaolinite that account for about 70-90 wt% of clay sample. The other clay minerals were very rare, and especially smectite was not more than 3 wt% of the sediment. The variation of the clay amount tended to correlate with that of the illite content and the illite crystallinity but inversely with that of the kaolin mineral content. Therefore, it is suggested that the weathering of parent minerals (e.g., micas, feldspars) formed not smectite but kaolinite through illitic minerals.

The variation of the illite crystallinity index for the upper part of the RB core are in harmony with the pollen analysis results of the same samples. The increasing hydrolysis condition expected from the results of the illite crystallinity index corresponds to the pollen zone in which some pollen as warm and wet climate indicators increase, while the decreasing hydrolysis condition corresponded to the pollen zone showing the increase of pollen as cold and dry climate indicators.

Calcite was sporadically detected in laminite in the RB core, as not detritus but authegenic mineral precipitated in lake water. Judging from the results of the clay and pollen analyses of the RB core, the periods of calcite formation correspond to dry and cold climate. Similar results have been reported by the XRD study for other cores (e.g., JW-3). Such authegenic calcite plays not only an important indicator of dry and cold climate but also a key mineral in correlation between (core) sediments of the Kathmandu Basin.