MAGNETOSTRATIGRAPHY OF PLIO-PLEISTOCENE LACUSTRINE DEPOSITS IN THE KATHMANDU VALLEY, CENTRAL NEPAL

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The basin filling deposits in the Kathmandu Valley are categorised into three groups: the older, middle, and younger stages deposits. The older stage deposits, the Lukundol Formation, range from the Gauss Chron to the early Brunhes Chron in age (Late Pliocene to early Middle Pleistocene). The middle and younger stages deposits were formed during the Brunhes Chron (<730Kyr). The horizon of Plio-Pleistocene boundary (the upper age limit of the Olduvai Subchron) was detected in the Member IV of the Lukundol Formation based on palaeomagnetic and palaeontological data. The Plio-Pleistocene boundary is coeval with climatic deterioration which corresponds to a cold phase already observed in the Kashmir Valley, western Himalaya.

Key Words: Kathmandu; Intermontane Basin; Plio-Pleistocene Boundary; Palaeomagnetism

INTRODUCTION

The Kathmandu Valley is one of the biggest intermontane basins in the Lesser Himalaya. It is circular in shape occupying an area of 340km² with an average altitude of 1,300m. The basin is filled by thick semi-consolidated terrestrial deposits which unconformably overlie the Precambrian-Paleozoic Kathmandu Complex. The maximum thickness of the deposits exceeds 500m.

The basin filling deposits have been considered as an equivalent of the Siwalik sediments by various researchers. However, a detailed chronological setting is not clear. In this paper, we will show the chronological framework of these deposits and discuss the Plio-Pleistocene boundary on the basis of palaeomagnetic data. Simultaneously, a palynological study was carried out by Igarashi et al. (this volume).

GEOLGY

According to the data by Yoshida and Igarashi and the present study, the basin filling deposits in the Kathmandu Valley can be categorized into three groups: the older stage deposits (Lukundol Formation), the middle stage deposits (Pyanggaon, Chapagaon; and Boregaon terrace deposits), and the younger stage deposits (Gokarna, Thimi, and Patan Formations) (Fig. 1).

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The Older Stage Deposits (Lukundol Formation)

The Lukundol Formation is exposed in the southern area of the valley and builds hilly landform (Fig. 2). The highest altitude of the distribution reaches around 1,550 m above the sea level. The formation consists of fluvial gravels and lacustrine sediments such as silt, fine sand, and lignite. Fluvial facies are dominant in the southern margin of the Kathmandu Valley. On the other hand, lacustrine facies prevail toward the center of the valley. At the type locality, in the vicinity of Lukundol village, seven sedimentary cycles of upward fining sediments can be observed, which are named as Members I to VII from the bottom to the top (Plate I). Furthermore, a large scale upward coarsening sequence is also recognized in the formation. Total thickness of the exposed section is more than 200 meters. The formation, however, may have larger extension in the subsurface at the central part of the valley (Fig. 1). The formation is slightly inclined towards the northeast.

A large number of vertebrate fossils were discovered in the lower part of the Lukundol Formation (Members II to IV). The fossil fauna found are *Elephas planifrons*, *Stegodon ganesa*, *Hexaprotodon sivalensis*, *Elephas hysudricus*, and *Crocodylus* sp. 

The Middle Stage Deposits

The middle stage deposits, Pyanggaon, Chapagaon, and Boregaon terrace deposits, unconformably overlie the Lukundol Formation. They are distributed only in the southern margin of the valley (Fig. 2). The deposits are mostly composed of rounded gravels which were derived from the southern mountainous range. The gravels are more or less weathered and they are covered by red soil caps.

The Younger Stage Deposits

The Gokarna, Thimi, and Patan Formations are distributed in the central and northern area of the valley (Fig. 2). They consist of lacustrine sediments such as
silt and clay with frequent intercalations of peat layers. Their fill-top surfaces occupy widely developed lacustrine terrace-plains. The chronological position of the younger stage deposits is correlated with the Last Glacial Age. The radiocarbon ages obtained from the Gokarna and Thimi Formations range from 30 to 20Kyr B.P., and the Patan Formation from 20 to 10Kyr B.P.²

**Magnetic Polarity Stratigraphy**

Palaeomagnetic measurements were carried out on the samples from 51 sites collected from four sections of the Lukundol Formation, distributed along the Khahare Khola river near the Lukundol village (Figs. 2, 3). The palaeomagnetic measurement procedure is the same as mentioned by Yoshida and Igarashi.² The polarity of each site identified by the remanent magnetization after a.f. demagnetization treatment is shown in Fig. 4. The peak field was selected as 200–300 Oe according to the results of progressive demagnetization analysis².

Three magnetic-polarity zones are recognized within the Lukundol Formation of the surveyed area. They are named as the magnetozones K1, K2, and K3 from the top downward. The magnetzone K3 is recognized as having a long interval of normal polarity with a basal intercalation of reversed polarity subzone. The stratigraphic position of magnetzone K3 covers Member I to lower part of
**PLATE I**

*a:* A panoramic view of the exposures of the Lukundol Formation near the Lukundol village.

*b:* A distant view of the cliff constructed from conglomerates in the Member VII.

*c:* A laminated silt bed with intercalation of lignite layers in the Member IV.
Member III. The magnetozone K2, which ranges from the middle part of Member III to the Member V, exhibits mainly reverse polarity except two distinct normal polarity bands (K2a and K2b) confined in the Member IV. The Members VI and VII consist mainly of thick gravel layers. Therefore, only a few samples appropriate for palaeomagnetic measurement could be collected from these members. Only normal polarities were detected from these members. This interval is named as the magnetozone K1 (Fig. 4).

A part of the magnetozone K1 is probably correlatable with the normal polarity interval of the Lukundol Formation in the Chapagaon area. The younger stage deposits exhibit normal polarity. No reverse polarity was detected above the Lukundol Formation.

DISCUSSION

The assemblage of the Lukundol fauna corresponds to the Pinjor faunal zone in the Indian Siwaliks and also the *Elephas planifrons* interval zone in the Pakistan Siwaliks. These biostratigraphic zones range from the Gauss Chron to the Matuyama Chron. Moreover, the Pinjor type fauna disappeared after the Jaramillo Subchron. In the surveyed area, the Lukundol fauna has not been found above the Member IV. Accordingly, the magnetozones K3 and K2 can be safely correlated with the Gauss and Matuyama Chrons, respectively. The two normal polarity subzones found in the magnetozone K2 may be correlated to the Olduvai and Jaramillo Subchrons (K2b and K2a). The magnetozone K1 is probably assignable to Brunhes Chron. Thus it is concluded that the horizon of Plio-Pleistocene boundary corresponds to the middle part of the Member.
IV, which is observed in the silt bed, 25m below the base of the Member V at the section C (Figs. 3 and 4).

Depending on the correlation between the local magnetic polarity stratigraphy and the palaeomagnetic time scale, the sedimentation rate of the Lukundol Formation can be estimated to be 0.2–2 cm/100 yr, with an average of 0.7 cm/100 yr (Fig. 5).

A distinct climatic deterioration was estimated on the basis of palynological work. The age of this deterioration was correlated with the K2b (= Olduvai Subchron). Based on the palaeoclimatic studies of the Upper Pliocene Hirpur sequence of the Kashmir Kurewa sediments a subtropical to temperate palaeoclimate of the Kashmir basin during the Late Pliocene time turns to cold
Fig 5 Comparison of the magnetic-polarity stratigraphy of the Lukundol Formation with the Mankinen and Dalrymple (1979) time scale. The slope of solid line is directly proportional to sedimentation rate. The broken line shows the average trend.

one ("glaciation") at the depositional time of the upper-most part of the Hirpur sequence. The age was estimated to be the Olduvai Subchron by the palaeomagnetic and radiometric methods. The cold phase in Kashmir Valley\textsuperscript{12} is in accordance with the age of the climatic deterioration detected in the Member IV of the Lukunol Formation.

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