

Origin Of The Quaternary Deposits Of Nepal And Their Neotectonic Significance

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Introduction

The earth is at unrest. This fact is very well seen in the various orogenic belts of the earth. The Himalaya, fringing the northern part of the Indian peninsula, is one of the youngest orogenic belts of the world. Conspicuous level changes, gradual as well as abrupt, during the early and recent times is imprinted in the various landforms of this dynamic portion of the earth's crust. The earlier events of the Himalayan orogeny, that started sometime during the Cretaceous and attained maximum intensity during Miocene to Pleistocene periods, is preserved in the structural features and sediments deposited during this interval. The later and more recent events are best revealed in the vast network of intermontane valley fill deposits and fan deposits skirting the SE-NW running mountain fronts of the Sub-Himalaya. The various rivers, cutting the Himalayan trend transversely, have given rise to a series of terraces on these intermontane valley-fill deposits; the fan deposits have been dissected and segmented. Thus Quaternary deposits of Himalaya not only bear a tectonic history, but in the mean time reveal the various evidences of the more recent disturbances of the earth's crust in their landforms.

A systematic study of the various Quaternary deposits and the diverse landforms sculptured on them are of great significance in evaluating the relationship between tectonism and geomorphology. The Quaternary deposits of Himalaya, not only point to the geomorphic activity, but also are the measure of the nature and the intensity of neotectonic processes.

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Most of the geoscientists who worked in the Nepal Himalaya, devoted much of their time in the hard rock geology.¹ Only recently, Quaternary deposits are being investigated to reveal the neotectonism of this Himalayan belt. Very little has been understood about the nature of the Quaternary deposits and their geomorphological features. A vast tract of the Himalayan Quaternary deposits are still unexplored and those explored are also subject to controversies. The present author during the course of his study, has come across complexly terraced valley-fill deposits in tectonic depression and along the principal river courses of central Midlands of Nepal. Similar Quaternary deposits have been mentioned in the literature from both the eastern the western part of the country. However, an unifying study of the various causes of the formation and subsequent dissection of these vast tract of the Quaternary deposits is still awaited. This paper is an attempt towards this direction.

Distribution Of The Quaternary Deposits In Nepal

Excluding the Gangetic alluvium, the Quaternary deposits of Nepal can be grouped into three distinct classes following the orographic and tectonostratigraphic divisions of Himalaya as under.

1. Sub-Himalayan Quaternary and Recent deposits,
2. Lesser Himalayan Quaternary and Recent deposits, and
3. Greater Himalayan and Tethysian Quaternary and Recent deposits.

1. Sub-Himalayan Quaternary and Recent deposits.

Depending upon the nature and position of the Quaternary of the deposits; the Sub-Himalayan Quaternary deposits can be described in sub-headings namely the Bhabar and Dun Valley deposits.

1. P. Bordet, *Recherches géologiques dans l'Himalaya du Nepal, région du Makalu*, (Paris : Edit. Cent. Nat. Rech. Scie., 1961), p. 275; G. Fuchs and W. Frank, "The geology of the west Nepal between the rivers Kali Gandaki and Thulo Bheri", *Jahrbuch der Geol.* Vol 18 (1970), p. 103; T. Hagen, "Reports on geological survey of Nepal", *Denskschriften der Schweiz. Naturf. Ges.*, Vol. 1 (1969), pp. 185; Hashimoto et. al. (Ed.), *The Geology of Nepal Himalaya* (Japan: Him. Commit. Hokkaido Univ., 1973), p. 292; V. A. Talalov, "Geology and ores of Nepal", (unpublished report to Nepal geological Survey, 1972, Kathmandu).

(a) Bhaber deposits : At the southern foot-hills of Siwaliks, Quaternary and Recent deposits form a more or less continuous belt called Bhaber. The deposits have a prominent development in the regions where the major south-plunging rivers emerge to Gangatic plain without any interruption by the Sub-Himalayan barrier i. e. Siwalik hills. The excellent example is that of Dharan. In Dharan, the deposits extend for 50 km along the mountain front, east of Sapta Kosi. It has a thickness of more than 300 m.

The Bhaber deposit mainly comprises the loose heterogeneous unstratified mixtures of boulders, cobbles and pebbles of various descriptions; materials exclusively derived from the Siwaliks and Lesser Himalaya. These are the talus deposits resembling alluvial fans or dry deltas.

(b) Dun Valley deposits: This is another prominent deposit of the Sub-Himalayas of Nepal. In areas with two Siwalik ranges, they generally do not have a parallel strike, but converge and diverge.² Thus spaces are left for wide valleys between the two Siwalik ranges, which are called Duns. The largest Duns are from west to east: Jogbura, Surkhet, Dang, Rapti, Nawalpur, Chitwan, Kamala Khonch, Trijuga and Kankai.

These valleys have been filled by the various streams descending to the valley from adjoining ridges. The deposit comprises loosely compacted, somewhat coarser gravels derived from the nearby areas. Singly and in groups towards the centre of the Dun Valleys, the deposits are relatively finer. Crude stratification at places are not infrequent. In general Dun deposits are the valley fill deposits similar to those of intermontane basin. Nature of the deposits vary from mountain wash to alluvial fan at the centre to mountain talus or fan towards the fringe of the valley.

2. Lesser Himalayan Quaternary to Recent deposits :

After crossing the Mahabharat Range (3000 m), on the northern side, one enters into a subdued low lying hilly country (600 to 700 m) called Mustang Zone. It is in this section of the Lesser Himalaya that Quaternary and sub-recent deposits have been best developed along the transverse courses of various rivers and in the tectonic depression zones.

The principal river courses of Karnali, Gandaki and Kosi systems are characterised by a vast network of Quaternary deposits, now standing

2. Hagen, op. cit., p. 20.

as distinct terraces flanking the river. The extent of the deposits is controlled by the valley configuration and the systems of the drainage pattern. The deposits are wider and cover significant area in the regions of the confluence of two major rivers, but are much linear in their distribution in the regions where no major rivers join them. Characteristically, the Quaternary deposits in these transverse river courses are confined only in the section between Mahabharat Range in the south and Greater Himalaya in the north. Such a distribution to the Quaternary deposits is of considerable importance.

The Quaternary and Recent deposits of the midland valleys of Nepal amount to hundreds of metres in thickness. The deposits in the Kali Gandaki, Seti Gandaki and other tributaries of the Gandaki system comprise compact, consolidated unstratified to weakly stratified heterogenous mixtures of boulders, pebbles and their fines held together by the impure calcareous cementing material. Similar characteristics of the gravel deposits have been described by Williams for the gravel deposits of Kosi river at Tumlingtar.³ In the Kali Gandaki and Seti Gandaki gravels, a large part of the boulders and pebbles are made up of the Central crystalline gneisses, Dhaulagiri and Nilgiri limestones, granites, schists of various descriptions and quartzites. It is very interesting to note that all the mentioned rock types are not seen in the adjoining areas, but have been derived from the region lying far to the north; only a small fraction of the gravel material is derived from the adjacent areas. Equally surprising is the rolled to rounded nature of the constituent boulders of the gravels.

The other worth-mentioning feature of the gravel deposits is a general decrease in the grain size of the gravel constituents from north to south. In the Kali Gandaki valley, there is a gradual increase in the grain size in the vertical section, from top towards the bottom. However, in Seti Gandaki such a distribution is not seen. Interestingly, they show crude alternating layers of coarser and finer gravelly materials, repeating at least three to four times. The lateral extent of such alternating layer is, however, doubtful.

Unlike Kali Gandaki gravel resting directly on the rocky beds, Seti

3 V. S. Williams, "Neotectonic implication of the alluvial record in the Sapta Kosi drainage basin; Nepalese Himalaya", (Unpublished Ph. D. dissertation submitted to the University of Washington, 1977), p. 80.

Gandaki gravel is resting over 2 to 4 m thick alluvial to lacustrine soil (near the confluence of Seti Gandaki and Phurse Khola). Irrespective of minor differences, there is a homogeneity in the gravel constituents in the north-south section within a depositional valley. There is also certain degree of similarity in the gravel constituents of the nearby valleys. But it should be remembered that the gravelly materials of the different valleys could be of diverse nature depending upon the tectonic setting and the processes of degradation involved.

Besides these river valley-fill Quaternary to Recent deposits of gravelly nature, there are purely lacustrine and fine alluvial type of deposits, amounting hundreds of metres in thicknesses, in the tectonic depression zones of the Lesser Himalaya of Nepal. The deposits of the Kathmandu valley, Tila valley, Darondi valley, and Diplang, west of Gurkha, are examples.⁴ These deposits of the tectonic depression zones are also situated in front of the southern barrier-Mahabharat Range, a tectonic situation similar to the river valley-fill deposits of Lesser Himalaya.

The deposits of Kathmandu comprises an alternation of black clay (locally called Kalimati), silt and sand with thin lenses of lignites. These rest over the basal boulder beds. The deposits are covered by the mountain wash sand and silt at the centre and unconsolidated fan gravels along the fringes of the valley. The total thickness of the Kathmandu valley fill exceeds more than 450 m. The study of the deposits reveal that even the deposits of the tectonic depression zones were localised in the valleys of the small streams. The fluvialite basal boulder beds of the Kathmandu valley are the unmistakable proofs of the existence of a stream prior to the formation of the lake.

3. Greater Himalayan and Tethysian Quaternary and Recent deposits:

Thakkhola basin caused by the huge transverse structure, is filled by Tertiary and especially Pleistocene formations of extraordinary thickness. It consists of lake deposits clays sandstones, and marls with varves and are superposed by large formations of boulder beds.⁵ Analogous lake deposits are found in most of the other transverse valleys north of the main range for example in the Langu basin, in the Manag valley, in the Buri Gandaki valley, north of Manasalu and Ganesh group, in the upper course of Trisuli, the

4. Hagen, *op. cit.*, pp. 142-143.

5. *Ibid.*, pp. 140-142.; Bordet, *op. cit.*

basin of Kyirong Dzong and in the upper course of Arun river.⁶

Besides these lakes and river gravel deposits, the Quaternary and recent deposits of the Pleistocene and Recent glaciers are found all along the southern and northern valleys of Greater Himalaya. The morainic deposits in the southern slopes of the Greater Himalaya are reported to occur only above 3000 m.⁷

Origin And Age

In order to understand the true nature and origin of the Quaternary deposits of Nepal, the following features have to be kept in mind.

1. A remarkable tectonic situation of the Quaternary deposits, confined only along certain tectonic belts.
2. Similar lithological characters of the Quaternary deposits confined within one tectonic belt.
3. Most of the Quaternary depositional basins are confined in the major and minor river valleys; some of the Sub-Himalayan and Greater Himalayan deposits are exceptional to the rule.

The above mentioned characters of the Quaternary deposits of Nepal Himalaya suggest a tectonic phenomenon. The present author feels that the tectonic disturbances during the final phase of the Himalayan upheaval were responsible in giving rise to the diverse Quaternary deposits of the Nepal Himalaya. The deposits are obviously controlled by the then existing drainage pattern. Hence to frame the Quaternary deposits of Nepal in the regional set up one has to turn the pages of the sequential history of Himalayan upheaval and their relation to the development and evolution of the drainage pattern of Nepal Himalaya. The study of the different stages of Himalayan evolution is beyond the scope of this paper. However, a tentative picture of the final stage of Himalayan movements will be discussed keeping in mind their relationship with the evolution of drainage pattern and ultimately the processes leading to the deposition of the Quaternary sediments.

6. Hagen, *op. cit.*, p. 142.

7. *Ibid.*, p. 135

The principal river system of Nepal exhibits a pattern pointing to their evolution in four stages, each characterising a period of uplift. The Kali Gandaki, Trisuli and Arun-Kosi rivers, of Gandaki and Kosi system, originate from beyond the Tibetan Marginal Range (i. e. the main watershed between the Ganges and Tsangpo rivers). These rivers obviously the oldest and predating the Himalaya, cross through the deep narrow gorges and flow due south across the Midlands. Then there are rivers like Humla Karnali, Mugu Karnali, Seti, and Bheri of Karnali system; Marsyangdi and Buri Gandaki of Gandaki system and Sun Kosi, Tama Kosi Dudh Kosi and Tamur Kosi of Kosi system, that originate on the southern slope of the Tibetan Marginal Range, cross the Higher Himalayan Ranges and flow southward. These rivers though predating the main Himalayan uplift, originated during the rise of Tibetan Marginal Range. On the other hand there are some principal tributaries like Tila of Karnali system; Modi, Seti, Madi, and Chepe of Gandaki system and some prominent tributaries of Kosi system, all point to their origin during the rise of the Greater Himalaya as these appear on the southern slope of the highest hill ranges. These rivers do not form conspicuous gorges like those of the rivers originating in Tibetan Marginal Range and beyond, and also they follow south, southeasterly and southwesterly courses. Till this stage of the Himalayan upheaval, which started first in the north and shifted gradually towards the south, all the Himalayan rivers were flowing directly due south emptying themselves in the Himalayan fore-deep, later to give rise to the Siwalik Ranges.⁸

Rivers originating in the Tibetan Marginal Range and beyond were maintaining their southerly course, which can be seen in their present antecedent relationship with the Greater Himalaya. However, the Tertiary and Pleistocene deposits in the transverse course of Kali Gandaki, Marsyangdi, Trisuli, and Arun Kosi, to the north of the Greater Himalayan Range amply suggest that the rivers were blocked by the rising Greater Himalaya (or in other words, the original river courses are deformed forming depositional basins). The various rivers, though these did not change their courses, have formed lakes at the northern foot hills of the Greater Himalaya. It is in this period that the Greater Himalayan and Tethysian Quaternary deposits have been formed. Lower Tertiary and Pleistocene age is assigned to these deposits by Hagen. It is likely that, lakes thus formed to the

8. Ibid., p. 150.

north of the Greater Himalaya were maintained for long periods during the other successive stages of the Himalayan upheaval.

In the next stage, the relative rise of the Mahabharat Range to the south of the Greater Himalaya brought a drastic change in the then existing drainage pattern. This rise of the mountain range, not only deformed and dammed the original river courses, but also deflected the rivers from east to west in front of the range. It is during this period that the various rivers so far flowing independently due south in the Himalayan fore-deep joined each other in front of the Mahabharat Range. Thus three main drainage system of Nepal Himalaya—Karnali system in the west, Gandaki system in the centre and Kosi system in the east were established. It is also in this period that the midland zone came into existence.⁹

This rise of the Mahabharat Range is also responsible for the formation of various tectonic depression zones and the drowning of the various river valleys of Lesser Himalaya. It is in this period that the Quaternary deposits were deposited in the tectonic depression zones and in the various deformed river valleys of Karnali, Gandaki and Kosi systems. Similar origin of the Lesser Himalayan Quaternary deposits have been envisaged by Hagen, Gurung, Williams, and Sharma et. al.¹⁰

The rise of the Mahabharat Range is thought to be a late Pleistocene event.¹¹ Hagen has shown that the Late Pleistocene Upper Siwalik conglomerates form wide belts only in the regions of supposed prolongations of the various rivers in front of the Mahabharat Range, while such deposits are completely missing in the regions where the present Karnali, Gandaki and Kosi systems meet the southern Siwalik belt. According to Hagen, the Upper Siwalik conglomerates were deposited as alluvial fans in front of the various rivers prior to the uplift of the Mahabharat Range. The

9. Ibid., p 150.

10. Ibid., p. 150; H. Gurung, "Geomorphology of the Pokhara Valley", *The Himalayan Review*, Vol. 2-3 (1970), pp. 29-49; V. S. Williams, op. cit; T. Sharma, ; B. N. Upreti, and N. M. Vashi, "Kali Gandaki gravel deposits of central west Nepal—their neotectonic significance", *Tectonophysics*, Vol. 62 (1980).

11. Ibid.

findings of the vertebrate fossils from the lower part of the Kathmandu sediments also support the Late Pleistocene age of the rise of the Mahabharat Range and the initiation of the deposition of the various valley fill deposits of Lesser Himalaya. The fauna are identical to that described for the Upper Kerwa formation of Kashmir and Pinjaur formation of the Siwalik.¹²

Thick heterogenous mixture of gravels with big boulders of the crystallines and limestones of the north in the river valleys of midland has confused earlier workers (Wegner, Gurung, and Hagen). The nature of the deposits so far observed can not be explained by the simple mechanism of alluvial processes. The author in his earlier paper has discussed the problem in detail.¹³ He had come to the conclusion that the rapidly melting glaciers of the Higher Himalaya in the Late Pleistocene period, which accidentally coincided with the drowing of the river valleys, provided the bulk of water that carried huge quantities of morainic and other glacial materials of the north. The steep north-south gradient helped the accumulation of the fluvio-glacial sediments. Considerable non-glacial material (mainly fluvialite, scree etc) was also added by various tributaries draining the adjacent midland areas. A similar concept is also seen in the work of Gurung.

Deposits of the tectonic depression zone, especially that of Kathmandu, is purely lacustrine in nature. According to Boesch, the lake of Kathmandu was not a deep clear mountain lake, but was amphibious and swampy.¹⁴ These deposits differ with the other valley fill deposits of the midlands even though they are related to the same tectonic episode. This difference resulted from the difference in the tectonic, geomorphic processes. To the present author the nature of the debris of the Quaternary deposits of the midlands is dependent on whether the material came from the snow fed rivers of the north or was contributed by the various smaller streams draining the midland areas all around. To the former category belong the gravelly

12. V. J. Gupta "On the stratigraphic position of the Kathmandu valley sediments, Nepal", *Geogra Helv.*, V. 30 (1975), pp 27-28

13. Sharma, Upreti, and Vashi, op. cit.

14. Hans Boesch, "Investigation on morphogenesis in the Kathmandu Valley; Untersuchungen zur Morphogenese in Kathmandu Valley", *Geogr. Helv.*, Vol. 29 (1974), pp. 15-26, (translated for the U. S. Geological Survey by Dorothy B. Vilalane, December, 1977).

deposits of the various river valleys of Karnali, Gandaki and Kosi systems and to the later belong the deposits of Kathmandu and other alleid valleys.

However, lacustrine to alluvial deposits are encountered at the basal portion of the gravels in the snow fed rivers of Seti Gandaki, Tila Karnali etc. It is assumed that considerable time gap existed between the actual processes of filling the river valleys by fluvioglacial agencies and the rise of the Mahabharat Range. Lacustrine and alluvial deposition are supposed to have predated the processes of fluvioglacial aggradation.

The rise of the Mahabharat Range also initiated another groups of drainage channels. Various streams originated from the southern slopes of the Mahabharat Range. Immediately after the rise of the Mahabharat Range, the rocks of the Himalayan fore-deep were folded, faulted, thrust and uplifted. This newly rising landmass (now called Siwaliks), because of unequal upliftment, formed various tectonic valleys called Duns. Once again a very new drainage is established in the newly emerged Siwaliks. The minor and major rivers coming from and beyond the Mahabharat Range deflected and guided by the tectonic depressions that give rise to the Dun deposits. Besides, considerable debris was also added from the newly elevated mountains in the form of the mountain talus and mountain wash.

The rise of Mahabharat and Siwalik is also responsible for the aggradation of the Bhabar deposits. In the regions where no major rivers emerge, the Bhabar deposits are very linear, but where the major rivers find their velocity checked by the Terai plain, big alluvial fans or dry deltas have been developed. This is because of their geographical situation and the lack of the presence of the active degradational and transporting agencies.

Quaternary Landforms And Their Neotectonic Significance

In the present set up, the Quaternary deposits of Sub-Himalaya, Lesser Himalaya, Greater Himalaya and Tethysian zone are subjected to copious erosional processes. The Sub-Himalayan Bhabar deposits are very intensively segmented. The Dun sediments are labouriously entrenched and eroded by the major and minor rivers flowing through them. Two to three erosional paired river terraces are developed.

Likewise, the Lesser Himalayan valley-fill deposits and debris of

the tectonic depression zones are characterised by unique terraced landforms in Kali Gandaki, Seti Gandaki,¹⁵ Kosi system¹⁶ and Karnali system¹⁷ and in Kathmandu¹⁸ three distinct terraces have been recognised. The very flat terraces alternate with the successive terrace cliffs of 15 to 200 m. Terraces stand in pairs flanking the river on either sides. Rivers are entrenched and channelised along narrow gorges. Some of the rivers like Seti Gandaki and Bagmati are still flowing on the fill materials, where as the other rivers like Kali Gandaki, Arun Kosi and other principal rivers of Gandak, Karnali and Kosi systems have just exposed the rocky beds. In such rivers lower terrace flat is of cut and fill type and are different from the terraces formed within the gravels.

The different terrace levels can be classified from their paired nature, variation in gravel composition, and the constituent grain size and from the stages of soil development on the terrace flats.

In the Quaternary deposits of Greater Himalaya and Tethysian zone also similar terraces have been formed. The terrace levels can to some extent be correlated with the terrace levels of Lesser Himalaya. The difference is only in their situation at higher altitudes and in the tectonic position.

The similarity of many of the landscape characters of the Quaternary deposits of Nepal Himalaya indirectly suggests a common cause of their sculpture and it can be explained by the prevalent neotectonic activity of the Himalaya. There are a number of evidences to suggest that the Himalaya are still rising. According to Hagen, the rise of the Mahabharat Lekh continued even after the valleys were filled and the lakes disappeared.¹⁹ Considerable northerly dip of the Quaternary deposits of Kathmandu (near Tispani) and Tila Karnali Valley north of Porpanai are attributed to such movements. To Williams, the southern post lake deposits of Kathmandu have been lifted up to an altitude of about 1450 m. indicating uplift of at least 0.08 since fill deposits began; and perhaps 0.008 occurred since the

15. Sharma, et. al., op. cit.

16. Williams, op. cit.

17. Hagen, op. cit.

18. Boesch, op. cit.

19. Hagen, op. cit., p. 150.

end of the lake deposits.²⁰ The observation of Bordet also support the continuous uplift of Himalaya; the series of rapids in the various mountaneous rivers and the processes of aggradation at the altitudes of Dolalghat along Sun Kosi river bed is the net result of such processes.²¹

The segmentation of the alluvial fans and the present day terraced topography of the Quaternary deposits of Nepal are related to this neotectonic activity of the Himalayan belt. The periodic rise of the mountains relative to the southern plain initiated the rejuvenation of the rivers and other degradational processes. As a result the fan deposits were segmented and the rivers excavated a valley within the gravel deposits themselves.

According to Williams, the segmentation of Dharan alluvial fan is because of the periodic tilting. At Dharan tilting events have occurred at least four times. He has calculated the age and average tilting rate for the tilting event 1 and 3. Tilting rate of $7.4 \cdot 10^{-7}$ years or $4.2 \pm 0.5^{\circ}/10^5$ years for the Dharan fan, $5.4 \pm 0.5^{\circ}/10^5$ years for Panburi fan and $2.1 \pm 0.3^{\circ}/10^5$ years for the Keriburi fan is suggested.²²

The terraces at three different levels in the valley fill deposits are also the result of this neotectonic activity. The terraces indicate that the rise of the mountain ranges was not continuous. Sharma et al, from the study of tributary profiles of Kali Gandaki, have concluded that in the Kali Gandaki valley at least three periods of major uplift alternated with two intervening periods of non-uplift in the Late Quaternary cycle. They further maintain that the periods of uplift were essentially oscillatory. They noticed occasional smaller terraces between the major terraces which represent the minor fluctuations with periods of relative non-uplift within the major uplift cycle. They did not visualise any major tilting of the gravel beds, but they are lifted vertically.²³ Similar observation were made by Williams in the terrace deposits of Tumlingtar. His uplift curve shows an uplift rate of 1.7 m/1000 years for the terrace deposits of Tumlingtar. The uplift occurred in three consecutive steps of 76m, 61m, and 23m.²⁴

20. Williams, op. cit., p. 61.

21. Bordet, op. cit., pp. 256-257.

22. Williams, op. cit., p. 45.

23. Sharma, et. al., op. cit.

24. Williams, op. cit., p. 47.

Such an alternation of the periods of uplift and relative quiescence are responsible for the formation of the terraces. During the periods of uplift the deposits were deeply entrenched forming high cliffs, where as in the periods of relative quiescence the lateral cutting by the rivers gave rise to flat terraces. Sharma et al (1973) shows that the formation of the lakes of Pokhara and their shrinking is also related to this neotectonic activity.²⁵

These movements are still in play today. The perfect V shaped gorges of the various rivers of Nepal Himalaya, very narrow and channelised river beds, and thrusting of the Siwalik sediments over the Terai alluvium at Petkot (west Nepal) and Kherwa (east Nepal) are the current proofs of the neotectonic activity.²⁶

Conclusion

The evolutionary history of the Quaternary deposits of Nepal points to a succession of events—each connected with the Himalayan upheaval.

The configuration of the various deposits is controlled by tectonism, paleo-drainage pattern and topographic lows. Formation of depositional basins and their filling up is related with the periodic rise of the mountain chains. The nature of the deposits depended upon the aggradational processes; tectonic setting and geographical location are the other factors that played a vital role. Subsequent dissection of the deposits into successive terraces and segments in the later periods is related to the periodic uplift of the Himalayan belt with intervening periods of quiescence. All these events are faithfully recorded in the morphology of these deposits. Thus the Quaternary deposits of Nepal provide an interesting example of diverse geomorphic processes—tectonic, climatic, depositional and erosional—that operated at different stages in the uplift of the Himalaya.



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25. T. Sharma, S. S. Merh, and N. M. Vashi, "The terraced conglomerates of Pokhara Valley, Central Nepal", Symposium on morphology and evolution of landforms, Department of Geology, University of Delhi, Dec. 22-23, 1978, pp. 226, 240.
26. Hagen, *op. cit.*, p. 108.