

STRATIGRAPHY OF THE LOWER TERTIARY ROCKS OF NEPAL HIMALAYA

N. B. Kayastha

Petroleum Exploration Project, Department of Mines & Geology
Lainchaur, Kathmandu

ABSTRACT

The Lower Tertiary rocks of Nepal Himalaya are classified under the Surkhet Group which comprises Melpani, Swat and Suntar Formations. (Paleocene - Lower Miocene). There is perfect stratigraphic harmony between Surkhet Group and underlying Metasediments of Mahabharat Group, Lesser Himalaya (Palaeozoic-Mesozoic) with an unconformity. Correlation of the Lower Tertiary rocks of Nepal, India, Pakistan, and their European and North American equivalents is tabulated (Table 2).

INTRODUCTION

Stratigraphy of the Lower Tertiary rocks of Nepal has not been studied well so far. The present work has made an effort to establish the stratigraphy of the Lower Tertiary rocks based on geological investigation around Surkhet, Jajarkot, Dang, Piuthan, Sallyan, Rolpa and Tansen areas. The Surkhet Group has rocks ranging in age from Paleocene to Lower Miocene. The upper limit of the group is always truncated by a thrust, named as Ranimatta/Dibidanda thrust. The lower limit has an unconformable contact with the different members of the Lakharpata and the Sangram Formations of the Mahabharat Group (Palaeozoic to Mesozoic). The Surkhet Group has been classified into the Melpani, Swat and Suntar Formations based on lithological and palaeontological assemblages (Tater et. al 1982). A generalised composite columnar section of Lower Tertiary rocks of the Nepal Himalaya is presented (Figure 2).

DISTRIBUTION OF OUTCROPS

The Lower Tertiary rocks (Paleocene- Lower Miocene) is well exposed at several places in Nepal Himalaya (Figure 1), however its best development has been recorded in Surkhet, Dang and Tansen area, Western Nepal. The Lower Tertiary exposures are lenticular in shape and found to extend from the sharp bent of Karnali River in the west to east of Dang valley. The repetition of Lower Tertiary rocks up to six times are noted in the Dang area on account of tight folding and thrusting. Scattered outcrops are found in Jajarkot and Sallyan areas with East- West and North- South trend along the thrust zone. Its exposure is also distributed almost continuously on the both flanks of Tansen Synclinorium. In Central and Eastern Nepal, the Lower Tertiary rocks are not exposed.

STRATIGRAPHY

A complete stratigraphic succession of the Lower Tertiary rocks of Nepal Himalaya includes the Surkhet group which comprises the Melpani, Swat and Suntar Formations (Paleocene- Lower Miocene).

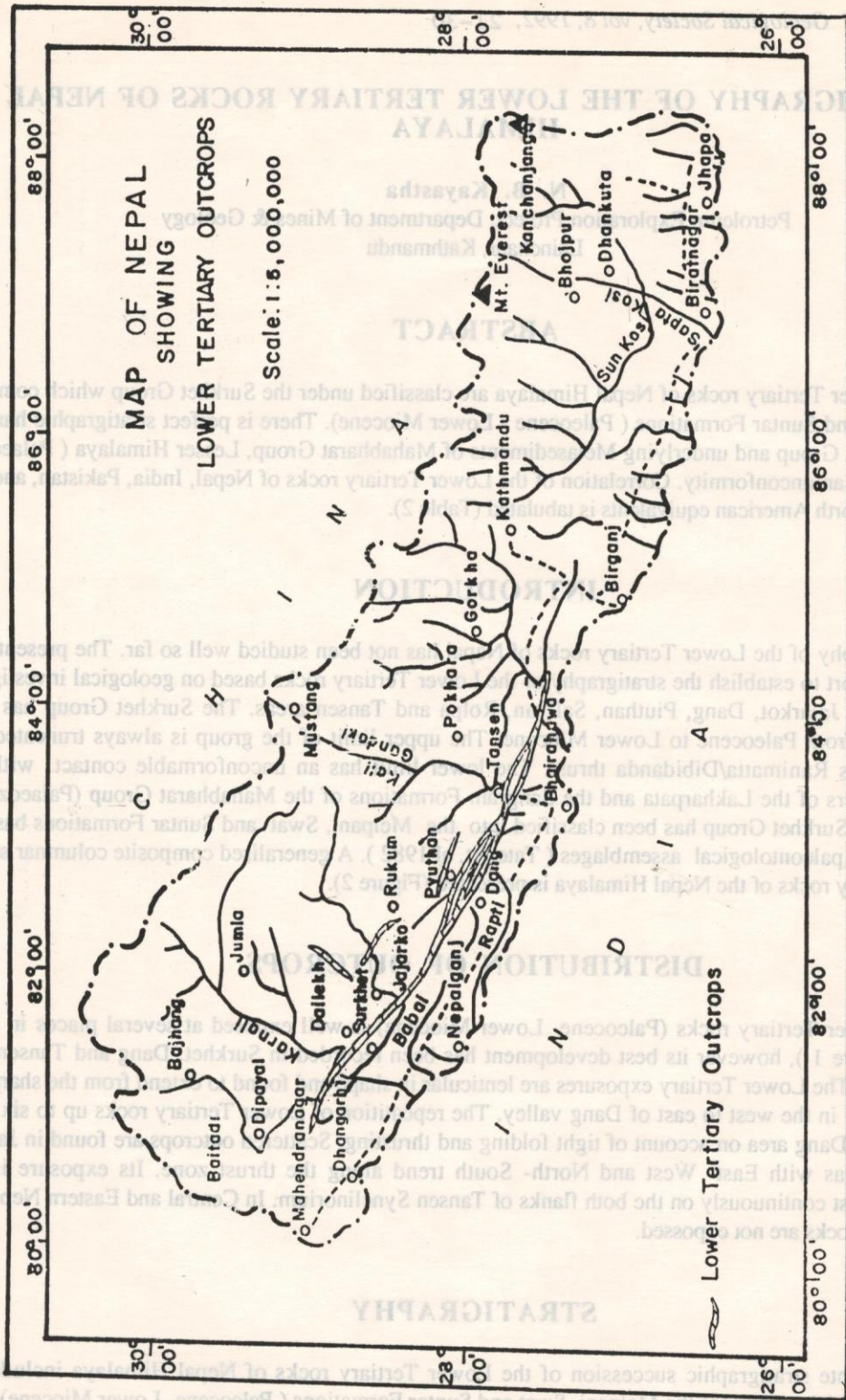


Figure 1 Map showing distribution of Lower Tertiary Rocks in Nepal Himalaya

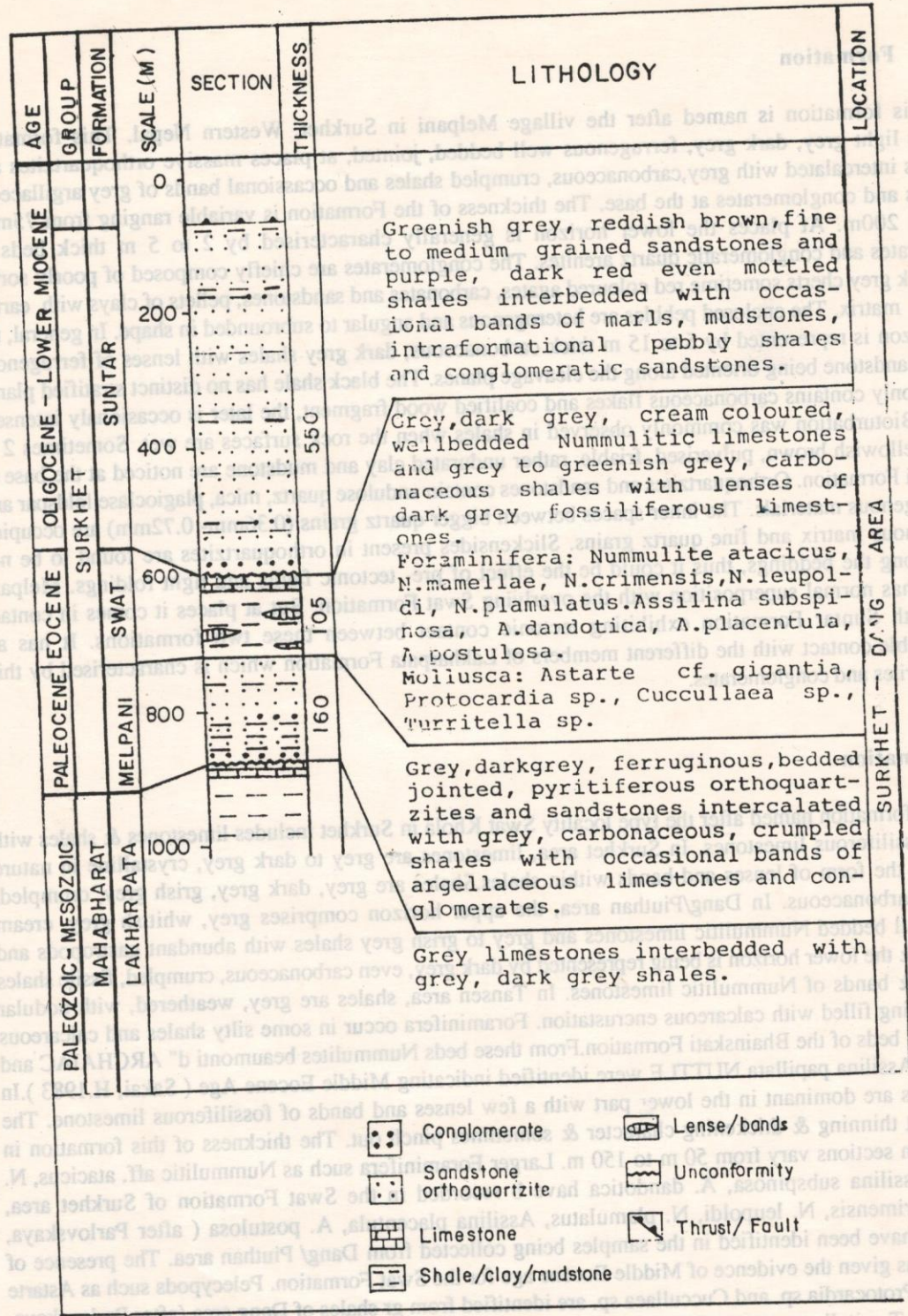


Figure 2 Generalised composite columnar section

Melpani Formation

This formation is named after the village Melpani in Surkhet, Western Nepal. This formation comprises light grey, dark grey, ferruginous well bedded, jointed, at places massive orthoquartzites and sandstones intercalated with grey, carbonaceous, crumpled shales and occasional bands of grey argillaceous limestones and conglomerates at the base. The thickness of the Formation is variable ranging from 75m to maximum 200m. At places the lower horizon is generally characterised by 2 to 5 m thick beds of conglomerates and conglomeratic quartz arenites. The conglomerates are chiefly composed of poorly sorted grey to dark grey cherts sometime red coloured agates, carbonates and sandstones, pellets of clays with earthy calcareous matrix. The enclosed pebbles are heterogenous and angular to subrounded in shape. In general, the lower horizon is represented by 5 to 15 m thick carbonaceous, dark grey shales with lenses of ferruginous quartzose sandstone being oriented along the cleavage planes. The black shale has no distinct stratified planes and commonly contains carbonaceous flakes and coalified wood fragment, the later is occasionally intensely pyritized. Bioturbation was commonly observed in shales when the rock surfaces are wet. Sometimes 2 to 5m. thick yellowish brown, pulverised, friable, rather undurated clay and mudstone are noticed at the base of the Melpani Formation. Orthoquartzites and sandstones contain undulose quartz, mica, plagioclase feldspar and some ferruginous materials. The inner spaces between bigger quartz grains (0.36mm- 0.72mm) are occupied by ferruginous matrix and fine quartz grains. Slickensides present in orthoquartzites are found to be not oriented along the beddings, thus it could be the effect of pre- tectonic faults and tight foldings. Melpani Formation has normal superposition with the overlying Swat Formation. But at places it comes in contact directly with Suntar Formation exhibiting tectonic contact between these two formations. It has an unconformable contact with the different members of Lakharpata Formation which is characterised by thin layer of laterites and conglomerates.

Swat Formation

This formation named after the type locality Swat Khola in Surkhet includes limestones & shales with lenses of fossiliferous limestones. In Surkhet area, limestones are grey to dark grey, crystalline in nature occurring in the form of lenses and bands within shales. Shales are grey, dark grey, grish grey, crumpled, sometimes carbonaceous. In Dang/Piuthan area, the upper horizon comprises grey, whitish grey, cream coloured, well bedded Nummulitic limestones and grey to grish grey shales with abundant gastropods and pelecypods, & the lower horizon is being represented by dark grey, even carbonaceous, crumpled, fissile shales with lenses & bands of Nummulitic limestones. In Tansen area, shales are grey, weathered, with nodular characters being filled with calcareous encrustation. Foraminifera occur in some silty shales and calcareous concretionary beds of the Bhainskati Formation. From these beds Nummulites beaumonti d' ARCHAIC and HEIME and Assilina papillata NUTTLE were identified indicating Middle Eocene Age (Sakai, H.1983). In general shales are dominant in the lower part with a few lenses and bands of fossiliferous limestone. The shales exhibit thinning & thickening character & sometimes pinch out. The thickness of this formation in various stream sections vary from 50 m to 150 m. Larger Foraminifera such as Nummulitic aff. ataticus, N. mamellae, Assilina subspinoso, A. dandotica have b recorded in the Swat Formation of Surkhet area, Nummulite crimensis, N. leupoldi, N. plamulatus, Assilina placentula, A. postulosa (after Parlovskaya, 1981 USSR) have been identified in the samples being collected from Dang/ Piuthan area. The presence of such fossils has given the evidence of Middle Eocene age for the Swat Formation. Pelecypods such as Astarte cf. gigantea, Protocardia sp. and Cuccullaea sp. are identified from gr shales of Dang area (after Parlovskaya, 1981, USSR). Turritella sp. are well noticed in Surkhet as well as in Tansen area. The Chinese Petroleum Investigation Team (CPIT, 1973) has identified the following fossils from the Surkhet area :

Foraminifera - Nummulites aff. ataticus Leymerie, N. cf. mamille (Fichtel and Moll), Assilina spinosa Davies, A. subspinosa Davies, A. laminosa Gill.

Bivalvia - Cordiopsis cf. incassata Sowerby, Cordiopsis sp., Euphenax aff. jamaicensis (Trechmann), Septifer cf. denticulatus (Lamarck), Tellina sp., Dimya aff. deshaysiana Rouault, Oatrea (? Flemingostrea) cf. flemingi d" Archiac and Haime, Botula sp., Corbula cf. daltoni Cotter, Cardita mutabilis d" Archiac and Haime.

Gastropoda - Limacina cf. pseudopyamaea Eames, Volutilithes sp., Turritella cf. hollandi Crossmann and Pissarro. These fossils indicate the age ranging from Middle Eocene to Upper Eocene. The contact with the overlying Suntar Formation has a distinct erosion surface and an abrupt change of lithofacies. At places Swat Formation shows sheared carbonaceous materials at the base suggesting the contact betw Swat and Melpani a tectonic one.

Suntar Formation

The Suntar Formation is named after the Suntar Khola in Surkhet which comprises alternate sequence of sandstones and shales intercalated with marl bands. Sandstones are generally grish grey and reddish brown in colour. They are hard, fine to medium grained while the shales are purple in colour. Generally, sandstones have rounded to subrounded, well sorted detrital quartz cemented in sericite and argillaceous matrix. Sandstones are highly fractured and jointed. Some beds of sandstones exhibit wedge- shaped cross bedding but those as much as a few metres thick are generally massive and scarcely has stratification planes. Ripple marks are recognized on the surface of the bedded sandstones. There are also intraformational shale pebble conglomerate and conglomeratic sandstones at the basal part of the sandstone beds. Bioturbation is common in shales and is easily recognised by mottled structures or sineous tubes. The individual bed of sandstone varies from 15m. to 20m., where as shales differ from 5 m. to 10 m. Within purple shales, reddish brown coloured marl bands and lenses are frequently encountered in Surkhet, Dang/ Piuthan, and Tansen areas. The maximum thickness of this formation varies from 150 m. to 775 m. However, the true thickness is not known since its upper limit is always truncated by a longitudinal thrust termed as Ranimatta/ Dubidanda Thrust (Table 1) in the type locality of the Surkhet /Dang areas, Western Nepal. The Suntar Formation is devoid of fossils with exception of fucoid markings and traces of worm burrows. Its lower contact with the underlying Swat Formation has an unconformity due to contrast lithology and erosion surface.

GEOLOGICAL SETTING

The tectonic set up of the Lower Tertiary rock of Nepal Himalaya is presented in the Table-1. A transect from south to north shows the following tectonic elements:

1. Indo-Gangetic Plain (Terai)

The Indo- Gangetic Plain is the fore- land of the Himalaya. It occupies a broad area that stretches from the Siwalik Fold Belt in the north to Indian Shield in the south. Most of the basin lies in India, the portion falling within Nepal is termed as the Terai.

Table 1 TECTONIC SET UP OF THE LOWER TERTIARY ROCKS OF NEPAL

| South | Tectonic set up |
|------------------------------|----------------------------------|
| I. Gangaic Plain (Tarai) | Alluvium |
| ----- | Main Frontal Thrust (MFT) ----- |
| II. Autochthon Siwalik Group | Upper Siwalik |
| exposing the Upper Tertiary | Middle Siwalik |
| sediments in the southern | Lower Siwalik |
| foot hills. | |
| ----- | Main Boundary Thrust (MBT) ----- |
| III. Para-autochthon Surkhet | Suntar Formation |
| Group exposing the Lower | ----- Unconformity ----- |
| Tertiary sediments with a | Swat Formation |
| disconformity over the | Melpani Formation |
| Metasediments of Mahabharat | |
| Group. | ----- Unconformity ----- |
| | L |
| | A |
| | K |
| | H |
| Mahabharat Group of Lesser | A Fm. |
| Himalayas | R |
| | P |
| | A |
| | T |
| | A |
| | ----- |
| | Sangram Formation |
| ----- | Mahabharat Thrust ----- |
| IV. Allochthon Midland Group | Ranimatta /Dubid- |
| of Lesser Himalayas | anda Formation |
| exposing metamorphic rocks. | |

2. Sub- Himalaya

The Sub- Himalaya is termed as Churia Range in Nepal, rises abruptly from the Terai along the Main Frontal Thrust (MFT) and forms a series of ridges and valleys that are composed of thick beds of north dipping rocks (Siwaliks) which are thrust and repeatedly folded. The Main Frontal Thrust (MFT) separates the Siwaliks from the Gangetic Plain (Terai) and forms the southern tectonic limit, while the Main Boundary Thrust (MBT) marks the northern boundary.

3. Lesser Himalaya

The Lesser Himalaya is wide, geologically complex zone that lies immediately north of the Siwalik fold belt above the MBT and south of the Main Central Thrust (MCT) or the Higher Himalaya. This zone includes Lower Tertiary sediments of Para- autochthon Surkhet Group, the metasediments of Mahabharat Group and the low grade metamorphic rocks of Midland Group. The major rocks in the Midland include low grade metamorphics and basic igneous rocks of Proterozoic to Palaeozoic age. Ranimatta/ Dubidanda thrust usually separates the Midland Group with the metasediments of the Mahabharat Group. The Lower Tertiary sediments lie unconformably over the Lakharpata/ Sangram Formations of Mahabharat Group.

DEPOSITIONAL ENVIRONMENT

The sediments of Surkhet Group are represented by unfossiliferous Suntar, fossiliferous Swat and Melpani Formations. These sediments lie unconformably over metasediments of the Mahabharat Group are affected by the Ranimatta thrust which has exposed low grade metamorphic rocks such as phyllites, quartzites and basic intrusives. Melpani Formation is composed of grey, dark grey, ferruginous orthoquartzites and sandstones intercalated with grey, carbonaceous shales. The ferruginous nature of the orthoquartzites and sandstones exhibit oxidising environment and its coarseness, well sorting and roundness of the grain shows that the sources of the deposited sediments were far enough. Further, thin sequences of grey shales indicate reducing environment, probably at that time, the sea water was withdrawn completely. Thus the sediments were unoxidised imparting black colour. This sequence is followed by the marine fossil bearing sediments of the Swat Formation. Broken fragments of shells suggest turbulent condition as well as transgression at the time of deposition. Thus the presence of larger foraminifera (*N. atacicus*, *A. subspinosus*) in the sediments of Swat Formation suggests a shallow marine environment of deposition. Suntar sediments are grey to red, grish grey sandstones interbedded with grey to purple shales. Such rhythmic deposition of grey to red sandstones and shales of Suntar Formation indicate the resultant cylindrical transgression and regression of the sea. Thus, only a slight, but variable thickness is attained along with frequent changes in oxidising environments. It also suggests that the sedimentary environment of the Suntar Formation could be of epicontinental type as well.

AGE AND CORRELATION

The Melpani Formation comprising orthoquartzites, sandstones and shales lies unconformably over the different members of the Lakharpata Formation and is overlain by the Swat Formation. Well preserved large foraminiferal fossils were identified at Surkhet, Dang/Piuthan, and Tansen area from limestone beds and lenses that are interbedded with carbonaceous shales of Swat Formation. The grey to grish grey shales of Swat Formation includes abundant gastropods and pelecypods. The presence of *Nummulites beaumonti* "ARCHAIC and HEIME and *Assilina papillata* NUTTLE indicates Middle Eocene age (Sakai, 1983). In the

Table 2 Correlation of the Lower Tertiary Rocks of Nepal Himalaya

| Ma | European Age (1985) | North American Provenical Age | Surkhet, Nepal Kayastha, N.B. (1970) | Dang \ Piuthan Nepal, Kayastha et al. (1983) | Tansen, Nepal Sakai, H. (1983) | Kumaon, India Valdiya, K.S. (1980) | Kohat-Potwar Basin, Aditya et al (1979) | Upper Assam Plains, Rangarao, A. (1982) |
|------|---|--|--------------------------------------|--|--------------------------------|------------------------------------|---|---|
| 5.3 | M I O C E Langhian Aquitanian | Hemingfordian Arikareean | SIWALIK | SIWALIK | SIWALIK | SIWALIK | SIWALIK | TIPAM SERIES |
| 23.7 | O L I C E Rupelian | Whitneyan Orellan Chadronian | SUNTAR (775m) | SUNTAR (550m) | DUMRE (725m) | KASAULI DAGSHAI | MURREE | SURMA SERIES |
| 36.6 | E O C E N E Priabonian Bartonian | Duchesnean Uintan | SWAT (150m) | SWAT (105m) | BHAINSKATI (160m) | SUBATHU | LAKI | KOPILI SYLHET TURA |
| 57.8 | P A L E O C E N E Danian | Clarkforkian Tiffanian Torrejonian Dragonian Puercan | MELPANI (100m) | MELPANI (160m) | AMILE (230m) | RANIKOT | | |
| 66.4 | C R E T A C E O L I G O C E N E Maestrichtian | Up-Cretaceous | | | TALTUNG (250m) | TAL | | |

Himalayan Range, fossiliferous Eocene beds are distributed discontinuously along the foothills of the Lesser Himalaya. In the Garhwal and Kumaon area, the Eocene beds called the Subathu are represented by a basal bed of pisolitic laterite and bauxite, pyritiferous shale with interbeds of coal and ironstone, grey and olive coloured shale and Nummulitic limestone with some olive shale in ascending order. This Subathu Formation has been assigned to the Laki Series of early Eocene age on the basis of Nummulites and other larger foraminifera which occurred from limestones in the upper part (Valdiya, 1980). Thus it may be correlated with the Swat/Melpani Formations due to similar lithofacies. The Sutar Formation comprising sandstones and purple shales is barren of fauna with exception of fucoid markings, worm burrows and plant remains. No fossils significant for age determination were obtained from the Sutar Formation. This formation is definitely younger than Swat Formation as overlies unconformably. The Sutar Formation is similar in lithofacies to Lower Murrees and Dagshai Formation of the Indian Himalayas. The Dagshai Formation comprises a series of grey or purplish, fine grained quartzitic sandstones with red to purplish brown, mottled clay interbedded. The sandstones are massive having poor stratification and gradually increase in proportion and thickness in the upper part. These features are entirely common to the Sutar Formation. Thus the Sutar Formation may be equivalent to Lower Murrees, Barail and Dagshai of Indian Himalayas presumed to be Oligocene - Early Miocene in age.

ACKNOWLEDGEMENTS

Permission to publish the article by the Petroleum Exploration Project, DMG, Kathmandu is gratefully acknowledged. Sincere thanks are due to Mr. U.M.S. Pradhan, Divisional Geologist and Mr. S.R. Sharma, Geologist for their kind cooperation and discussion during the preparation of this paper.

REFERENCES

- Aditya, S., Raju, A.T.R. and Shukla, S.N. (1979): Assessment of hydrocarbon prospects of the Sub-Himalayan Punjab and Ganga Basins. Proc. Himalayan Geology Seminar, Sec. III, New Delhi, Misc. Publ. Geol. Surv., India. 1979, 41(5), pp 127-140.
- Bashyal, R.P. (1986): Geology of Lesser Himalaya, Far Western Nepal Science de la Terre, Memoire 47, Nancy, France. pp 31-42.
- CPIT, (1973): Report on the investigation of Petroleum Geology in the Kingdom of Nepal, The Chinese Petroleum Investigation Team, Beijing, China.
- Dhital, M.R. and Kizaki, K. (1987): Lithology and Stratigraphy of the Northern Dang, Lesser Himalaya. Publ., Bulletin of the College of Science, University of the Ryukyus, Okinawa, Japan. No. 45, pp 183-244.
- Gansser, A. (1964): Geology of the Himalayas. John Wiley and Sons, London, pp-289. Hashimoto, S., Ohta, Y and Akiba, Ch. (Eds.). (1973): Geology of the Nepal Himalayas. Saikon Publ. Tokyo, pp 292.
- Kayastha, N.B. (1970): The Geology of Nepalgunj- Surkhet Area in Western Nepal, Unpubl., Geol. Surv. of Nepal, pp 32.

- Kayastha, N.B. and Aryal, R.K. (1976):** Geology of Sunauli- Pokhara Highway, Unpubl., Geol.Surv.of Nepal, pp 14.
- Kayastha, N.B. and Shrestha, R.B.(1982):** Report on Detailed Geological Sections of Dang/Puithan Area, Far Western Nepal, Unpubl., Dept. of Mines & Geology, Kathmandu, pp 36.
- Kayastha, N.B. (1982):** Chure Surkhet Basin, Nepal, ESCAP ATLAS OF STRATIGRAPHY III, Vol. VIII, NO.48, pp 113- 114, United Nations Publication, New York.
- Kayastha, N.B. and Pradhan, U.M.S. (1983):** Contribution to Project No.32, Stratigraphic Correlations betw Sedimentary Basins in the ESCAP Region, Nepal National Committee for UNESCO Geological Correlation Programme, Kathmandu, pp-18.
- Kayastha, N.B. and et.al. (1983):** Report on Detailed Geological Sections of Dang/ Rolpa Area, Western Nepal. Unpubl., PEPP/ DMG, Kathmandu. pp 25.
- Matsumaru, K. and Sakai, H.(1989):** Nummulites and Assilina from Tansen area, Palpa District, The Nepal Lesser Himalayas.Trans. Proc. Palaeont. Soc. Japan, N. S. No. 154, Tokyo, Japan. pp 68-76.
- Ranga Rao, A.(1982):** Geology and Hydrocarbon potential of a part of Assam - Arakan Basin and its adjacent region, in Petroliferous Basins of India -I, Petroleum Asia Journal, pp 127-158.
- Sakai, H. (1983):** Geology of the Tansen Group of the Lesser Himalaya in Nepal, Mem. Fac. Sci., Kyushu Univ., Ser.D.Geol., Vol.xxv, No.1, Fukuoka, Japan. pp 27-74.
- Sharma, C. K.(1990):** Geology of Nepal Himalaya and adjacent countries. Publ. Bisal Nagar, Kathmandu, Nepal. pp 479.
- Tater, J.M., Kayastha, N.B. and et. al (1982):** Geological map of Nepal. Scale 1:100,000, DMG., Nepal, Prin.,Tolworth, Surrey, England.
- Tater, J.M., Kayastha, N.B. and Murphy, R.W.(1989):** Nepal opens a second Bidding Round; Nepal offering Seismic Survey of Eastern Block: Oil and Gas Journal, March 13 and 20,1989.
- Valdiya, K.S.(1980):** Geology of Kumaun Lesser Himalaya. Wadia Institute of Himalayan Geology, Dehradun, India, pp 291.