STRATIGRAPHY OF THE LOWER TERTIARY ROCKS OF NEPAL HIMALAYA

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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, Puthan, Salliyar, 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 paleontological 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 bend 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 Salliyar 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).
LITHOLOGY

AGE

GROUP

FORMATION

SECTION

THICKNESS

LOCATION

PALEOCENE-MESOZOIC

MAMOHAHAT

GRAND CANYON

LOWER MIOCENE

SWAT

SURKHET

SUBSURKHET

SUFRIRPATA

PALEOCENE

LAMARPAHAT

PALEOCENE-EDOCENE

MULUSCA

CECCO CONIFEROS

FOSSIL REEF

Grey, dark grey, ferruginous, bedded, pyritiferous orthoquartzites and sandstones intercalated with grey, carbonaceous, crumpled shales with occasional bands of argillaceous limestones and conglomerates.

Grey limestones interbedded with grey, dark grey shales.

Grey, dark grey, cream coloured, wellbedded Nummulitic limestones and grey to greenish grey, carbonaceous shales with lenses of dark grey fossiliferous limestones.


Mullusca: Astarte cf. gigantia, Protocardia sp., Cucullaea sp., Turritella sp.

Greenish grey, reddish brown, fine to medium grained sandstones and purple, dark red even mottled shales interbedded with occasional bands of marls, mudstones, intraformational pebbly shales and conglomeratic sandstones.
Melpani Formation

This formation is named after the village Melpani in Surkhet, Western Nepal. This formation comprises light grey, dark grey, ferrugeneous well bedded, jointed, at places massive orthoquartzites and sandstones intercalated with grey, carbonaceous, crumpled shales and occasional bands of grey argillaceous limestones and conglomirates 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 conglomirates 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 heterogeneous 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 ferrugeneous 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 unstratified clay and mudstone are noticed at the base of the Melpani Formation. Orthoquartzites and sandstones contain undulose quartz, mica, plagioclase feldspar and some ferrugeneous materials. The inner spaces between bigger quartz grains (0.36mm-0.72mm) are occupied by ferrugeneous matrix and fine quartz grains. Sticksends 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 fissiliferous 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, grishy grey, crumpled, sometimes carbonaceous. In Dang/Piuhuan area, the upper horizon comprises grey, whitish grey, cream coloured, well bedded Nummulitic limestone and grey to grishy 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 Bhaimkati Formation. From these beds Nummulites beaumontii d’ ARCHAIAZ 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 fissiliferous 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. atacicus, N. mamellae, Assilina subspinos, A. dandotica have been recorded in the Swat Formation of Surkhet area. Nummulite crineminis, N. leupoldi, N. planulatus, Assilina placenta, A. postulis ( after Parlovskaya, 1981 USSR) have been identified in the samples being collected from Dang/ Piuhuan area. The presence of such fossils has given the evidence of Middle Eocene age for the Swat Formation. Pelecypods such as Astarte cf. gigantica, Protocardia sp. and Cucullaea 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 Chinesse Petroleum Investigation Team ( CPIT, 1973 ) has identified the following fossils from the Surkhet area :
Foraminifera - Nummulites aff. atacicus Leymerie, N. cf. mamille (Fichtel and Moll), Assilina spinosa Davies, A. subspinosa Davies, A. laminosa Gill.

Bivalvia - Cordiopsis cf. incrassata Sowerby, Cordiopsis sp., Euphenax aff. jamaicensis (Trechmann), Septifer cf. denticulatus (Lamarck), Tellina sp., Dimya aff. deshayesiana Rouault, Oastrea (? Flemingostrea) cf. Flemingi d' Archiac and Haime, Botula sp., Corbula cf. daltoni Cotter, Cardiaria mutabilis d’ Archiac and Haime.

Gastropoda - Limacina cf. pseudopygmaea Eames, Volutilithes sp., Turritella cf. hollandi Crossman 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 between 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 serice 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 recognized by mottled structures or sinuous tubes. The individual bed of sandstone varies from 15 m to 20 m, whereas 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/Pithan 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/ Dhubdana Thrust (Table 1) in the type locality of the Surkhet/Dang areas, Western Nepal. The Suntar Formation is devoid of fossils with exception of fusoid 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.
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<th>South</th>
<th>Tectonic set up</th>
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<td>of Lesser Himalayas</td>
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<td>exposing metamorphic rocks.</td>
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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 thrusted 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 Surkec 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 ferrigenous 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. subspinosa) 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 beauvoitti d'ARCHAIC and HEIME and Assilina papillata NUTTLE indicates Middle Eocene age (Sakai, 1983). In the
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 pisolithic 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 Suntar 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 Suntar Formation. This formation is definitely younger than Swat Formation as overfies unconformably. The Suntar 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 Suntar Formation. Thus the Suntar Formation may be equivalent to Lower Murrees, Barail and Dagshai of Indian Himalayas presumed to be Oligocene - Early Miocene in age.

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