CHAPTER 1

INTRODUCTION

The Area under Study

For the present work an area of about 35 sq km around Lumshnong (25°11'00" : 92°24'15"), a small tribal village in the Jaintia Hills of Meghalaya in the northeastern part of India was geologically studied and mapped (Text- fig. 1).

This area is covered by the Survey of India toposheet No. S3C/54 on one inch to two miles scale. It lies on the southeastern slope of the Shillong plateau and about 70 km southeast of Shillong (25°38'00" : 91°56'00"), the state capital and administrative headquarters of Meghalaya. The area is served by the Jowai-Sadarpur road.

Generally a thick mantle of red lateritic soil covers the area and supports a luxuriant growth of a richly varied vegetation because of the heavy rainfall from the southwest monsoon. The deep jungles are inhabited by a varied wild life.

Previous Work

There are several publications concerning the
geology and allied aspects of Meghaleya. Of these the more important contributions having direct bearing on the present study are reviewed here.

Colebrooke (1821) provided the first geological report of 'shell limestone' from areas now constituting Meghaleya.

After about three decades since then and during the early territorial surveys by the Geological Survey of India an interim report of Oldham's systematic geological investigations in the Cherrapunji (25°16'00" : 91°45'00")-Therriaghat (25°11'00" : 91°45'20") area appeared in the proceedings of the Asiatic Society of Bengal (1854). The details of Oldham's work on the Upper Cretaceous-Pleistocene rocks of this region were published in 1858 in the first volume of the Memoirs of the Geological Survey of India. He proved the occurrence of Pleistocene rocks with mammalian fossils. He also suspected an Upper Cretaceous age for the underlying rocks in the Cherrapunji area.

A valuable account of the geology of the area between Shillong, Shella (25°10'45" : 91°34'00") and Therriaghat in the Khosi Hills was written by Medlicott (1869) from the systematic field study of the Cretaceous-Pleistocene rocks. He recognized four rock units in the geological sequence of Khosi Hills and introduced the nomenclature Rammulitic
Series, Cherra band, Langpar band, and Mahadeo band for successively older rock units. The infra-Mahadeo rocks in descending order were referred to by him as the great bottom sandstone and the basal conglomerate. In his Nummulitic Series from the Tharriaghat section, Medlicott included the following descending sequence of four limestone bands and three clastic interbeds:

1. Massive, coarse, blue limestone … 200'
2. Yellowish coarse sandstone … 100'
3. Fine, compact, chalky, blue or pink limestone … 200'
4. Greenish and ochreous earthy sandstone … 50'
5. Limestone … 50'
6. Yellowish sandstone … 100'
7. Limestone … 200'

He considered the coal-bearing sandstone and the conformably underlying limestone in the Cherrapunji area as correlative with the lowest sandstone and limestone units of the above sequence.

Le Touche (1889, 1890) while discussing the stratigraphic relation between the coal-bearing sequences of Cherrapunji in the Khasi Hills and Lakadong (25°91'07" N; 91°16'30") in the Janitia Hills, considered the coal beds of
the two areas as stratigraphically comparable.

Palmer (1923) followed Medlicott's scheme of stratigraphic classification in course of his field studies in the Phani-Jaintia Hills and retained the nomenclature Nummulitic Series (sensu Medlicott). However, he treated all the infra-Nummulitic rocks as a single unit (Cretaceous).

Das Gupta (1926) discovered some calcareous algae from the limestones of Cherrapunji area. He also described 'Lower-Middle Kirthar' Foraminifera from these rocks. (The identifications and age-assignments have since been modified by subsequent workers).

In his classic work "Tertiary Succession in Assam" Evans (1932) introduced the nomenclature Sylhet limestone stage for the Nummulitic Series of Medlicott. This unit was grouped by him with the Hopili stage in the Jaintia series as under:

| Jaintia Series | Hopili alternations stage |
|               | Sylhet limestone stage   |

Evans considered the coal-bearing sandstones of Cherrapunji and Lakadong areas as belonging to the Hopili stage.
Mukherjee (in Fox, 1939) worked in the Khisi and Jaintia Hills district during the 1937-38 field season and mapped a portion of topo-sheet No. 83C/EW. His work revealed that a considerable portion of the area is occupied by the 'Cherra sandstone' apparently conformably overlying the Upper Cretaceous beds. The generalized succession for the area as can be made out from the account of Fox (1939) is:

- Kopilia and other Tertiary 'supranannulites'
- Sylhet limestone stage
- Cherra sandstones
- Upper Cretaceous beds

The 'Sylhet limestone stage' in the Jaintia Hills area was found by Mukherjee to consist of beds of limestone separated by beds of sandstone. The limestone was described as "generally impure and often highly siliceous, occurs both massive and bedded, is usually highly fossiliferous and has cavities, swallow holes and other evidences of solution". The sandstones of 'Sylhet limestone stage' were found to contain thin coal seams near Ulaatdoh (25°11'00" N; 92°17'00" E).

Chosh (1940, 1954) preferred to restrict the nomenclature 'Sylhet limestone' to the three upper beds of limestone and two upper clastic interbeds of Medlicott's
Nummulitic Series of the Tharriaghat section. He correlated the lowest clastic interbed and the basal limestones of Tharriaghat section with the 'Cherra sandstone' of Cherapunji area. Ghosh recorded that on the east bank of the Un Bhorngkaw River the above three limestone bands of the 'Sylhet limestone' are characterised by distinctive foraminiferal compositions. In his words, "... uppermost limestone is mostly built of large and medium sized Nummulites and Assilina ... middle limestone is teeming with Alveolina, while the third or basal limestone show sections of gastropods and tiny foraminifera". He further recorded that between Tharriaghat and Bhalo the uppermost limestone, as referred to above, is overlain at places by an earthy limestone and marl entirely made up of Discoconus. Coming to the fixation of age, Ghosh (1934) correlated the Cherra sandstone with the '? Banikot' (Pleisocene) beds of Pakistan. The age of the lowest limestone unit of Sylhet Limestone was indicated by him as '? Late Banikot'. The Alveolina-bearing middle limestone and the Nummulites and Assilina-bearing upper limestones were correlated with the Early to Middle Eocene Laki and Kirther beds of Pakistan.

From the limestone collections of Ghosh and of Fox from a few localities of the Whai and Garo Hills Rao (1943) described following calcareous algae belonging to the
family Corallinaeae:


He assigned Lower-Middle Eocene age to the algae. Precise horizons of the original limestone samples, however, are uncertain. In a later paper Rao (1947) reported the discovery of the dasyclad genus Parvulosora from limestone immediately underlying Cherra sandstone in west Cherrapunji and favoured a Lutetian-Altovenian (Laki) age for the Cherra sandstone.

Wilcox and Metre (1953) named the limestone-sandstone interbeds of the Jaintia Hills in descending order as follows:

<table>
<thead>
<tr>
<th>Sylhet Limestone</th>
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</thead>
<tbody>
<tr>
<td>Prang Limestone (Middle Eocene)</td>
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<tr>
<td>Nargah Sandstone (Lower Eocene)</td>
</tr>
<tr>
<td>Usalatoh Limestone (Lower Eocene)</td>
</tr>
<tr>
<td>Lakadong Sandstone (Paleocene)</td>
</tr>
<tr>
<td>Lakadong Limestone (Paleocene)</td>
</tr>
</tbody>
</table>

This development of the Jaintia Hills corresponds to the three upper limestone units and two intervening clastic units of Medlicott's Eumulitic Series of the Thirrighat.
section. The lowest sandstone and the basal limestone beds of the Hummulitic Series of Thirringhat section were designated by Wilson and Metre as the Upper Therria Substage and the Lower Therria Substage of Tura Sandstone of Palaeocene age. These were compositcd with the Jaintia Hills sequence.

While following Wilson and Metre in the break-down of the Sylhet and infra-Sylhet rocks, Megappa (1959) united the Lower Therria and Upper Therria Substages into the Therria Stage, the Lakadong Limestone and the Lakadong Sandstone into the Lakadong Stage and the Uniatdo Limestone and the Harph Sandstone into the Harph Stage and referred to the Prang Limestone as Prang Stage. The infra-Therria rocks were subdivided into the Mahadek (= Mahadeo) and the Langpar Stages from base upwards. From his foraminiferal studies (1951a,b, 1952, 1954, 1959, 1960) Megappa assigned an Upper Cretaceous (Maastrichtian) age to Mahadek Stage, Palaeocene age to the Langpar, Therria and Lakadong Stages, an Early Eocene age to the Harph and a Middle to basal part of Late Eocene age to the Prang Stage.

Dines (1962) accorded the rank of Formation to the Mahadeo, Langpar, Cherra, Tura and Sylhet Limestone Stages on the pattern of American Code of Stratigraphic Nomenclature (1961). In his scheme the Sylhet Limestone
Formation corresponded to Medlicott’s Mammalitic Series of which the lowest unit was designated by him as Basal Member, and the remaining units in ascending sandstone-limestone couples as the Lower, Middle and Upper Members respectively. Biswas found the basal and the top parts of the Sylhet Limestone Formation to be characterised by Miscellanea spp. and Palliatispina spp. assemblages respectively (e.g. between the Khasisara River section, 25°12’00” : 91°30’00”, and the Schryngtew River section, 25°11’00” : 91°45’20”).

Mathur and Evans (1964) more or less followed the succession given by Wilson and Metre (1953). They preferred to retain the terms ‘series’, ‘stage’ and ‘substage’ because of their long usage, whilst appreciating that the terms are not strictly applicable to the lithostratigraphic units under consideration.

Chose (1967) recognized a possibility of subdividing the ‘Jaintia Series’ into ‘Stages’ on the basis of biostratigraphic considerations including the first appearance of easily identifiable larger Foraminifera.

Krishnan (1968) in his textbook “Geology of India and Burma” presented the following succession in the Jaintia Series as recognized by the geologists of Assam Oil Company Ltd.:
<table>
<thead>
<tr>
<th>Kupili Stage</th>
<th>Alternations of shales and sandstones with bands of calcareous sandstones and shales (1500')</th>
<th>Upper Eocene</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sylhet Limestone Stage</td>
<td>Prang Limestone—Fossiliferous limestone (600-900')</td>
<td>Middle Eocene</td>
</tr>
<tr>
<td></td>
<td>Burpah Sandstone—Sandstone with subordinate calcareous bands (80')</td>
<td></td>
</tr>
<tr>
<td>Therria Stage</td>
<td>Unletodh Limestone—Limestones with occasional sandstone bands (200')</td>
<td>Lower Eocene</td>
</tr>
<tr>
<td></td>
<td>Lakadong Sandstone—Coal-bearing sandstones (80')</td>
<td>Upper Paleocene</td>
</tr>
<tr>
<td></td>
<td>Lakadong Limestone—Fossiliferous limestone (500')</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Upper Therria—Hard sandstones (upto 100')</td>
<td>Lower Paleocene</td>
</tr>
<tr>
<td></td>
<td>Lower Therria—Limestones and calcareous sandstones (upto 225')</td>
<td></td>
</tr>
</tbody>
</table>

While listing the foraminiferal fossils of the Sylhet Limestone beds he recognized the presence of Ranikot, Laki and Kirther elements in these.

Chakraborty and Bakshi (1972) observed that the *Miscellanea miscella* Range Zone entirely covers the Lakadong Limestone southwest of the Shillong Plateau and that this species is quite frequent in occurrence and is associated with *Ammonolithals* and *Alocelana prirnaya* of Ranikot age. They pointed out that this *M. miscella* Range Zone is equivalent to the *Globorotalia wilczomski*—*G. vallesconensis* Assemblage Zone of Upper Paleocene age.
Sah and Dutta (1974, vide Sah and Singh, 1977) recorded characteristic palynofossils including *Assemblatoza dubius* and *Sandatiospora aligera* from the Lakadong Sandstone Member of Khasi and Jaintia Hills.

Recent studies by Ghose (1976, 1977) suggested the existence of a Palaeogene for-algal reef-rock complex around the Cherrapunji-Therriaghat axis and indicated the ecologic distribution patterns mainly of its important larger Foraminifera.

Murthy, Chakrabarti and Talukdar (1976) reviewed the stratigraphic status of the entire Cretaceous-Tertiary sediments of the Shillong Plateau and proposed a classification of these sediments using lithostratigraphic nomenclature as follows:

**KOPILI FORMATION**

- **JAINITIA GROUP**
  - **SHELL FACTION**
    - **Upper Sylhet Limestone Member**
    - **Upper Sylhet Sandstone Member**
    - **Middle Sylhet Limestone Member**
    - **Middle Sylhet Sandstone Member**
    - **Lower Sylhet Limestone Member**
    - **Lower Sylhet Sandstone Member**
      - (Excluding the fourth limestone band of Therriaghat)

**LANGPAR FORMATION**

- (Including the limestone band originally placed in the Therri Stage)
MAHADEK FORMATION
KHASI GROUP
BOTTOM CONGLOMERATE FORMATION
(Developed only in the Plateau)
JADUKATA FORMATION
(Developed only south of the Plateau)

In the above nomenclature Jaintia Group covers existing Jaintia Series and the Danian Langpar Stage (a calcareous facies) which underlies it and marks the beginning of a stable shelf condition. The Khasi Group, as proposed by its authors, is a distinct thick and extensive arenaceous facies.

Sah and Singh (1977) discussed the geology, palynology and palaeocology of Cretaceous-Tertiary rocks of areas including present Meghalaya.

Bhattacharya, A. and Chatterjee, B. P. (1977) showed the general patterns of vertical distribution of Foraminifera and algae in the Lower Tertiary rocks of Tharriaghat and Thalia sections and correlated the sections with the combined Banikot-Laki-Nirthar sequence of Pakistan. (Amongst the algae only Distichonias biserialis was identified by them).

Shortly after the present author had finalized the manuscript of his thesis and started getting the rough typescripts, an attempt by Pal and Dutta (1979) to identify the calcareous algae of the Sylhet Limestone Formation
from localities including Lumshnong area came to light. Some discussions on the fossils described by them has, however, been incorporated now in the palaeontological chapter of this thesis. The check list of the forms recorded by them is as follows:

Archaeolithothamnium aff. A. kearnani Howe, Lithothamnium andamanensis Chatterjee and Gururaja, L. aff. L. boffilli Lemoine, Masophyllum machalavensis sp. nov., Lithoporella (Foslie) Foslie melobesioidei Melobesia sp., Distichopora biserialis (Riet) Fia, D. reei Varma, Jania occidentalis, Halimeda sp., Grinoporella arctica, Neoporeia sp., Furcocorella diphonora, Trincocladus umatocensis sp. nov., Cyanopora sp., and Dissociatedella lakadongensis sp. nov.

A summary of literature relating to the foraminiferal investigations of the Shillong Plateau areas is available in the "Annotated Bibliography of Foraminiferida from India" compiled by Sastri, Kumar and Gowda (1971). Samanta (1973, 1974, 1976) offers discussions on certain aspects of foraminiferal biostratigraphy pertaining to regions including the Shillong Plateau areas.

Classification of the Meghalayan Palaeocene-Eocene Sediments

The Palaeocene-Eocene succession of Meghalaya has been variously divided and subdivided into stratigraphic units of different ranks. Table 1 presents a compilation
of the various schemes of classification used by different workers for the Palaeocene-Eocene successions of Mashi-Jaintia Hills areas of Meghalaya where a fuller development of these successions is seen. Most classifications of Meghalayan sediments employ a time-stratigraphic and/or time-rock-stratigraphic nomenclature, while a few use rock-stratigraphic nomenclature on the pattern put forward by the American Commission on Stratigraphic Nomenclature (1961) and the Committee on Stratigraphic Nomenclature of India (1971). With minor exceptions, however, the classification by Wilson and Metre (1951) forms the basis in all subsequent schemes of classifications of Meghalayan sediments by other workers. Further, the usage of Wilson and Metre's scheme of classification is already firmly entrenched in the published literature on Meghalayan geology.

Under the circumstances the present author feels that adherence to Wilson and Metre's scheme of classification of the Meghalayan Palaeocene-Eocene successions in connection with the present micropaleontological study will facilitate easy reference to published geological literature on Meghalaya. This scheme of classification will, therefore, be basically followed in this thesis. However, as rank terms Group, Formation, Member etc. will be adopted instead of System, Series, Stage, Sub-stage etc., as the established
stratigraphical units of the Meghalayan sediments are essentially rock units (Litho-units).

Regional Geological Setting

Shillong Plateau

The northeastern region of India constitutes the northern part of the 'Assam-Arakan' geological province. Of this region the Garo, Khasi and Jaintia Hills belonging to Meghalaya are, in convenient geological usages, together termed the Shillong Plateau with the Mikir Hills of Assam on the east forming its outlying part. This plateau is looked upon as a disconnected (because of the intervening Ganga-Brahmaputra alluvium) wedge-like portion of the Indian Peninsula trapped between the Himalayan and Burmese elevatory movements. It is a roughly east-west horst with a criss-cross of ancient fault-lines in it. The plateau has been uplifted since probably the Jurassic times (Dasikachar, 1974). Its present height varies from about 700 m to about 2100 m above M.S.L.

Viewed in terms of plate tectonics model, the Shillong Plateau is a part of the Indian plate (Dasikachar, 1974).

The core of the plateau is an ancient mass of Precambrian metamorphic and igneous rocks. Jurassic Cylbot Traps occupy the southern part. The Shillong Plateau is
fringed on its southwest, south and southeast by Upper Cretaceous-Tertiary shelf sediments. Text-figure 1 (Inset, bottom left) illustrates the geology of the western part of the Shillong Plateau wherein the present study area lies.

Upper Cretaceous-Eocene shelf sediments:

A good development of marine Upper Cretaceous-Eocene shelf sediments is found in a continuous narrow strip along the southern edge of the Shillong Plateau bordering the Bangladesh plains. On the plateau these sediments occur as discrete outliers.

The sediments have a gentle southerly dip on the plateau but at the southern edge they plunge abruptly towards the south and beneath the Bangladesh alluvium. This gives rise to a monocline with its axis trending SW to ESE-NEW. The crest of this monocline is split by the Dauki fault which passes eastward into the well-known Maflong-Nisang thrust (Text-fig. 1, Inset, bottom left).

Recent mapping of the shelf sediments south of the Shillong Plateau has revealed that the area is a classic example of basement-controlled tectonics wherein the sedimentation has been influenced by differential movements in discrete fault-bounded basement blocks from time to time (Murthy et al., 1969).
The base of the thick sequence of Meghalayan sedimentaries rests unconformably on a pre-Cambrian platform in the Garo Hills, and on the Sylhet Traps (= Rajmahal Traps of the Rajmahal Hills of Bihar and West Bengal) in the Khasi and Jaintia Hills. The basal beds in the Khasi and Jaintia Hills are conglomeratic. With the thick, extensive and distinctly arenaceous facies called the Mahadek Formation the earliest cycle of sedimentation in Meghalaya ended. This is taken to indicate the end of the Cretaceous period (Maastrichtian) in Meghalaya and no important movements are known to have separated the Mesozoic and the Tertiary. The succeeding Langpor Formation (Danian) is a calcareous facies and tectonically marks the beginning of an overall stable shelf condition. During the Paleocene-Eocene times this stable shelf condition was well established throughout the shelf area as indicated by the repetitive limestone-sandstone alternations belonging to the overlying Jaintia Group.

Sylhet Limestone Formation:

The Sylhet Limestone Formation which constitutes a major part of the above mentioned limestone-sandstone alternations of the Jaintia Group (vide Table 1) is extensively developed in Meghalaya. It has been traced
northeastward to the Mikir Hills and has been found in deep wells in the upper Assam valley. It also occurs southwestward beneath the alluvium of West Bengal. However, the most complete succession of this formation is seen in the Um Slhaynglaw River section near Tharriaqhat in the Khasi Hills.

North of the Dauki fault belt the formation is a part of the east-west monocline described in the foregoing section.