CHAPTER 1

INTRODUCTION

Meghalaya, the newly formed State of India (Fig. 1) contains a number of formations belonging to different geological ages.

Marine transgression was a dominant feature during the Cretaceous Period along the Southern flank of the Khasi and Jaintia Hills, Meghalaya (Krishnan 1968, p.370 and p.395; Goswami, 1960, p.73). Extensive areas were also transgressed in other parts of India where systematic work has revealed many interesting aspects of Geology.

1.1 LOCATION OF THE AREA:

The area studied is located between
Latitude 25°10'N and 25°16'N
Longitude 91°58' and 92°07'E

and is included in the Survey of India topographic sheet, number 78-O and 83-C. It lies in the south eastern part of the Khasi and Jaintia Hills, Meghalaya and covers an area of approximately 120 sq. km. (Map No.1).

1.2 A REVIEW OF THE GEOLOGY OF MEGHALAYA:

Meghalaya occupies a coveted position in the Indian Geology, because of its possession of diversified lithostratigraphic units of different geological ages.
Fig. 2.
Stratigraphy as developed in Meghalaya is shown in the table (Table 1) and (Fig. 2).

**Table 1**

(Showing Stratigraphy of Meghalaya, after Subramanyam M.R. 1964).

<table>
<thead>
<tr>
<th>Age</th>
<th>Formation</th>
<th>Thickness (in metres)</th>
<th>Lithological character</th>
</tr>
</thead>
<tbody>
<tr>
<td>EOCENE</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(JAINTIA SERIES)</td>
<td>Kopili Stage</td>
<td>450</td>
<td>Shale &amp; Sandstones.</td>
</tr>
<tr>
<td></td>
<td>Sylhet Limestone</td>
<td>250-530</td>
<td>Limestones with alternating coal bearing sandstones.</td>
</tr>
<tr>
<td></td>
<td>Therria Stage</td>
<td>100</td>
<td>Sandstones with intercalated calcareous beds.</td>
</tr>
<tr>
<td></td>
<td>Langpar Stage</td>
<td>90</td>
<td>Sandstones with intercalated shales and impure limestones.</td>
</tr>
<tr>
<td>CRETACEOUS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mahadek Stage</td>
<td>235</td>
<td>Coarse glauconitic sandstones and shales, with grits and conglomerates.</td>
</tr>
<tr>
<td>JARASSIC(?)</td>
<td>Sylhet Traps</td>
<td></td>
<td>Vesicular and amygdular basaltic lavas, ash beds and also some dolerite dykes.</td>
</tr>
<tr>
<td>PRE-CAMBRIAN</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(DHARWARS)</td>
<td>Basic dykes</td>
<td></td>
<td>Dolerite</td>
</tr>
<tr>
<td></td>
<td>Acid intrusives</td>
<td></td>
<td>Mylliem granite, quartz veins and pegmatites.</td>
</tr>
</tbody>
</table>
Khasi Green stones

Metadolerites and Meta basalts.

Quartzites, conglomerates, phyllites and schists.

Gneisses, schists and granitoid rocks.

PRE-CAMBRIAN (DHARWARS)

Shillong Series.

Older metamorphics (Gneissic complex)

ARCHEAN:

Biotite schist, biotite garnet gneisses, fine grained aplitic gneiss and granulites along with granite, pegmatites, hornblende-biotite gneiss and biotite-cordierite gneiss with a general N.E-S.W. strike of foliation is found to occur in the northern part of the Shillong Plateau.

Quartz-biotite-sillimanite-cordierite rocks and a quartz-sillimanite rocks with sillimanite corundum masses are found near Nongstoin area of the Khasi Hills.

PRE-CAMBRIAN:

The Shillong Series composed of quartzites, conglomerates, phyllites, sericite-chlorite-mica and hornblende schist with occasional carbonaceous slates and banded ferruginous rocks which are equivalent to the Dharwars, are overlying the Archean gneissic complex. Some of the schists are garnetiferous.

The Khasi-green stones which is composed of greenstones, epidiorites, amphibolites and amphibolite-schists
probably represent the metamorphosed sheets, sills and dykes of dolerite and other basic intrusives occur within the Shillong Series (Krishnan 1968, p. 134).

The Mylliem granite which is composed of a homogeneous fairly coarse to medium grained biotite granite, containing phenocrysts of pink microcline occurs in the form of bosses and thin inter-foliar veins in the schists and is distinctly of later age than Shillong Series. A grey granite also occurs in the area which is thought to be a variety of the Mylliem granite (Krishnan 1968, p.134).

JURASSIC:

The Sylhet Traps consists of flows of lavas. They are vesicular and amygdaloidal and at places carry intercalated ash beds. They are basaltic to andesitic in composition. Sometimes it bears olivine which is frequently serpentinised. The granite and to some extent the gneisses are traversed by dykes of dolerite. Its age is tentatively fixed as Jurassic (?).

CRETACEOUS:

The marine incursions during the Cretaceous Period was responsible for the development of huge thickness of the sedimentary rocks (Krishnan 1956, p.401). The transgression took place from the south (Bay of Bengal side) to north. The rocks are exposed over a very limited area confined between
FIGURE 3

Showing the limit of the Marine transgression during Cretaceous in Meghalaya.
MAP OF MAHADEK AND LANGPAR SEA IN MEGHALAYA

FIG. 3.
longitude 92°08' E and 91°11'52" E and latitude 25°21'30" N (Fig. 3) (Changkakoti and Borooah 1964, pp. 702-704). The succession as developed in Meghalaya is given below.

Table 2

(Showing Cretaceous succession in Meghalaya after Krishnan 1960)

<table>
<thead>
<tr>
<th>Stage</th>
<th>Description</th>
<th>Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>LANGPAR STAGE</td>
<td>Yellow-brown impure limestone with bands of sandy shales</td>
<td>100'</td>
</tr>
<tr>
<td>(305')</td>
<td>Shales with thin limestone and argillaceous sandstone bands</td>
<td>135'</td>
</tr>
<tr>
<td></td>
<td>Sandy shales and sandstones</td>
<td>70'</td>
</tr>
<tr>
<td>MAHADEK STAGE</td>
<td>Sandy shales and sandstones</td>
<td>40'</td>
</tr>
<tr>
<td>(770')</td>
<td>Shales mainly (not exposed)</td>
<td>40'</td>
</tr>
<tr>
<td></td>
<td>Greenish sandstones</td>
<td>40'</td>
</tr>
<tr>
<td></td>
<td>Hard gritty massive sandstones with a thin fossiliferous sandstone band near top</td>
<td>650'</td>
</tr>
<tr>
<td></td>
<td>Basal conglomerate</td>
<td></td>
</tr>
</tbody>
</table>

The Cretaceous rocks of Meghalaya rest unconformably on the Pre-Cambrian basement complex, Mylliem granite and Sylhet Traps and overlain by the Tertiaries.

The "Mahadek Stage" derives its name from the Mahadeo village (Medlicott 1869, p. 178) and "Langpar Stage" is named after the Langpar spur (Medlicott 1869, pp. 170-179).
Though the thickness is variable, Mahadek and Langpar are measured as 230 metres and 90 metres respectively (Krishnan 1960, p.463). The "Mahadek Stage" is represented by basal conglomerate, hard gritty coarse glauconitic sandstone with fossiliferous horizon. The succeeding "Langpar Stage" consists of impure thin limestone, calcareous shale and sandstone (Krishnan 1960, p.463).

On the southern foothills, near Therriaghat, the Cretaceous sandstones show a thickness over 300 metres. The basal sandstone thins out to the north and east and includes bands of conglomerate of variable thickness at its base.

On the north and eastern part of Cherrapunji the conglomerate which is about 70 metres thick is overlain by massive sandstone 150 metres and then by the calcareous shale and earthy limestone. On the road to Nongpriang, north of Cherrapunji, the Cretaceous conglomerate about 30 metres thick is capped by sandstone, shale and sandy limestone. The massive Cretaceous sandstone thins out very rapidly from Cherrapunji northwards (Ghosh 1940, p.4).

On the western side of the Cherrapunji overlooking the valley of the Umiew river, the Cretaceous is represented by about a couple of hundred feet of massive sandstone. The basal conglomerate and the Calcareous earthy beds of Langpar are absent. The Cretaceous sandstone thins out further north.
Along the south eastern side of the Meghalaya, Langpar is denuded away. The sandstone with a pebble bands at its base in the valley of the Piyan Gang River near Dawki is considerably reduced in thickness. Between Dawki and Mawshun the sandstone thins rapidly. Outliers of the Cretaceous conglomerate from which the overburden of the sandy limestone has been entirely removed by denudation, occur in the neighbourhood of the villages of Pynter and Mawprau. The conglomerate is about 2 metres thick. It seems that the true Cretaceous beds do not extend north of Khyrwet (Ghosh 1940, p.7).

The Mahadek Stage is nearly horizontal, or shows moderate dip of 25° to 30° in a southerly direction. The Mahadek terrace is associated with a fault dislocation, having a southerly throw. The fault has apparently been initiated in the upper Cretaceous times (Biswas 1962, p.11). Steeper dips characterise the outcrops of the "Mahadek Stage" involved in the monoclinal flexure. South of the Mahadek terrace and dips of the order of 50° have been recorded from the Therriaghata area. The "Stage" appears to be more than 150 metres.

The "Langpar Stage" has low southerly dips in the Cherrapunji Plateau south of Mawsmai; it has steeper dips and the dip of the beds in the southern scarp section is of the order of 50° to the south. The thickness of "Langpar Stage" is more than 135 metres in this area. It thins to the north.
The northern most limit of the "Langpar Stage" is about a Km. further north of that of the "Mahadek Stage". The stage thins towards the Khasimara river and seems to wedgeout completely in between the Khasimara and Mukhai Rivers. The "Langpar Stage" thins to the south of the Um Sohryngkew river and is not represented in Dawki.

From the study of the macro and micro faunas, the age of the "Mahadek Stage" is fixed as either Cenomanian or upper Cenomanian (Stoliczka 1869, pp.181-183; Spengler 1923, 1-67 and Das Gupta 1929, pp.25-34). From the examination of the petrographic and faunal characteristics of the "Stage" an open marine sub-littoral neritic depositional environment, with a moderately steep dipping towards south of the depositional basin is suggested (Biswas 1962, p.13).

Available palaeontologic data indicate that the "Langpar Stage" ranges in age between the upper most Cretaceous to approximately the base of the paleocene i.e. the time interval represented by the uppermost part of Maastrichtian and Danian. This "Stage" was deposited in a steeply sloping marine shelf in the Khasi depositional trough (Biswas B. 1962, pp.11-18).

Fossils and age:

Spengler (1923 pp.5-20) reported fossils from the Mahadek Formation of Sokha. These are Stigmatopygus elatus

From the type occurrence of the Mahadeo, Das Gupta (1929) reported occurrence of Pyrina ataxensis. From Therriaghat, the Mahadeo Formation yielded Stigmatopygus elatus, Gryphaea vesicularis, Ostrea (Alectryonia) Ungulata and Baculites vagina (Biswas 1962, p.13), Orbitoides sp., Echinoconus douvillei, Hemiaster, Rhynchosomella depressa, Terebratula carneae, Turritella pondicherriensis, Nautilus baluchistanensis, Stoliczkaia dispar (Krishnan 1968, p.397).


The "Langpar Stage" from Therriaghat yielded Globigerina pseudobulloides and Globigerina triloculinoides (Nagappa 1959, pp.1-19). Biswas (1962, p.16) also recorded a number of smaller foraminifera and assigned upper Cretaceous to Paleocene age.

TERTIARIES:

Among the Tertiaries, only the Eocene Formation is represented by the Jaintia series. It is developed along the southern flanks of Meghalaya.
The Jaintia series has been divided into three Major Stages - "Therria Stage", "Sylhet Limestone Stage" and "Kopili Stage" on the basis of lithology and fossil contents.

The "Therria Stage" which is of shallow water marine deposit consists of fine to coarse grained, cross-bedded friable sandstone of variegated cream and buff colours intercalated with shales and clays. Sometimes at places coal seams are found to occur. They are almost devoid of fossils.

The "Sylhet Limestone Stage" consists of alternating sandstones and limestones. The lower "Lakadong Sandstone Stage" is coal bearing. This stage bears fossil assemblages.

The "Kopili Stage" composed of alternating beds of shales and sandstones with several fossiliferous limestone horizons and is overlying the "Sylhet Limestone Stage". The rocks are highly feruginous and are best developed along the Hari-Lubha and Kopili valleys on the eastern and southern flanks respectively of Jaintia Hills.

1.3. STRUCTURE:

Structurally, the southern part of Meghalaya is very complicated. Because of the presence of Dawki tear fault, a major feature of the structure of India, the area has attained geological importance (Evans 1964, pp.80-96). The Disang thrust that occurs in the eastern part of Assam
running in N.E-S.W. direction passes near Haflong and is known as the Haflong fault. Further westward, the fault runs in more or less east-west direction and is known as Dawki-tear fault. Between Haflong and Dawki the beds north of the fault are generally horizontal or gently dip towards south. But the beds on the southern side of the fault dip steeply and even becomes vertical (Evans 1964, p.90). The monocline is associated with a major dislocation, e.g. the Dawki-tear fault (Mathur and Evans 1964, p.28). There is appreciable horizontal movement along the fault. The Surma valley region e.g. the southern part of the fault has moved westward relatively from the Shillong Plateau e.g. the northern side of the fault to a distance of about 200 kilometers and hence the fault is known as Dawki-tear fault (Evans 1964, p.92) (Map 1).

1.4. AIMS AND METHOD OF STUDY:

The present area of investigation lacks detail geological map and study of the sedimentary rocks.

The aim of this investigation is to prepare a detail geological map of the area. For this, stratigraphical successions are measured and represented in the form of columns. The rock stratigraphic units are established in this area. The clastic sediments are classified microscopically and texturally. The environment of deposition and
mode of transportation of the sediments are studied in detail. The clay minerals of the sediments are also studied and an attempt is made to trace the provenance of the sediments.

For detail field investigations the topographic sheet number 78 (2nd edition) and toposheet No. 83 supplied by the Survey of India in the scale of 1 inch to a mile were enlarged to 2 inches to a mile. The enlarged map was used as the base map for geological mapping of the area.

In the middle part of the year 1968 the field work was started and with intermittent intervals during the summer, the field work was completed in the month of December 1971. For field mapping, altimeter, and Brunton compass were used. Jacob's staff and at places steel tape were used to measure the vertical sections and stratigraphical column were prepared.

Samples of representative sandstone were collected from the sections at 10 to 15 metres intervals. Besides, spot samples were also collected. Four different stratigraphical column i.e. Dawki-sokha, Sokha-Nongtalang, Dawki-Pamshu-tia & Dawki-Muktapur are constructed for detail works.

Directional properties and length of the longest axis of the oriented fossils were measured. At least 30 such readings were taken from each station. The stratigraphical
positions of the samples, mode of occurrence like convex and concave side of the bivalves with respect to the bedding planes were recorded.

The cross-bedded strata were located and the following informations were obtained (1) dip and strike of the bedding of the sedimentation unit (2) thickness of the cross bedded unit (3) dip and strike of the foreset beds and (4) length of the forest beds.

Three intercepts of the pebbles of the conglomerate namely, maximum (x), intermediate (y) and minimum (z) were measured with the help of slide caliper. The azimuth direction and angle of inclinations of the maximum intercept of the pebbles were measured with Brunton compass, before the removal from the bed. 100 pebbles were measured from the outcrop.

1.5 PREVIOUS LITERATURE:

Literature pertaining to the sedimentological aspects of the Cretaceous sediments from Meghalaya are lacking. However systematic attempts were made by the Geologists of the Geological Survey of India and the Assam Oil Company, Directorate of Geology and Mining of Government of Assam and Meghalaya to establish the chronological order of the rocks.
Oldham was the pioneer worker and dealt with the upper Cretaceous-Eocene rocks (Oldham 1851, 1852, 1859). He proved the occurrence of Eocene rocks with the help of fossil Nummulite and also suspected the occurrence of upper Cretaceous rocks in the Cherrapunji area.

Medlicott was the next Geologist to attempt a systematic field geologic study from the central part of the Khasi Hills. He is the author of the rock units Mahadeo "band", Langpar "band", Cherra "band" and Nummulitic series (Medlicott 1869). His fossil collections from the Mahadeo Formation and also from the Sylhet Limestone Formation were studied by Stoliczka (1869) and Spengler (1923).

In course of field studies on the western part of the Khasi Hills, Palmer (Palmer 1923-24) followed the same scheme of stratigraphic classification of the sediments as suggested by Medlicott. Palmer, however, did not distinguished between the "Bottom Conglomerate", "Mahadeo Bed", "Langpar Band" and "Cherra Sandstone" for purposes of field mapping. Instead, he treated all of these rock units as Cretaceous. Palmer has, however, established the following stratigraphical sequence in the Khasi and Jaintia Hills -

Alluvium
Post Nummulitic sands and clays
Nummulitic limestone
Cretaceous sandstones
Sylhet traps
Granite
Gneiss

Evans (1932) pointed out that the succession "Mahadeo beds" "Langpar band" and "Cherra sandstone" is of local value in parts of the Khasi Hills. Further, Evans regarded the coal bearing sandstones, underlying the Sylhet Limestone Formation of the Mikir Hills, to be Eocene and as such to be stratigraphically unrelated to the Cretaceous succession of the Cherrapunji Plateau. However, Evans was unanimous with the Geological Survey of India in considering the infra Numulitic coal-bearing sandstones of the Garo Hills as Cretaceous.

Fox (1934–1938) mainly concentrated his work upon the coal-bearing horizons of Eocene age.

Biswas (1962) tried to modify the nomenclature of the old terminology after detail study of Khasi & Jaintia Hills. He tried to establish rock stratigraphic and time stratigraphic units of the Cretaceous time in Meghalaya. He found that the Garo, Khasi and Jaintia Hills experienced differential tectonic movements during the upper Cretaceous and lower Eocene times and the movements controlled the sedimentation.