CHAPTER 1

INTRODUCTION

1.1. Location of the area :

The area under investigation is situated in Meghalaya, a state of India, and included in the topographical map Nos. 78 $\frac{C}{11}$ and 78 $\frac{C}{12}$ of the Survey of India and bounded by —

Latitude $25^{o}11'65"$ N — $25^{o}22'45"$ N

Longitude $91^{o}42'0"$ E — $91^{o}45'0"$ E

1.2. Review of the Geology of Meghalaya :

The Geology of Meghalaya is characterised by the presence of diversified rocks, formed during the different geological times. The marine incursions on the southern part of the Meghalaya plateau (Assam plateau) during the Cretaceous-Tertiary time was responsible for the formation of contrasting sedimentary rocks (Goswami 1960 and Krishnan 1968). The sedimentation in Meghalaya took place in a shelf and as a result dominantly shelf facies of rocks are developed. In contrast, however, the geosynclinal condition was prevalent in the neighbouring areas, namely, Assam, another state of India (Mathur and Evans 1964). The Geological Survey of India also suggested a stratigraphical classification of Meghalaya (G.S.I. 1974).

The Tertiary succession in Assam (including Meghalaya) is given below (Mathur and Evans 1964).

Table 1: Shewing the Tertiary succession

Age	Series	Geosynctial facies Surma valley	Upper Assam	Shelf facies
PLIOPLEISTOCENE	Dihing	Dihing (400 m)	Dihing (400 m)	Dhekiajuli (1800 m)
		UNCONFORMITY		
MIOPLIOCENE	Dupitila	Dupitila (3600 m)	Namsang (800 m)	Namsang (800 m)
		UNCONFORMITY		
MIOCENE	Tipam	Girujan clay (1500 m)	Girujan clay (1800 m)	Girujan clay (600 m)
		Tipam sand-stone (1500 m)	Tipam sand-stone (2300 m)	Tipam sand-stone (900 m)
	Surma	Bekabil (1500 m)	Surma (900 m)	Surma (200 m)
		Bhuban (4000 m)		
		UNCONFORMITY		
OLIOGOCENE	Barail	Renji (1000 m)	Tikak Parbat (600 m)	Barail (1200 m)
		Jenam (1200 m)	Barogoloi (5300 m)	
		Laisong (2400 m)	Naogong (2200 m)	
EOCENE	Disang	Disang (1500 m)	Disang (1500 m)	Jaintia Series
				Kopili (500 m)
				Sylhet Lst (500 m)
				Therria (100 m)
		UNCONFORMITY		
CRETACEOUS				

The Sylhet Limestone Stage of the Jaintia Series is further subdivided (Goswami 1960, Mathur and Evans 1964, Krishnan 1968) as shown below :

Table II. Showing Eocene succession (After Krishnan 1968).

Kapili Stage	Alternations of shales and sandstones with bands of calcareous sandstones and shales (1,500 ft.)	Upper Eocene
	Prang Limestone (400—900 ft.) Fossiliferous Limestone	
	Nurpuh sandstone, Sandstone with subordinate calcareous bands (200 ft.)	Middle Eocene
	Umlatodoh Limestone. Limestones with occasional sandstone bands (200 ft.)	Lower Eocene
Sylhet Limestone Stage	Lakadong sandstone. Coal bearing sandstones (At present coals are completely mined in the area of study)	Upper Paleocene
	Lakadong Limestone (500 ft.) Fossiliferous Limestone	
Therria Stage	Upper Therria — Hard sandstone (upto 100 ft.)	Lower Paleocene
	Lower Therria — Limestones and calcareous sandstone (upto 225 ft.)	

The geological formations carring the state of Meghalaya are classified by the Geological Survey of India (1974). The classification is given below :

Table III. Showing the stratigraphic succession in Meghalaya (After G.S.I. 1974).

Geological Age	Group Name	Formation Name	Rock Type
Recent	Newer Alluvium (Thickness not known)	Unclassified	Sand, silt and clay
Pleistocene	Older Alluvium (Thickness not known)	Unclassified	Sand, clay, pebble, gravel and boulder deposits
- - - - - - - - - - - - - - - - Unconformity - - - - - - - - - - - - - - - -			
Plio-pleocene	Dupitila group (1050 m)	Unclassified	Mottle clay, feldspethic sandstone and conglomerate
- - - - - - - - - - - - - - - - Unconformity - - - - - - - - - - - - - - - -			
Oligocene	Garo Group	Chengapara	Sand, sandstone, clay, marl
		Baghmara Formation	Feldspethic sandstone
			Pebble conglomerate, clay silty clay
		Kopili Formation	Shale, sandstone, marl
Eocene	Jaintia Group	Simsang Formation (1050 m)	Siltstone, sandstone, alteration of sand
		Shella Formation	Alteration of sandstone, limestone
		Langpar Formation (180 m)	Calcareous shale sandstone, limestone

Upper Cretaceous	Khasi Group	Mahadek Formation (150 m)	Arkose (Glauconite)
		Bottom Conglomerate Formation	Conglomerate arkose
		Jadukata Formation (140 m)	Sandstone Conglomerate alteration
- - - - - - - - - - - - - - - Unconformity - - - - - - - - - - - - - - -			
Jurassic (?)	Sylhet Trap		Basalt, alkali basalt, rhyolites, acid tuff
- - - - - - - - - - - - - - - Unconformity - - - - - - - - - - - - - - -			
Precambrian		Intrusives (Acid & base)	Porphyrotic and coarse granites, pegmatites aplites, quartz vein, epidiorite dolerite, basalt
		Shillong Group	quartzite, phyllite conglomerate
- - - - - - - - - - - - - - - Unconformity - - - - - - - - - - - - - - -			
Archaean		Gneissic Group	Biotite gneiss, biotite hornblende gneiss, granite gneiss, migmatites, mica-schist, sillimanite-quartz schist, biotite, granulite-amphibolite, pyroxene granulite etc.

Archaean :

The Archaean gneissic complex is the oldest group of rocks and is exposed in the central and north eastern part of Meghalaya plateau.

They are represented mainly by biotite-gneiss, biotite-granulites, amphibolites, calc-granulite, banded magnetite quartzite, biotite-schist, quartz-sillimanite schist, biotite-cordiorite, and granulite. Around Sonapahar, detached remnant bodies of older gneissic complex is represented by biotite-schist, quartz-sillimanite schist, metabasites and biotite cordiorite-granulite occur over the older gneissic complex.

The associated mafic rocks are mainly ortho-amphibolite, metadolerite and metapyroxenite.

Precambrian :

The precambrian rocks of Meghalaya is represented by the Shillong Group of rocks and intrusive rocks. Exposed in the central and eastern parts of Meghalaya plateau, the Shillong Group of rocks are composed of quartzite, with subordinate phyllite, quartz-sericite schist, and conglomerate. Subsequently these rocks are intruded by basic-ultramafic and acidic sills and dykes. Representatives of the basic and ultrabasic intrusives are epidiorite, dolerite, amphibolite and pyroxenite. The acid intrusives include large bosses of granite with pegmatite and quartzites. Along the axial region of the Shillong Group of rocks, there is an extensive intrusive bodies of granite, known as Mylliem granite.

Lower Gondwana :

A small outcrop of the rocks of Lower Gondwana occurs at Singrimari (G.S.I. 1974) in the Garo Hills, represented by pebble bed, sandstone and impressions of Vertebraria indica.

Mesozoic Group (The Sylhet Trap) :

The Sylhet Traps are exposed in a narrow strip extending in E-W direction along the southern border of the Shillong plateau. They are plateau (Flood) basalts in nature and comprise mainly basalts and minor alkali basalts (Nepheline tephrite), rhyolite and acid tuffs. The basalts occur as flows and measure 5-7 metre average thickness. They comprise mainly phenocrysts of diopside, hornblende, augite, euhedral nepheline, magnetite and secondary minerals, like calcite, quartz and zeolite as fillers of vasicles.

Cretaceous-Tertiary sediments :

The Cretaceous Tertiary sediments occupying the southern part of Meghalaya plateau are thick and extensive. These sediments are affected mostly by basement controlled faults.

They include sandstones, limestones and shales (mudstone). Three well defined fossiliferous limestones occurs as i) discrete outlyers and ii) a continous narrow belt fringing the southern margin of the state bordering the Bangladesh plains. These sediments are divided into two group, (a) the Khasi Group and (b) the Jaintia Group. The Khasi Group is

of arenaceous facies and includes the oldest Jadukata Formation followed by the Bottom Conglomerate and the Mahadek Formation. The Jaintia Group represents calcareous facies and has been divided into three formations, namely the Langpar, the Shella and the Kopili Formation.

Khasi Group :

Jadukata Formation :

The Jadukata Formation rests unconformably over the Sylhet Trap and composed of alternation of conglomerate and sandstone.

Bottom Conglomerate Formation :

During the time of deposition of Jadukata Formation, there was a progressive migration of the shoreline towards north. As a result, a thick horizon of conglomerate on the plateau over the precambrian basement north of Raibeh fault was developed. This lithostratigraphic unit is termed as the Bottom Conglomerate Formation.

Mahadek Formation :

Overlying the Jadukata and Bottom Conglomerate Formation, the Mahadek Formation consists of coarse arkose, usually glauconitic bearing sandstone. The Mahadeo Formation is nearly horizontal in the northern direction. It has a low southerly dip in the type area. South of Mahadeo terrace, it dips about 30° near Therriaghat area.

Jaintia Group :

Langpar Formation :

The Mahadeo Formation is conformably overlain by the Langpar Formation of the Jaintia Group. It consists of calcareous shale, sandy limestone and fine calcareous sandstones. The Langpar Formation was developed in a stable shelf condition over which the Shella Formation with alternating limestones and sandstone was formed.

Shella Formation :

The Shella Formation includes three members, namely Lower(Therria sandstone/Lakadong limestone), Middle (Lakadong sandstones/Umlatdoh limestone) and Upper (Narpur sandstone/Prang limestone/Siju limestone and Sylhet sandstone/limestone) member.

The sandstone of the Therria stage and Lakadong limestone of the Sylhet limestone stage, and Lakadong sandstone along with Umlatdoh limestone of the Sylhet limestone stage (Goswami 1960, Mathur and Evans 1964 and Krishnan 1968)are grouped in Lower and Middle member by the Geological Survey of India (p. 3) without assigning any reason.

In Jaintia Hills and Garo Hills of Meghalaya and North Cachar and Mikir Hills of Assam, only the upper member is developed. Lying above the basement rocks and traps and below the upper member limestone of the Shella Formation is undifferentiated sandstone member known as Sylhet sandstone and is probably the facies variant of the lower and middle limestone member.

Kopili Formation :

Though Kopili Formation is included in the table in the Garo Group, it belongs to Jaintia Group and accordingly described by G.S.I. (1974).

The Kopili Formation overlies the Shella Formation conformably. It includes alternations of thin sandstone and shale with occasional thin fossiliferous bands of limestone.

Garo Group :

The eldest formation of the upper Tertiary sandstone is represented in Garo Hills by Simsang Formation, which conformably overlies the Jaintia Group. The Group includes the Simsang, Baghmara and Chengapara Formation.

The Simsang Formation includes massive cross bedded sandstones, alternating with siltstone and sandstone. The Baghmara Formation is represented by minor mudstone streaks, pebble conglomerate, massive clay and silty clay beds, thin alternating beds of mudstone and fine sandstone.

Dupi Tila Group :

A prominant unconformity is observed at the top of the Chengapara Formation in the western part of the Garo Hills over which lies the Dupi Tila Group. It consists alternation of coarse feldspathic sandstone with pebble beds and mottle clay.

Quaternary and Recent deposits :

Along the southern border of the Meghalaya plateau isolated patches of older alluvium overlies the Tertiary Rocks.

The Recent Alluvium is found in the river valleys on the northern foot hill region of Garo and Khasi Hills and is represented by fine silty sand and light to darkgreyish clay with rare pockets of coarse sand.

1.3. Aims and Methods of Study :

The present study is aimed to the following :

(a) Preparation of a detail geological map of the area.

(b) Measurements of thickness of the rock units to prepare the stratigraphical logs.

(c) Study the carbonate rocks petrographically.

(d) Geochemical studies of major and minor elements of the carbonate rocks.

(e) Study the clastic rocks.

The topographical map of the Survey of India on scale 1" to 1 mile was enlarged to four times and the geological map covering 31.22 square kilometres was made (Map 1). During the time of mapping, altimeter and Brunton compass were used. With the help of the Jacob's staff and steel tape, the geological sections were measured at the following localities :

(a) Section near Mausmai

(b) Section near Mawmulh

(c) Section near Ramkrishna Mission

The representative samples of the carbonate rocks were obtained at 1 to 2 metres intervals from the stratigraphical section. Besides spot samples were also collected and depositional structures are studied.

1.4. Previous literature :

Scanty literatures about the sedimentology and geochemistry of the carbonate rocks are available.

Fox (1947) dealt with the economic mineral resources of Assam.

Oldham (1851) gave the geological accounts of the area. He observed the occurrences of nummulitic bearing limestones and assigned Eocene age.

Medlicott's (1869) account on the geology of the area, laid emphasis on the Cherra Sandstone. Fossils collected by him were studied by Stoliczka (1869) and Spengler (1923).

Palmer (1924) described the limestone as a "Nummulitic limestone" and placed it above "Cretaceous sandstone" and below post "Nummulitic sands and clay."

Evans (1932) pointed out that the coal bearing sandstone under lying the Sylhet limestone of Mikir Hills, to be Eocene and as such to be stratigraphically unrelated to the cretaceous succession of the Cherrapunjee plateau.

Nagappa (1951) recorded the following algae from the limestones of the Cherrapunjee area-- Corallina grandis (Das Gupta), Distichoplax biserialis (Dietrich) and Lithothamnion Cherrapunjensis.

Biswas (1962) established the stratigraphy of the Mahadeo, Langpar, Cherra and Tura Formations in Assam (Meghalaya). He found that that the Garo, Khasi & Jaintia Hills experienced differential tectonic movements, during the upper cretaceous and lower eocene times and the movements controlled the sedimentation.

In Assam, the Eocene rocks are represented by the Jaintia Series, which are classified by the Geologist of the Assam Oil Company (Krishnan 1968).

Wilson and Metre (1953) described the stratigraphy of Assam and Arakan and included the Tertiary sequences of Meghalaya.

Mathur and Evans (1964) for the first time introduced the concept of dual facies development of the Tertiary Rocks in Assam, including the present Meghalaya. According to them the Tertiary rocks were formed in shelf and geosynclinal facies. The lithostratigraphic units in Meghalaya were formed in the shelf facies.

The Geological Survey of India (1974) dealt with the Geology of Meghalaya.