CHAPTER 1
GENERAL INTRODUCTION

1.1 Introduction

Meghalaya is a small state located at the north eastern part of India. This state which is also termed as ‘House of clouds’ is geographically bounded in the east and north by the state of Assam while it shares international boundary with Bangladesh in the west and south. The state is comprised of 11 districts namely North Garo Hills, South Garo Hills, East Garo Hills, West Garo Hills, South-West Garo Hills, East Khasi Hills, West Khasi Hills, South-West Khasi Hills, West Jaintia Hills, East Jaintia Hills and Ri-Bhoi. However, importance is bestowed on East Khasi Hills district as the study is confined to this area only.

Geologically Shillong Plateau is comprised of rocks ranging from Precambrian to Recent. However, the studied areas are represented by Jurassic-Cretaceous Sylhet Trap, Cretaceous Mahadek Formation of Khasi Group, Paleogene Langpar Formation, Sylhet Limestone Formation and Kopili Formation of Jaintia Group. The present study is restricted to the limestone deposits of Sylhet Limestone Formation found as linear patches along the southern border of the plateau. As a part of globally extended platform of the late Paleocene - early Eocene carbonate distribution phase (Kiessling et. al., 2003) Shillong Plateau witnessed many of the paleoclimatic, paleoceanographic changes of early Paleogene. Thus detailed petrographic, geochemical and palaeontological study of the Sylhet Limestone Formation of the plateau may substantiate the paleoenvironmental interpretation of the basin during Paleogene. In global scenario limestone and dolostone
together constitute a meager amount of the world’s sedimentary column. In spite of their deficient presence among the sedimentary rocks, the carbonate rocks have great economic importance as they constitute reservoirs for most of the world known hydrocarbon reserves. Carbonate rocks also host base metal deposits and groundwater resources. However, these carbonates are characterized by different petrographical constituents as well as a varied range of major oxides and trace elements. Proper identification and detailed study of these characteristic components may also provide sufficient clues to understand the depositional history of the carbonate sediments. Moreover, sedimentary carbonate rocks contain fossils of different time periods starting from Precambrian to Recent which interconnects the paleobiological, paleoceanographical, paleoecological, paleoenvironmental, basinal as well as organic evolutional aspects. The Paleogene carbonate successions are one of the best host for fossils of calcareous foraminifers along with algae, brachiopods and marine molluska like gastropods, cephalopods, lamellibranches etc. The occurrence of these foraminifers having varied shapes and sizes is evident in near shore to deep sea and near surface to ocean floor. The appearance of simple forms of foraminifera in the Cambrian (early Palaeozoic) to the relatively large and complicated forms of late Palaeozoic provides an outstanding record in stratigraphic, paleoenvironmental, paleobiological, paleoceanographic study. According to Scheibner et al. (2005), Zili et al. (2009), Alegret et al. (2009) larger foraminifers being the most common constituent of the late Paleocene-early Eocene shallow water carbonate platforms show a major change in morphology as well as their dominance during Paleocene-Eocene transition period. As foraminifers make excellent index fossils
at family, generic and species levels, based on these fossil foraminiferal contents rock strata can also be organized into different units which guide the practice of differentiating stratigraphic sections into units complying with conventions of biostratigraphy.

1.2 The research problem and the scope of the research

Since the mid of 19th century the Precambrian to Recent geologic succession of Shillong Plateau has attracted the attention of many geologists of different organizations. Although systematic and detailed geological work on this plateau were carried out by many earlier workers yet global benthic foraminiferal biostratigraphic status as well as sedimentological and geochemical characterizations were not integrated to evaluate the depositional environment of all the three units of Sylhet Limestone Formation together in a time frame depositional manner. Retrieval of sedimentological, geochemical and biological information of a rock sequence may undoubtedly provide substantial clues to decipher its depositional history by knowing their stratigraphic status and genetical relations with the other associated sequence as well. Hence this study is contemplated to present a comprehensive understanding in regards of sedimentological, geochemical and paleontological aspects of the Formation.

1.3 Hypothesis

Limestone deposition in a sedimentary basin is governed by physical, chemical and biological factors in various proportion of combinations. On the other hand the study of limestone divulges the contribution of each of those factors during deposition.
The process of deposition of limestones on the sea floor is attributed primarily due to accumulation of CaCO$_3$ rich materials. It is governed by various physical, chemical and biological factors. Further these factors are influenced by geotectonics and climate. Moreover, the sea level which is controlled by geotectonics and climatic conditions play an important role in deposition of limestones. It is noteworthy that slight variation like increase or decrease of these contributing factors result in genesis and deposition of different types of limestones. Therefore, the limestones thus formed may be classified as organic, chemical and detrital. Organic carbonates are composed of dead remains of the carbonate secreting organisms. These organisms extract calcium carbonate (CaCO$_3$) from sea water to build up their shells or skeletons. Chemical limestones are derived from the process of chemical precipitation. On the other hand detrital limestones are constituted with pre-existing detrital fragments of limestones. Besides geotectonics and climate, the physical parameter of limestone deposition includes the relative position of global sea level determined by ocean basin volumes and glacial ice volumes (Tucker et. al, 2005). However, terrigenous influx, temperature and salinity of the depositional environment, water depth, turbidity etc. are another vibrant physical factor of carbonate environment. Moreover, carbon di oxide concentration has a significant role in carbonate formation and its availability is governed by various physical and chemical parameters like pressure, temperature and degree of agitation in a basin. An ideal organic carbonate environment depends on carbonate secreting organisms and availability of these organisms are determined by the temperature and salinity of the depositional basin. Since larger foraminifers exhibit
significant adaptive potential to different environments as elicited from their evolutionary mechanism, their study holds tremendous potential and importance in determining vital information of its host carbonate depositional environment. Corroborative information regarding depositional environment can also be acquired from petrographic, major oxide as well as trace element study of sedimentary carbonates.

Therefore, it can be summarized that carbonate deposition in a sedimentary basin is controlled by different physical, chemical and biological parameters whereas sequential study of various limestone helps to understand the controlling parameters prevailed during deposition of the limestone in wider perspective.

1.4 Aims and Objectives

The objectives of this study are

- Study of sedimentological characters of the three limestone units of the Sylhet Limestone Formation
- Study of geochemical characteristics of the three limestone units of the Sylhet Limestone Formation
- Taxonomic identification of benthic foraminifera present in the three limestone units of Sylhet Limestone Formation
- Establishment of biozones based on identified benthic foraminiferal assemblage and their calibration with standard Tethyan Shallow Benthic Zonal framework
Understanding depositional condition of the three limestone units of the Sylhet Limestone Formation in the light of larger benthic foraminiferal, sedimentological and geochemical data

1.5 Review of literature

The pre requisite to any scientific study on any topic or place is a thorough in depth knowledge about the topic or place of study. This can easily be done with the help of innumerable literature review of noted researchers on that particular subject. Literature review is mostly associated with secondary sources and helps the readers to draw a concrete notion about the information already present on a topic after analysing the strength and weakness present in the source of information. This pattern of study essentially helps to frame a broad concept of the topic with a definite scientific strategy. To arrive at a conclusive study on the palaeoenvironment of this plateau, various literatures of many noted researchers suggesting different conclusions are studied and summarized. This results in familiarization with the previous knowledge and ideas that were already established by different scholars in their published papers.

Various methods can be employed to carry out literature review which include direct study and analysis of different books, journals, thesis, reports, papers etc. to gain knowledge and ideas. Moreover, the introduction of digital methods like e Library which allow readers to access a wide range of e Books, papers, journals etc. has simplified the knowledge gaining and sharing process and essentially helping literature review to a great extent. Digital library therefore has made a niche for itself in the present purpose and its popularity is gaining new heights with each passing day. Considering this view sources like J Store,

Separation of India from Antarctica – Australia Assembly during early Cretaceous helped the formation of east coast of India. It is believed that the SW part was separated first following the movement towards its NE part (Singh and Swamy, 2006). According to them several sedimentary basins were formed such as Cauvery, Pennar, Krishna - Godavari, Mahanadi, Bengal and Assam - Arakan Basin closed to the newly forming east coast of India during the process of separation. The Shillong Plateau is a part of the Assam - Arakan Basin where major sedimentation took place during Cretaceous - Tertiary time. During latest Campanian - Maastrichtian time, sedimentation in the Meghalaya Basin started in a rift basin depositing mainly conglomerates and sandstone of Khasi Group. However, during Paleocene - Eocene time when the basin attained passive margin condition, deposition of terrigenous clastic sediments and carbonate buildups took place on inner shelf of the sea. Carbonate sedimentation of the basin occurred mainly due to a change in the sedimentation pattern with decreased supply of terrigenous clastic material from land (Jauhri, 1988; 1994; Garg and Ateequzzaman, 2000). According to Garg and Ateequzzaman (2000),
the limestone bands with intermittent clastic facies were developed in the inner
neritic shallow shelf of this region and continued during Paleocene - Eocene time.

Paleogene involves several long and short duration palaeoclimatic changes, large scale plate reorganizations and paleoceanographic changes as suggested by Banerji (1981), Bains et. al. (1999). Large scale spreading of shallow epicontinental seas in the mid latitudinal areas e.g. Tethys Sea that covered the major areas of mid low latitude exhibit extensive development of shallow water carbonate platform. It is worth mentioning that Shillong Plateau of North East India has undergone many changes of globally extended carbonate formation phases of the late Paleocene - early Eocene. Occurrence of marine Eocene beds with Nummulitic fossils in the plateau was first reported by Oldham (1859) and ‘Sylhet limestone stage’ was further reported by Evans (1932) from Garo Hills, near Therria Ghat and Cherrapunji area of Khasi Hills.

Sylhet Limestone Formation is well exposed on the southern fringes of the `Shillong Plateau (Oldham, 1859; Evans, 1932; Wilson and Metre, 1953; Medlicott, 1869) and the succession is rich in larger benthic foraminifera. Nagappa (1956, 1959) established occurrence of Danian foraminifera in the Langpar Formation of Jaintia and Khasi hills including occurrences of other foraminifera in ‘Therria stage’ and upper part of the ‘Mahadek stage’ of the places. Further, the foraminiferal assemblage of Sylhet Limestone Formation has been apprised by different workers. Pandey (1981), Jauhri (1988, 1996, 1998), Matsumaru and Jauhri (2003), Jauhri et. al. (2006), Gogoi et. al. (2009), Tewari et. al. (2010), Matsumaru and Sarma (2010), Kalita and Gogoi (2015) etc. Pandey (1981) and Jauhri (1988) studied foraminiferal fauna of the Lakadong Limestone
from Therria Ghat section of south Shillong Plateau. Jauhri (1996) reported *Ranikothalia nuttalli* (Davies) as a distinctive early Ilerdian marker in a study from Therriaghat area near Cherrapunji and in 1998 reported *Miscellanea* Pfender, 1935. Matsumaru and Jauhri (2003) reported a new genus *Lakadongia* from Lakadong Limestone. According to Jauhri *et. al.* (2006) the lower part of the Lakadong Limestone have yielded biostratigraphic markers such as *Glomalveolina primaeva, Glomalveolina levis, Miscellanea juliettae, Miscellanea yvettae* etc. and the upper part have yielded *Ranikothalia nuttalli, Miscellanea miscella* etc. (Jauhri, 1997). Gogoi *et. al.* (2009) interpreted the palaeoenvironment of the Lakadong Limestone of the Sylhet Limestone Formation with the help of Pellatispiridae, Nummulitidae, Lepidorbitoididae, Alveolinidae and Discocyclinidae. They suggested prevalence of both back reef and fore reef environment during deposition of this limestone. Kalita and Gogoi (2015) suggested calm, low energetic condition in the lower part of the Umlatdoh Limestone unit changing moderately to high energy conditions in the middle part followed by low energy restricted environment towards the upper part of the Umlatdoh Limestone. Further, they suggested microcrystalline allochemical rocks of biomicrite type and a mixture of packstone and grainstone for the Umlatdoh Limestone unit. Matsumaru and Sarma (2010) recognized Thanetian to Priabonian age for Sylhet Limestones of Jaintia Hills.


Furthermore, Mishra and Sen (2001) had reported occurrence of fossilized bone fragments of dinosaurs, fossilized shark and whale bones, shark tooth etc. These are reported from places like Mawsynram, Langrin, Bhowal, Malaisohmat, Dwar Nongtyrnem, Ranikor, Mawlyngbna, Pynursla and other places bordering Bangladesh.