GEOMORPHOLOGY AND STRATIGRAPHY OF THE JAINTIA GROUP (EOCENE) IN THE GARO HILLS, MEGHALAYA

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ABSTRACT

The Eocene sediments of the Jaintia Group occurring on both the sides of the Tura Range represent the near shore deposits under shelf facies conditions. The Tura Range, running in a W. W. N.—E. E. S. direction, and the Someswari valley are the most important physiographic features of the Garo Hills. The maximum height occurs near Nokrek (1417 metres or 4650 feet) on the Tura Range. The Someswari, Krishnai, and Dalmi are the three important rivers. The whole interior parts of the Garo Hills is extensively occupied by dense mixed forest. On the northern side of the Tura Range, the sedimentation occurred north of the Darang normal fault, while these sediments occur south of the Dapsi reverse fault on the southern side of the Tura Range.

The Jaintia Group of the Eocene period in the Garo Hills is sub-divided, on the basis of rock units, into formations, members and beds, relying on the sedimentary sequences as distinct from time stratigraphic units. The formations are tabulated below:

3. Rewak Formation
2. Siju Limestone Formation
1. Tura Sandstone Formation.

Only the Rewak Formation is further divided into members as given below:

2. Rewak Sandstone
1. Rewak Limestone.

These sedimentary members are mappable units, which have been incorporated in a comprehensive geological maps of the Garo Hills.

INTRODUCTION

The area under investigation is incorporated in the Survey of India topographic sheet No. 78 K and is bounded by the following latitudes and longitudes (Text-fig. 1):

Latitudes: N 25° 17′ 68″ and 25° 31′ 0″

Longitudes: E 90° 11′ 54″ and 90° 45′ 0″

The main objectives of the present study are: (1) to enunciate the physiography of the Garo Hills, and (2) to classify the Jaintia Group of the Eocene period, on the basis of the sedimentary sequences into rock units (such as formations, members, beds).

GEOMORPHOLOGY

The entire Garo Hills represent a rugged physiography (Text-fig. 2). Most conspicuous hill range is the Tura Range, running in a W.W.N.—E.E.S. direction. The Tura peak, occurring in the vicinity of the Tura Town (25° 31′ N; 90° 13′ 50″ E), is at an elevation of 1219 metres (4000 feet) above the mean sea level. The highest elevations, 4650 feet or 1417 metres, is recorded near Nokrek on the Tura Range. In general, overall relief

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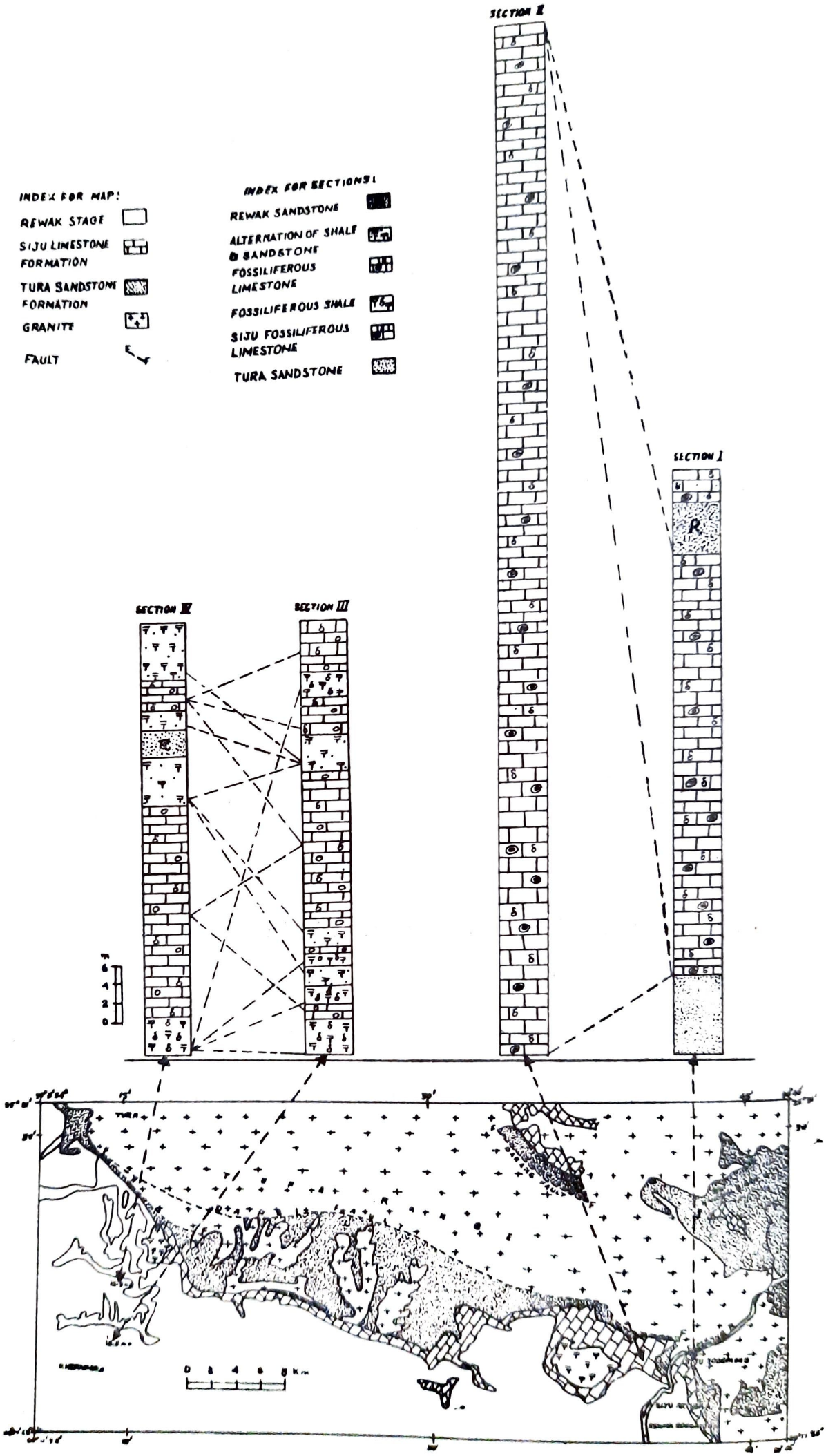

Text-Fig. 1. Geological Map of the Garo Hills showing the generalized sections of the Eocene Formations.

in the Tura area fluctuates from 182 metres (600 feet) to 304 metres(1,000 feet). The maximum altitudes of Nangwalbibra, Siju, and Rewak Songmong are more or less same and are about 609 metres (2000 feet) above the mean sea level. The whole area of the Garo Hills is extensively covered by dense mixed jungles of various shrubs, trees, creepers, shade loving plants, pitcher plants, bamboos, and so forth. Commonly, the valleys are cut by deep and steep gorges. Nangwalbibra, Siju, and Rewak areas are intersected by the river Someswari. A good number of tributaries with dendric pattern of drainage coming down from the hills enrich the channel of the Someswari throughout its course. Most remarkable one amongst the tributaries is the Rongju River which flows from south towards north and debouches at Nangwalbibra where it meets Someswari River. Other notable tributary is the Rongdik River at Rewak, Songmong area. It flows in E. E. S. direction. The south-western part of the Tura Range is disected by the Dalmi River which flows towards south-west direction in a zig-zag way. The Dalmi River has crossed the Tura-Dalu road at 11.2 kilometres (7 miles). In between the Bugi River and Norang River on the east of the Tura-Dalu road, three small hillocks are seen. The maximum altitude attained here is 198 metres (650 feet).

Tropical monsoon type of climate prevails in these areas. Temperate climatic condition is usually accomplished by the heavy rains. The rainfall caused by the south-west monsoon from April to September ranges from 100 mm to 1200 mm. The rainfall due to north-east monsoon in the winter season from November to March is very scanty. Most of the 'nalas' and 'streams' are dry during the winter season. The average temperature goes up to 37°C (100°F.) with increasing humidity throghout the year.

Text-fig. 2. Physiographic map of the Garo Hills.

STRATIGRAPHY

Recently, a few geologists have attempted comparison of the rock sequences of Khasi and Jaintia Hills and the Garo Hills on the basis of time stratigraphic units. Stratigraphical aspects of the area were discussed by FERMOR (1935), HERON (1936-1938) and WEST (1939,1949) in the memoirs and records of the Geological Survey of India. FOX (1937) suggested the term "the Tura Sandstone Stage" to the sedimentary rock which outcrops on the southern flank of the Tura Range, Garo Hills. GHOSH (1954) pointed out that the "Tura Sandstone Stage" is a lateral facies development of the middle and/or lower portion of the "Sylhet Limestones" of the Khasi and Jaintia Hills. NAGAPPA (1959)correlated some of the foraminifera from the Sylhet Limestone of Khasi and Jaintia Hills with the limstone of the Siju and Rewak Stages of the Garo Hills.

BISWAS (1962) also dealt with the Tura Formation in his systematic stratigraphy. A precise summary of the Tertiary Sequence of Assam was recently given by MATHUR and

EVANS (1964). KRISHNAN (1968) discussed the Tura Stage of the Garo Hills, gave its systematic stratigraphical position and correlated it with the Middle Sylhet Limestone of the Khasi and Jaintia Hills.

The Eocene sediments of the Jaintia Group in the Garo Hills rest on the Pre-Cambrian granitic and gneissic complex. The lithostratigraphical sequence is presented below in a tabular form:

System	Group	Formation	Member	Beds
Upper Eocene ..	JAINTIA	Rewak ..	Sandstone ..	Ferruginous sandstone
				Carbonaceous shale
				Fine-grained sandstone with concretions
				Black shale with their beds of sandy shale
			Limestone ..	Earthy limestone with fossils
				Gray shale with fossils
		Siju Limestone ..		Gray shale
				Nummulitic limestone
Middle Eocene ..				Ferruginous friable sandstone (lateritic soil)
				Coarse-grained sandstone with pebbly beds
				Thin coal bed
				Medium-grained sandstone
		Tura Sandstone.		Thin clay bed
				Medium-grained sandstone
Lower Eocene ..				Thin coal bed
				Fine-grained sandstone
				Clay bed
				Sandstone
Pre-Cambrian granitic and gneissic complex				

The detailed characteristics of the individual for mations are described below :

TURA SANDSTONE FORMATION

This formation possesses three lithologic units, namely, sandstone, coal and clay. The thickness of the Tura Formation is variable and is fairly strewned in the Garo Hills, on the N.N.E. and southern flank of the Tura Range. The Tura Formation is completely exposed in the Rongju river at Nangwalbibra, in the Someswari river at Siju Artheka, and along the road cutting near Tura Town.

The thickness of the different lithologic units has been measured from the Rongju river section (Text-fig. 1). The sandstone shows two conspicuous horizons, such as, white to gray, fine and medium-grained sandstone. The Tura Sandstone Formation, as exposed in the Rongju river near Nangwalbibra, is as follows:

Lithologic Units or Beds	*Thickness in metres*
Ferruginous friable sandstone with thinly bedded of pebbles	9.14
White clay with a few white sandy particles ..	4.57
Medium-grained, massive, gray sandstone ..	2.817
Coarse-grained, reddish sandstone	16.25
Thin coal bed	0.504
Medium-grained sandstone and carbonaceous shale	18.290
White clay	1.291
Flaky coal exhibiting sulphurous efflorescence ..	0.608
Ferruginous clay with quartz grains	1.570
Medium-grained sandstone with thin bands of shale bed	27.510
Coal bed	0.964
Gray shale	0.808
Coal bed..	0.379
Sandstone with fire-clay intercalations	11.069
Coal	0.758
Fine-grained, gray sandstone with current bedding..	7.700
Fire clay	1.903
——————Base is not visible——————	

The individual beds of the Tura Sandstone Formation are steeply dipping in south east direction at Siju Artheka.

Siju Limestone Formation

The Siju Limestone Formation conformably overlies the Tura Sandstone Formation. The limestone beds generally dip in south-east direction, but near Siju Songmong they form an anticline showing dip in both south-east and north-east directions. The axis of the anticlinal fold in limestone beds plunges 6° towards S.E. One limb of the anticline dips 12° N.E. and the other limb dips 18° S.E.

The Siju beds are also found near Sankinigiri (25° 24′ 16″ N:90° 16′ 6″ E) and the thickness is found to be 7.60 metres (25 feet). The bed dips 6° towards S. W. The limestone of Sankinigiri belongs to the Siju Limestone Formation. Near Darang Era Aning (25° 26′ 89″ N 90° 45′ E) the limestone beds dip 10° towards south-east and they are similar to the Siju limestone. At some places, the limestone bed contains pyrite crystals.

The Siju Limestone Formation as exposed on the left and right bank of the Someswari river between Siju Songmong and Siju Artheka has been measured. The section of the Siju Limestone Formation as exposed near Thaikam (25° 21′ 93″ N : 90° 41′ E) towards east of the Inspection Bungalow at Siju Songmong is given in the following succession:

Lithologic Units or Beds	*Thickness in metres*
Highly Nummulitic and Assilina bearing khaki limestone ..	0.914
Thinly bedded, highly foraminiferal weathered khaki limestone	0.758
Less foraminiferal limestone	1.064
Buff limestone with Nummulites	0.758
Compact, reddish, buff coloured limestone with fairly large foraminifera	0.783
Hard, gray and bluish-gray limestone with less foraminifera ..	1.114
Compact, buff and bluish-gray limestone with big Nummulites and molluscan shells	0.914
Massive gray limestone with very less foraminifera	1.266
Compact, cream to bluish-gray limestone with less foraminifera, mollusks, and calcite crystals	0.989
Hard, blusih-gray limestone with very scanty foraminifera and chert nodules	2.482
Hard, buff and bluish-gray limestone with Nummulites and calcitic surface	1.620
Compact, buff and gray limestone with less Nummulites and calcite crystals..	2.432
Massive, reddish and bluish-gray limestone with insignificant foraminifera	1.570
Massive, bluish-gray limestone with less foraminifera ..	3.115
Bluish-gray and buff limestone with large formanifera and nodules..	6.155
Compact, bluish-gray limestone with less Nummulites ..	3.040
Buff and bluish-gray limestone with high foraminifera (big) ..	7.396
Hard, buff and creamy limestone with fairly large Nummulites ..	6.080
Massive, bluish-gray limestone with high foraminifera and calcite crystal	3.748
Reddish, buff limestone with large foraminifera and fine calcite crystals..	3.080

——————Base is not seen——————

Rewak Formation

The Rewak Formation conformably succeeds the Siju Limestone Formation. The Rewak Formation is well exposed along the Someswari river between Siju Artheka (25° 19′ 64″ N : 90° 40′ 78″ E) and Rewak Songmong (25° 18′ N : 90° 40′ E), and between 4 miles post and Khanapara along the Tura-Dalu road south of the Tura Town (25° 31′ N: 90° 13′ 50″ E). Three main lithologic units, namely impure limestone, shale and sandstone, are the important representatives of this formation. The limestone is the bottommost lithologic unit in the chronological sequence.

The limestone and sandstone beds deposited between Siju Artheka and Rewak Songmong are dipping in south-east direction, varying in the amount of dip from 6° to 12°. But these beds dip from 5° to 15° S. W. along Tura-Dalu road. The entire shale beds are dipping in the same direction with different amount of dip, ranging between 3° to 6°.

The succession with thickness, as developed on the bank of Someswari River between Siju Artheka and Rewak Songmong, is given below:

Lithologic Units or Beds	*Thickness in metres*
Ferruginous friable, pebbly sandstone	2.582
Gray shale	0.658
Medium-grained, brownish sandstone	1.416
Coarse-grained, massive, reddish sandstone with concretion	2,917
Carbonaceous shale	1.064
Medium-grained, massive, friable sandstone with iron hollow concretion	2.582
Sandy shale	0.758
Medium-to-fine-grained, white and purple sandstone with tabular cross-bedding	2.353
Gray shale	0.454
Fine-grained, massive sandstone	1.620
Foraminiferal shale	0.529
Khaki weathering limestone with mollusks and forminifera	2.432
Reddish buff limestone with less foraminifera and mollusk	1.366
Earthy limestone with high foraminifera, mollusks and brachiopods	1.139
Reddish, yellowish limestone with Discocyclina	0.608
Foraminiferal shale	0.379
Brownish, earthy limestone with foraminifera	1.416
——————Base is not seen——————	

Two more measured successions of the Rewak Formation, as developed in a 'nala' at 21.6 and 29.6 kilometres south from Tura along Tura—Dalu road, are shown in the generalized geological map (Text-fig. 1).

Structure: The Garo Massif has been subjected to vertical block displacements in the Middle-Upper Eocene period (Biswas, 1962). There are two main faults, such as, (1) Darang normal fault on the northern side of the Tura Range, and (2) Dapsi reverse fault on the southern side (Fox, 1937). The Darang fault runs in north-west and south-east direction and Dapsi fault runs in east-west direction (Text-fig. 1). These faults apparently played an important role during the deposition of the formations. Many local and small faults are also observed that disturb the Tura Sandstone and Siju Limestone Formations. Notable amongst them is the fault exposed near Siju Artheka along Someswari River which steeply dips towards east. Above the Gudumi River along the Tura-Dalu road, there is one minor fault. The fault plane dips towards east, at an angle of 16°.

SUGGESTION AND CONCLUSION

In reviewing the present investigation, it would seem from the field observations and geological mapping that the Garo Hills had been tectonically disturbed at Rongrengiri, along the Tura-Range, and near Tura Town during Lower Eocene period. During Middle and Upper Eocene periods, the area was not tectonically deformed. At the time of Palaeocene period, there was no subsidence and no deposition. During Lower Eocene to lower portion of the Middle Eocene periods, the Garo Hills first started subsiding and developed

sedimentary basins where mostly organic materials along with other constituents were brought from different sources. Thus the shelf areas yielded the dominantly river and subsequently beach sandstones, thin coal bed, and clay deposition in the Garo Hills. During middle and upper parts of the Middle Eocene period, the huge and extensive good quantity of limestone with mainly microfossils and less amount of gray shale were deposited in the pelagic basin under marine and shallow-water conditions. Successively the impure and less extensive fossiliferous limestone, gray shale with and without fossils, and sandstone with iron hollow and solid concretions well deposited near the shore of the depositional basin in intermittent fresh-water and marine, and river conditions respectively which prevailed throughout the Upper Eocene period. The Upper Eocene sediments were successively followed by the Miocene sediments, near Goko, in the Garo Hills.

The author is not aware that the present study, especially lithostratigraphic status, has been recorded before in the Garo Hills. The Tura Sandstone Formation of the Garo Hills is equivalent to the middle and lower portion of he Upper Sylhet Limestone Stage (Lower-Middle Eocene) of the Khasi and Jaintia Hills. The Siju Limestone Formation overlies the Tura Sandstone Formation which is correlated with the Upper Sylhet Limestone Stage (Middle Eocene) of the Khasi and Jaintia Hills, as described by KRISHNAN (1968). *Discocyclina* observed from the Rewak Limestones near 7 miles post along Tura-Dalu road is the best indicator to distinguish the Rewak and the Siju formations (after NAGAPPA, 1959). The Siju Limestone Formation is conformably overlain by the Rewak Formation which is equivalent to the Kopili Stage (Upper Eocene) of the Khasi and Jaintia Hills. The basal part of the Rewak Formation, however, invariably rests upon a shale which is opulent with the fossils like Nummulites and Gastropods. Relying on the sedimentary sequences as rock units as distinct from time stratigraphic units, the correlations between the Jaintia Group sediments as developed in the Garo Hills during Eocene periods and the Jaintia Series as exposed in the Garo Hills as well as Khasi and Jainitia Hills during the Palaeocene and Eocene periods, are shown below:

System	Khasi & Jaintia Hills	GARO HILLS			
	Krishnan (1968)	Ghosh (1954)	Krishnan (1968)	Pandey (1970)	
Upper Eocene	Kopili Stage	Kopilis?	Rewak Stage	Rewak Formation	Sandstone Limestone
Middle Eocene	Prang Limestone	Upper Siju Limestone Stage	Siju Limestone Stage	Siju Limestone Formation	
	Nurpuh Sandstone	Lower Siju Limestone Stage			
Lower Eocene	Umlatdoh Limestone	Tura Sandstone Stage	Tura Sandstone Stage	Tura Sandstone Formation	
Upper Palaeocene	Lakadong Sandstone				
	Lakadong Limestone				
Lower Palaeocene	Therria Upper Therria Stage Lower Therria				

JAINTIA SERIES: SYLHET STONE LIMESTONE STAGE — UPPER, MIDDLE, LOWER

JAINTIA GROUP

It is concluded that the whole of Garo Hills was effected by two major tectonic movements i.e. (1) Dapsi reverse fault, and (2) Darang normal fault. The sedimentation has taken place near these deformed portions of the Garo Hills. There is no marked break in between the Tura Sandstone Formation and Siju Limestone Formation, while a change in the condition of deposition of the sediments is suggestive of abrupt change from a predominantly clastic rocks of the Tura Sandstone Formation to a predominantly non-clastic (Calcareous) rocks of the Siju Limestone Formation. On the basis of the sedimentary sequences as rock units, the Jaintia Group of the Eocene period is classified into formations, members, and beds. Only the Rewak Formation is, here, grouped into members, viz. (1) Limestone, and (2) Sandstone. The sedimentary rock units, as well developed near the shore of the depositional basin under different environments during Eocene periods, are the most useful indicators in the light of systematized code of Litho-Stratigraphic Nomenclature.

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