

MAN AND ENVIRONMENT

IN NORTH EAST
INDIA



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DILIP K. MEDHI

This book in a series will be an exclusive projection of *Man and Environment in North-East India*, a territory of seven states, which was formerly known as a single political unit—the Assam. Former Assam or the present day North-East India is little known to the outside world. In the prehistoric and the early historic times, this part of India acted as a corridor between mainland India and the Southeast Asia including China and migration from the latter took place in the past. Myanmar was connected to this part of India during the British rule and so was the Sylhet of Bangla Desh and Koch Behar of West Bengal. It is from here Netaji Subhas Chandra Bose's army attempted to liberate India and the valiant Assamese army defeated the mighty Mughals on eighteen occasions. Sixteen century born saint Sankardeva united the population of this region with a preaching of a *Vaishnavite* religion based on *Bhagabata dharma* and attempted to extricate the evils of caste system in India. No death occurs here due to the non-existence of the dowry system. A legal court is not immediately approached here—all sorts of disputes are settled by a village council. Inexpensive home made wines is the elixir of life in this part of India and death due to spurious liquor is unheard of. Herbal care and cure of diseases and ailments an age old practice of this territory. Outside the Brahmaputra and the Barak valleys land ownership is different and governed traditional tribal rules.

Huge forest resources including the prestigious one-horned rhino, tea, petroleum and coal are found abundantly and tremendous potentiality for producing enormous hydel power also characterise the region. And in future, a lot more on this region will be focused in this series of books.

Dilip K. Medhi (b. 1951), editor of this volume on the series 'Man and Environment in North-East India' belongs to the discipline of Anthropology and also a prehistorian and an archeologist. He obtained his postgraduate degree in Anthropology from the Gauhati University and Ph.D. in Archeology from the Deccan College under Poona University. A gold medalist and the recipient of the coveted B.S. Guha medal and also the National merit Scholarship, Dr. Medhi has travelled extensively into the territories of the Philippines, Japan, Indonesia, Thailand, Singapore, Hong Kong and Hawaii (USA). He was a visiting fellow of the Asian Cultural Council, New York, USA and worked on Southeast Asia pottery, its archeology and prehistory with Professor W.G. Solheim II in the Department of Anthropology, University of Hawaii at Manoa, Honolulu, USA. Dr. Medhi teaches Anthropology and Prehistoric archaeology and was a Reader in Anthropology, Dibrugarh University. Currently he is a Faculty Member in the Department of Anthropology, Arya Vidyapeeth College, Guwahati.

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MAN AND ENVIRONMENT IN NORTH-EAST INDIA

VOLUME-I
(Introductory)

Editor

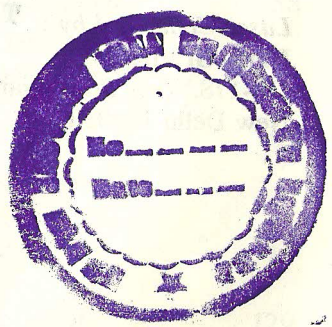
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Foreword

This book is about North-East India, its people and their environment. Geographically the area is almost cut off from the rest of the country, connected with it only by a narrow corridor between Bhutan on the north and Bangladesh on the south. Politically and economically it is today very much a part of India, but historically, and in many other ways, it is an entity in its own right. It is a land of striking contrasts. The Brahmaputra valley, with its near-tropical climate, is a fertile alluvial plain, dominated and continually re-shaped by one of the world's great rivers. Much of the remainder is magnificent hill country, ranging from Nagaland in the east, with peaks rising to over 10,000 feet, to the gentler Garo Hills in the west. The Mizo hills in the south reach down to a lower latitude than that of Calcutta, while in the north the vast territory of Arunachal, with forested hills and torrential rivers, reaches to the snow peaks of the Himalayas.

The earliest history of North East India has been lost in the mists of time, but for 2000 years or more the Brahmaputra valley has been open to powerful influences from the Indian heartland to the west, in the form of Hindu thought, religion and culture. But the people themselves, both of the plains and the hills, came largely from the east, in successive migrations across the mountain passes. It is of interest to note that whereas the history of mainland India was often profoundly influenced by incursions from the north-west, there was nothing comparable from the north-east. The Koch kingdom was strong and aggressive in its day, but rarely reached beyond the Karatoya. The Ahom Kingdom, for all its power and military prowess, never aspired to the Delhi throne or threatened the Mogul empire. The history of Assam (using the word in its old sense) was played out, so to speak, on its own stage. For that reason, perhaps, historians have often seen it as merely peripheral and of little significance. For example the two-volume Pelican 'History of India', though excellent in other ways, dismisses Assam in half a dozen lines. The whole vast episode of the Ahom Kingdom, which endured through six centuries, merits only a single sentence.

N.E. India offers a fascinating field of study in almost every discipline, not only to the historian. To the geophysicist it is a crucial area in the study of plate tectonics, where, some millions of years ago, continental India impacted the Asian land mass. To the geographer it presents almost every kind of terrain, from the arctic to the sub-tropical. The zoologist finds here an immense range of species; the butterflies alone would make a lifetime's study, as would the orchids for the botanist. For the anthropologist and the sociologist there is a rich field to be harvested, in the study of political systems, tribal cultures and customs, arts and crafts, music and dancing. And for the philologist this area is a paradise, with a hundred or more languages belonging to three of the great language families, Indo-European, Tibeto-Burman, and Mon-Khmer.

It was my privilege to spend more than seven years in N.E. India, including three as Vice-Chancellor of Gauhati University. It was then the only University and was responsible, as far as higher education was concerned, for a territory of about a hundred thousand square miles. Scattered over the area were forty or more affiliated colleges, many in remote and isolated places. By visiting them, and in other ways, I was able to learn far more than would otherwise have been possible about the country and its people, and I gained an enduring affection for both. The University was already doing much to promote studies of the area, and of its history, development and culture. In particular there was much excellent research (which no doubt still continues) into the political, social and economic conditions of the Ahom period, based on the buranjis and other surviving records.

Sir Edward Gait's 'History of Assam' is a classic to which we are all indebted. There have since been other studies of the area, as for example Hem Barua's 'Red River and Blue Hill', which deals not only with history, but with the cultures, languages and literature of the area. But times change, knowledge grows, and new problems constantly arise. The old Assam is now re-constituted into seven distinct states, each with its own character and ethos. They are likely to face problems in such areas as population growth, economic development, industrialisation and urban expansion. There are already acute environmental dangers, especially in de-forestation and soil erosion. In the monsoon the streams which

drain the Khasi Hills run red with eroded soil, millions of tons every years, and the same is doubtless true elsewhere. There is thus a constant need for new appraisals and new research, and a more widespread knowledge of all aspects of life in N.E. India.

I am therefore particularly glad that Dr. D.K. Medhi and his colleagues have undertaken the task of preparing and publishing these studies of Man and Environment in N.E.India. They have the knowledge and the professional expertise required for the task, and the book should do much to promote a wider and more deeply informed interest in N.E.India, its people, its character, its resources, and its present problems. I am happy to commend the work, which I believe to be of major importance, and I trust it will be well received.

H.J. Taylor

Editor's Note

On a fine evening of February, 1985 in the luncheon room of Hotel Aurelio at Manila in the Philippines myself, Professor Jack Golson and Dr. Peter Bellwood (both from the Australian National University, Canberra), Professor V.N. Misra (currently Director, Deccan College, Pune) along with a few delegates to the 12th IPPA Congress were having jubilant discussions comprising many issues of academic nature. On the previous night we were back from Penablanca, North Luzon where we had our assembly of the 12th International Congress of the Indo-Pacific Prehistory Association including a series of symposia of week long duration. We returned back to Manila via Banauae which was a famous tourist's spot and where one can see the world-famous Ifugao tribe and their terrace cultivation. Myself and Professor Misra observed that the trip to Banauae for us (Indians) was not necessary, because terrace cultivation was not an uncommon scene in India. I personally informed our mini assembly that the Apatanis, a tribe of the Arunachal Pradesh, were famous terrace cultivators in the world; so was the Angami Nagas. Professor Jack Golson asked me to repeat the names. Apatanis and the Angami Nagas not only practice the terrace cultivation, but are also expert in irrigation in the hills. Professor Jack Golson was fascinated and I could see in his face how he visualised my statement. Two Chinese delegates Dr. Liu Jun, an archaeologist in the Zhejiang Provincial Museum, Hangzhou and Dr. Wang Chaoba, Professor of English in the Zhejiang University, Hangzhou were also delighted to hear this. Professor Jack was keen on coffee which we all had plenty in that evening and were engaged ourselves in delightful chatting also. Once, I referred to the great story of Rip Van Winkle and Professor Jack and everybody blasted into laughter. At fifteen minutes to twelve we dispersed, because most of us had to leave Manila in the next morning.

Earlier to my departure to the Philippines, myself with my friend Dr. Zahid Husain of Anthropological survey of India first

conceived an idea of publishing a series of volumes on Man and Environment in North-East India, since this region is not well known academically. A lot of this region remains yet to be explored scientifically. Planners are hardly acquainted with every avenues that require planning in this region. Property ownership and land tenure system in this part of India have a different socio-political set-up. Geologically and geographically, the Northeastern states of India don't compare well with the mainland of India. People living in the hills and in the plains have a heterogenous composition. Similar to the African continent, Arunachal, a Northeastern province of India comprises a large number of varied ethnic groups, each of them speaking a distinctive dialect. Keeping in view the diversified ethno-cultural set-up of North-East India, myself with my friend Zahid decided to take up a project on Man and Environment in this part of India and a decision in this respect was taken on 8th December, 1984 in the premises of the Assam State Museum, Guwahati. On the same evening we approached Mr. C.D. Thipathy who was an administrator cum scholar from the Indian Administrative Service and he encouraged us in the proposed venture.

Other members included in our project were Dr. Phani Deka, a Faculty Member in the National Institute of Small Industry Extension and Training (NISIET), Guwahati, Mr. G.N. Bhuyan, Director, Directorate of Archaeology, Assam, Guwahati and my wife Anjali D. Medhi. In planning and programming we passed a period of two years and in the middle of 1986, I decided to change the strategy of the project with Mr. Dilip K. Dutta, an assistant editor of the Publication Board, Assam who joined me for a brief period and we approached Dr. A.C. Bhagabati in his residence and had discussion on the project in detail.

I decided to cover in our venture the man, the environment and the eco-system, socio-cultural and socio-political system of this region including all conceivable avenues relating to Man and Environment and their publication in a series of volumes. Further, it will also remain open to contributions from other parts of India and abroad as well.

For contribution of articles, I contacted over 20 scholars in and around India and abroad, but response was very poor. Ample

time limit was offered for writing an article, but a limited number of articles were received which were hardly sufficient for bringing out a volume. I again and again, requested different scholars in vein. However, I managed to receive a couple of articles for our proposed first cum inaugural volume.

We do not claim ourselves successful in academically representing the entire North-East India through our humble effort, but it is true that for the first time such a venture has been made to highlight the academic importance of North-East India under a single platform. Now I feel that the scholars whom I met in my various trip abroad will get some information on Northeastern India, the erstwhile territories of former Assam. My trips to Japan in 1987, to the University of Hawaii, U.S.A. as a Visiting Fellow in 1989-1990, to Indonesia in 1990 and again to Honolulu, Hawaii, U.S.A. for attending the Pacific Science Congress in 1991 revealed striking lack of knowledge about this part of India which acts as a corridor between the mainland Southeast Asia and the mainland India.

I feel scholars from various academic field would feel encouraged to contribute their academic finds and thoughts in our proposed series in future. We should no longer be hesitant in citing examples and instances in social sciences and in other scientific disciplines from Northeastern India and what I think is an unknown medicinal plant from this region will be known to the outside world or a planner will find his required materials to become handy for an all-round planning of the Northeastern states of India. That is why, we, a few people have put our heads together in bringing forth a new vista in the academic scenario of North-East India. And Professor Jack Golson will no longer be surprised to have an example of the famous Apatanis or the Angami Nagas of the Arunachal Pradesh for their world famous terrace cultivation with facilities of irrigation.

In the present volume with a desire to acquaint our readers with various folds of man and environment in North-East India, we have included articles on geology, ecology, on resource system, on land tenure system and on man, culture and language and folklore. The 'Forward' to this volume has been written by Dr. H.J. Taylor, the former Vice-Chancellor of the Gauhati University. I

am much grateful to Dr. Taylor who in his vision could point out the enormous potentialities of Assam and the entire Northeastern states of India as a whole. I am also grateful to all the contributors of this volume.

I would be much happy if this volume comes to the help of all those who are keen to know the North-East India. I further invite suggestions and criticism if any towards the production of this volume.

Lastly, I am thankful to Mr. Ramesh Kumar of Omsons Publications who has taken the responsibility of publication of this volume including the forthcoming volumes in this series.

Professor Colony
Guwahati 781016: Assam.

Dilip K. Medhi
Editor

Acknowledgement

I wish to acknowledge my gratitude to the following Institutions which kindly gave me permission to include in this book my articles and papers which have been already published and presented

- Sahitya Akademi — Bhagyachandra's Contribution to Manipuri Culture.
Vaishnavism in Manipuri Literature.
Mystic and Devotional Poetry in Manipur.
Manipuri Literature: A Survey.
Tantric Elements in Manipuri Culture.
- Manipur University — Renaissance in Manipur : Fact or Fiction ?
- Assam Academy for — Manipur and Assam : Quest for Cultural Relations Cultural Identity.
- Gauhati University — Rama-Katha in Manipur : Folk Tradition and Performing Arts.
- North-East India — Status of Religion in Tribal Areas of Council for Social Science Research. Manipur.
- Manipur Folk-Lore — The Concept of Sanamahi through the Society. Ages.
- Marg (Bombay) — Martial Arts of Manipur. Publications
- Paschimbanga — The Contribution of Indo-Mongoloids Bangla Akademi. to Indian Culture.

It would not be possible for me to name all the friends and scholars who gave me sufficient courage and inspiration for the publication of the remaining papers and articles. I am most grateful to all of them.

But I wish to thank, in particular, the dynamic and understanding publisher, Shri Ramesh Kumar of Omsons Publications, New Delhi who kindly agreed to accept my writings and undertake its publication in his admirable commitment to the projection of the cultures of North-East India. I shall remain always indebted to him.

Geology of North-East India

S.K. Dutta

North-East India as the name signifies forms the northeastern part of the continental mass of India. It is characterised by hills, mountains and valleys. The most prominent feature is the Brahmaputra valley, bounded on the north by the Himalayan mountains, the Mishmi Hills (Luhit district) shut it off to the north east, to the south east area are the Naga Hills (the state of Nagaland) composed of Mesozoic and Tertiary rocks extending southwards into Manipur, to the south-west is the Assam Plateau comprising the Garo, Khasi and Jaintia Hills (the state of Meghalaya) and the detached Mikir Hills (Karbi Anglong), to the south are the hilly regions of North Cachar and Mizo Hills (the State of Mizoram) and the adjoining hills in Tripura. Geologically this is the northeastern prolongation of the Indian Peninsular Shield with the Garo-Rajmahal Hills gap in between, through which the Ganges and the Brahmaputra are deflected southwards to flow to the Bay of Bengal.

Broadly speaking the northeastern region consists of Archaean and Shillong Group, and their time equivalent rocks exposed over a large part of the Khasi, Jaintia, Garo, Karbi Anglong and Arunachal Pradesh. The Archaean rocks are similar to the rocks which form the basement complex of Indian Peninsula especially in Bengal and Bihar of which the North-Eastern region was a part at one time. Palaeozoic rocks both marine and littoral are seen exposed in Arunachal Pradesh. While a small isolated patch of continental Gondwana rock occurs at Singimari or present day Hallidayaganj in the Garo Hills. Dutta and Banerjee (1979) have reported the occurrence of sub-surface Gondwana sediments from Assam-Arakan Province. More recently Oil and Natural Gas Commission (ONGC) recorded

Gondwana sediments in the sub-surface around Barpather, Jorhat district (Personal Communication). Upper Mesozoic rocks are observed in the southern and southeastern parts of Meghalaya, Manipur, Nagaland and in Jorhat district. Tertiary rocks are encountered in the Brahmaputra valley, Karbi Anglong, North Cachar, Nagaland, Manipur, Mizoram, Surma valley, Meghalaya and at several places in Tripura.

From the Pre-Cambrian rocks exposed in the Meghalaya and Arunachal Pradesh, we can however, reconstruct part of physiographical conditions prevailing at that time. The nature of the rocks tell their own story. The quartzites and phyllites constituting the Pre-Cambrians were laid down in a shallow sea as is evidenced by the presence of current beddings, ripple marks displayed on the surface of the rocks. The topping conglomerate in the Shillong Plateau, a shoreline facies, indicates uplift of the provenance. Except that they resemble Pre-Cambrian rocks in other parts of the Indian shield no other precise data about their age are available. By radiometric methods Sarkar *et al.* (1964) estimated the age of the coarse muscovite from a E.W. trending mica schist of the Shillong Group at 472 million years and commented that the regional metamorphism of the group took place during the Ordovician. Until more age determinations are made by other methods the determined age cannot be taken as actual age as there is at present no evidence of any tectonic movement having taken place during the Ordovician for the regional metamorphism assumed.

Pathak and Chaudhury (1983) by Fission Tract method dated the sphene grains of the granite of Nartiang and Dawki region of Meghalaya as 1118 ± 66 m.y. and 1124 ± 79 m.y. respectively and concluded that these granites may be linked with a common cycle of Plutonic event.

The conglomerate is well displayed on the decent to the Bishop fall. The locale of the uplift cannot be pin-pointed, but from the nature of the constituent boulders and pebbles of the conglomerate, it is surmised that it must be in Shillong-Mawphlong area. Associated with these rocks are volcanic lava now metamorphosed to epidiorite and commonly known as the Khasi green stone. From time to time these rocks were intruded by some deep seated igneous rocks the last of which is known as the Myllem granite.

Lower Gondwana : The region remained a land mass till Permo-Carboniferous. In the Himalayan region (Arunachal Pradesh) sedimentation began in Permo-Carboniferous. There was also plateau volcanic here as is indicated by the Abor volcanics in the Siang district.

The first sign of marine life that we see in this region comes from the limestone laid down in the ancient Himalayan Mediterranean sea known as the Tethys, whose water washed the northern border of the southern landmass forming part of Gondwana land during Permo-Carboniferous time from the Ranganadi through the Dikrom valley to the Ranjit valley in Sikkim. In the above place are found remains of plants of the seed fern family called *Glossopteris* and *Cycad*. Nearly parallel to the southern shore line of the Tethys at such places as the Aka Hills (Kameng district) Se-La Agency and the valleys of Kalapani and Barnali in Bhutan and in the Singrimari, Garo Hills are found remains of the above plants entombed in the sandstone. Krishnan (1968) mentioned that in the Ranganadi valley, Gondwana plant bearing beds are associated with marine fauna such as *Spirifer*, *Chonets*, *Eurydesma* etc. In recent years Das (1973), Jain and Das (1973), Sinha (1974), Acharyya *et al.* (1974 a-b), Kumar and Singh (1974), Sinha and Mathur (1976-79) reported the occurrence of marine fauna from the Gondwana sediments of Arunachal Pradesh. Srivastava and Dutta (1977) and Andrew (Ph.D. thesis) have recorded *Spinose acritarchs* from the Siang district, while Gogoi (Ph.D. thesis) from the Kameng district have reported the occurrence of spores and pollen grains of terrestrial plants from the upper part of the Gondwana sediments. The occurrence of Palaeopoda *Eurydesma* is particularly significant, because it is a fauna of cold sea and characteristic of the old shore line of Gondwana continent to which glacier descended. The record of *spinose acritarchs* is especially significant as it is reported for the first time from the Lower Gondwana sediments of India. Subsequent work by ONGC has shown that in the areas west of Dikrang river upto Bhutan, the Gondwanas are mainly continental, while to its east the sediments are marine. From the report of various studies, it is apparent that the coal bearing Gondwana sediments of the Arunachal Pradesh are Permian. The Gondwana sediments were deposited under fluviomarine conditions. The palaeoclimate during the deposition of the Upper part of the Gondwana seems to have been cold and humid.

Triassic : On the east, the land sloped down to the southeast during Triassic. At this time the Tethyan sea appears to have covered the little explored inaccessible mountain belt on the Assam-Burma Frontier right down to the Arakan Yoma. Not much of the sea are known in detail except that the black slate, sandstone and quartzite are outcropping on the Burma border of Manipur and in Nagaland were laid down in this sea. The rest of the region appears to have remained as landmass.

On the northern border during the Triassic, the Tethys sea retreated to the north, but soon advanced, but we have no records of the actual time of these sea saw movements.

Jurassic : Recording the unstableness of the area south of the Shillong Plateau a few kilometers west of Mawmai, possibly in Middle Jurassic, there occurred welling up of volcanic lava on surface 500 meters thick interrelated with beds of ash which testify to the explosive intermittent nature of the eruption. How long eruption was active we do not know, but we do know it was subaerial. The line of instability trends north east, for in the south Karbi Anglong are found counterparts of the Mawmai volcanic lava known as the Sylhet Trap.

Cretaceous : In the Shillong Plateau, the oldest Cretaceous sediment is represented by the Jadukata Formation (= Gumaghat formation). It comprises alternating conglomerate and sandstone, rests directly on the crystalline basement. Each conglomerate and sandstone horizon indicates a minor cycle of deposition. Although the earlier suggestion was that the western limit of this formation is Jadukata river section eastward upto Jaintiapur, the recent study reveals that possibly this formation is highly impersistent as it has not been observed at many places between the eastern and the western limits.

The invertebrate fossil (Bhattacharya and Bhattacharya 1978) as well as spore-pollen assemblage (Dutta 1980; Kar and Singh : Personal Communication) and *phytoplankton* recorded from Jadukata and Gumaghat Formations (Sah and Singh 1977; Nandi 1979) completely differs from the overlying Mahadek Formation. Jain *et al.* (1975) have noted, the Jadukata and Mahadek assemblage are more or less the same. They have, however pointed out that the representation of miospore and dinoflagellates in Judukata

Formation is 45% and 55% respectively, while in Mahadek Formation the relationship changes to 75% and 25% respectively. Further they have recorded the occurrence of first appearance of *Odontochitina* in Mahadek Formation. Bhattacharya and Bhattacharya (1978) assigned Turonian age while Dutta (1978), Kar and Singh (personal communication) are in favour of Campanian age for this formation. Since Jadukata Formation underlies the Mahadek, it is obvious that it belongs to Campanian age, if not even lower in the sequence.

The occurrence of Permian flora in the Jadukata sediments (Dutta 1979) indicates reworked condition of deposition. The source of the Permian sediments is probably from the Singimari exposure of the Garo Hills. It is evident from the field observation of unassorted boulders and pebbles, that they were deposited on an ancient shore. The shallow marine condition is also suggested by the presence of microplankton such as *Hystrichoinium*, *Dinogymnium* etc. (Jain 1975) as well as poor sorting of sediments having skewness < 1.5 (Dutta 1979).

The Maestrichtian rocks are represented by Mahadek Formation in Mahadek, Mawkhnai, Thangkrang, Lumshnong, Mawsynrun, about 3 km N.E. of Dawki etc. in the Khasi and Jaintia Hills while in Garo Hills it extends from Baghmara to Maheshkhola on the Jadukata river and lashed against fault bound high cliffs. In Ukhrul on the international boundary between Manipur State and Burma occurs, on the western flank of the Arakan Yoma, a wide belt of limestone intruded by peridotite which has yielded Maestrichtian microfossils. Recently Maestrichtian rock has been recorded by ONGC from the sub-surface at Dergaon, Jorhat district and has been named as Jorhat Formation.

Duarah *et al.* (1983) for the first time reported the occurrence of Lower Cretaceous Radiolaria from Nagaland and Manipur from the Disang flysch sediments. They are *Novixitus* or *Xitus sp.*, Lower Cretaceous, *Archaeodictyomitra sp.*, Valanginian-Albian, *Holocryptocanium sp.*, Lower Cretaceous, *Cecrops sp.*, Valanginian-Barremian etc.

Satsangi from Geological Survey of India (G.S.I.) has recorded species of *Globotruncana* from limestone lense associated with the Disang Group and also from Disang shale exposed near the 5 Km

stone along the Ukhrul-Jessami road (Personal Communication). The occurrence of *Globo truncana* species indicate Upper Cretaceous age.

Dutta (1982) has recorded Palaeocene-Eocene palynoforms from the Disang Group of type area. The important forms are : *Dandotiaspora dilata*, *D. auriculata*, *Proxapertities microreticulatus*, *Lycopodiumsporites parvireticulatus*, *Lakiapollis matanomadhensis*, *Meliapollis ramanujamii* etc.

From the above facts it is apparent that the Disang Group possibly ranges from Lower Cretaceous to Palaeocene-Eocene. In other words, the Disang Group is dichronous.

The presence of Lower Cretaceous radiolaria in the Disang Group indicates that the Cretaceous transgression starts in the early Cretaceous. During Cenomanian time due to unique and sudden rise of the sea level throughout the world, the land of the Indian Peninsula was flooded. After about 15 m.y. (in Maestrichtian) since the advent of this world wide transgression an arm of the sea encroached upon the southern parts of the Shillong Plateau flooding the peneplaned surface. An arm of this sea extended in the west to Trichinopoly in Tamil Nadu and further south through south Bengal, Orissa and Andhra Pradesh, in the east it extended upto Assam-Burma border and through the Arakan region spread out to Australia. To the north it extended through Manipur and Nagaland upto Dergaon in the Jorhat district. So far no Maestrichtian rock has been recorded north of Dergaon.

In the Uttatur beds of the East Coast of South India are found the characteristic fossils *Schloenbachia inflata* and *Acanthoceras coleroonesis*. The same or closely allied forms have been recorded from the Arakan (Krishnan 1968). From some argillaceous limestone near Mai-i in the Sandoway district of the Arakan coast of Burma *Schloenbachia inflata* has been obtained and in the nearby Ramree Island *Acanthoceras daviesi* has been found; this, according to Cotter (1932) belongs to the *A. coleroonesis* 'group'.

From the above it would appear that the transgressive sea advanced on a wide front and carried with it the same or closely allied fauna as was already thriving in the Eastern gulf or in the sea washing the foot of the Western flank of the Arakan Yoma. This possibility has led Mathur and Evans (1964) to advance the

hypothesis of a close connection between the faunas of the Cretaceous of Tamil Nadu and of Assam (Now Meghalaya) strongly suggesting that the sediments from the Palk strait north-east ward were deposited in an extension of the Assam-Arakan Basin.

As far as the Maestrichtian is concerned the position of northeastern India seems to be very significant, since it exhibits faunistic characters of both Tethyan and Indo-Pacific provinces suggesting a link between them. The Indo-Pacific-Tethyan connection might have continued throughout Upper Cretaceous with its characteristic *Globotruncana* community. Nagappa (1959), however has pointed out that this transgression did not arrive until the beginning of Maestrichtian in places like Meghalaya (then Central Assam) and Ramree Island.

From the nature of the rocks laid down in N.E. of Dawki-Sohrarim (91°45'0" E : 25°21'15" N) Mahadek (91°44'30" E : 25°14'40" N) region of Meghalaya and Ukhrul (94°27'30" E : 25°06'45" N) in Manipur i.e. glauconitic sandstone and argillaceous limestone it is surmised that the sea was shallow swarmed with marine life of benthonic origin.

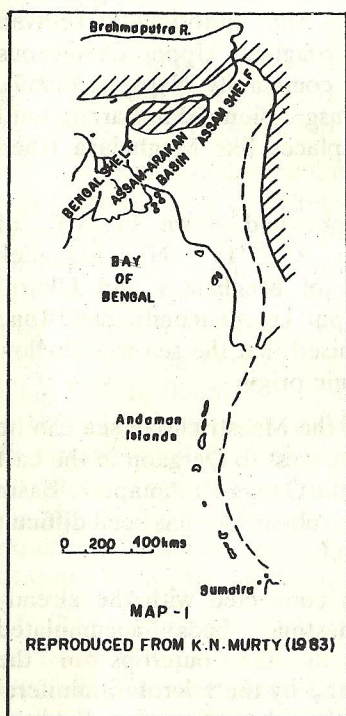
In a rough way the shoreline of the Maestrichtian sea can be followed from the Bengal Basin in the west to Dergaon in the east through Shillong Plateau although in the Ganga-Brahmaputra Basin (Bangla Desh) its exact position in the sub-surface has been difficult to locate due to an east throwing fault.

As mentioned, earlier this sea connected with the already extant Assam gulf where limestone beds accumulated simultaneously as is evidenced by the outcrops in the Ukhrul-Taupokpi area in Manipur and by the microforaminiferal fauna these beds contain. How the shore-line ran between Jaintiapur and the Ukhrul area, is however, uncertain.

At the end of Mahadek time a differential tectonic movement raised the Garo Hills marine shelf into land while in the Shillong Plateau area the sea transgressed as far as the latitude of Mawkma 25° 20' N (Changkakoti and Borooah 1964).

Tertiary : The Tertiary sediments of the northeastern region is very important as it contains oil and coal. These sediments are developed in two facies : (i) a Foreland facies and (ii) a Geosynclinal facies. The foreland or shelf facies about 5,000 meters

thick overlies the Foreland spur of Pre-Cambrian metamorphic rock while the Geosynclinal facies reach a thickness of over 13,000 meters. The lithological contact between the two facies is prominently observed in the Eocene formations where there is a calcareous shelf facies and a much thicker geosynclinal shale facies (Evans 1964).



Langpar Formation : The base of the Tertiary sediments is represented by the Langpar Formation. It consists of :
 (i) shales with bands of limestone and argillaceous sandstone,
 (ii) yellowish brown impure limestone and
 (iii) sandstone and sandy shale with sandy limestone in ascending order. Of the microfossils *Frankeina taylorensis*, *Marssonella oxycona*, *Globigerina pseudobulloides*, *G. trilocolinoides*, *G. cretacea* etc. are important. According to Nagappa (1959) the fossil assemblage suggests Danian age for this formation. Its equivalent rocks are reported from the subsurface of Dergaon, Jorhat district by ONGC and at Tengakhat ($95^{\circ}10'0''$ E : $27^{\circ}23'$ N) and Deohal ($95^{\circ}17'$ E : $27^{\circ}25'$ N) of Dibrugarh district.

The occurrence of Maestrichtian forms i.e. *Globotruncana* species at the base of the Langpar is significant because the Langpar has now been considered as the base of Tertiary in the Shillong Plateau (Dutta 1983). Hence, it is apparent that in the northeastern region the biostratigraphic boundary does not coincide with the stratigraphic boundary. The Jadukata, Mahadek and Langpar Formations of northeastern India correspond to the Bolpur, Ghatal and Jalangi Formations of Bengal Basin.

Sandstone while the rest has been correlated with the Sylhet Formation (Lower-Middle Eocene). Quddus (unpublished) suggests that the Tura Formation appears to be younger than the Cherra Formation. The fossil assemblage recorded from the limestone partings of the Tura Sandstone by Tewari and Mehrotra (1968) is typical of the Upper Ranikot age which shows close similarity to the fauna of Salt Range, Dughan Hill in Baluchistan (Nagappa 1956) and Kampa System, Tibet (Rao 1944). Later work shows that the Tura Sandstone is contemporaneous to Lakadong Sandstone of the Sylhet Limestone Formation. Biswas (1962) opined that the Tura Formation is the time equivalent of the Lower-Middle (Lower part) members of the Sylhet Formation.

According to Geological Survey of India (Personal communication) the Tura Sandstone of Garo Hills is equivalent to Umlatodah Limestone, a younger member of the Sylhet Formation of the Khasi and Jaintia Hills. It is just a facies change with limestone the eastern part and coal-bearing sandstone on the western part of the Shillong Plateau. Apparently the stratigraphical position of the three sandstones exposed at Khasi and Jaintia, Garo and Karbi Anglong is confusing. To avoid such confusion the geologists of the Assam Oil Company advocated the term Therria Sandstone for the "Cherra Sandstone." They pointed out that the Tura Sandstone near Tura is younger than the sandstone of Therriaghat in Khasi Hills (Lexique 1964). The new term Therria Formation was therefore introduced to replace the name Tura and Cherra as there was considerable doubt about their stratigraphical position (Mathur and Evans 1964).

Therria Formation : The Langpar Formation is followed upwards without any apparent stratigraphic break by Therria Formation. The basal portion of the Therria Formation is limestone (70 m) while the Upper part consists of hard compact quartzitic sandstone carrying coal (30 m).

Good exposure of Therria Formation is encountered in Lower Cherrapunji, Therriaghat section in Khasi Hills and Mynkre in Jaintia Hills. Its equivalents are found outcropping in Garo Hills, North Cachar and Karbi Anglong while in subsurface it is recorded from Jorhat, Sibsagar and Dibrugarh districts. Bhandari *et al.* (1973) have described Therria Formation from Teok which was encountered between 3,556 and 3,645 m log depth. They have introduced the name 'Teok Formation' for this rock unit.

The Therria Formation yielded *Cyclammia sp.*, *Ammobaculites sp.*, *Quinqueloculina sp.*, *Rotalia sp.*, *Nummulites sp.*, etc. (Bhandari *et al.* 1973). Amongst the palynomorphs *Dandotiaspora dilata*, *D. teleonata*, *Proxapertities crassimurus*, *Lycopodiumsporites parvireticulatus* are important.

The basal portion of the Therria Formation was deposited under marine environment while upwards they become fluviatile. The fossils suggest Palaeocene age for this formation.

Sylhet Formation : The successive overlying rock unit of the Jaintia Group is the Sylhet Formation. It consists of alternating relatively pure limestones and sugery white to ferruginous sandstone carrying coal.

The succession shows the following members (Das Gupta 1977):

Members	Maximum Thickness seen	Equivalent to
Prang Limestone	210 metres	Khirtar
Narpuh Sandstone	20 metres	
Umlatodoh Limestone	55 meters	Laki
Lakadong Sandstone	25 meters	
Lakadong Limestone	200 meters	Ranikot

Lakadong Limestone : So far Lakadong Limestone has been recorded from the Khasi and Jaintia Hills in the State of Meghalaya. Although quite a good number of dip oil wells have been dug in the Cachar, Sibsagar and Dibrugarh districts, so far no limestone belonging to Lakadong Member has been encountered. It is prolific in microfossils. Important forms are:

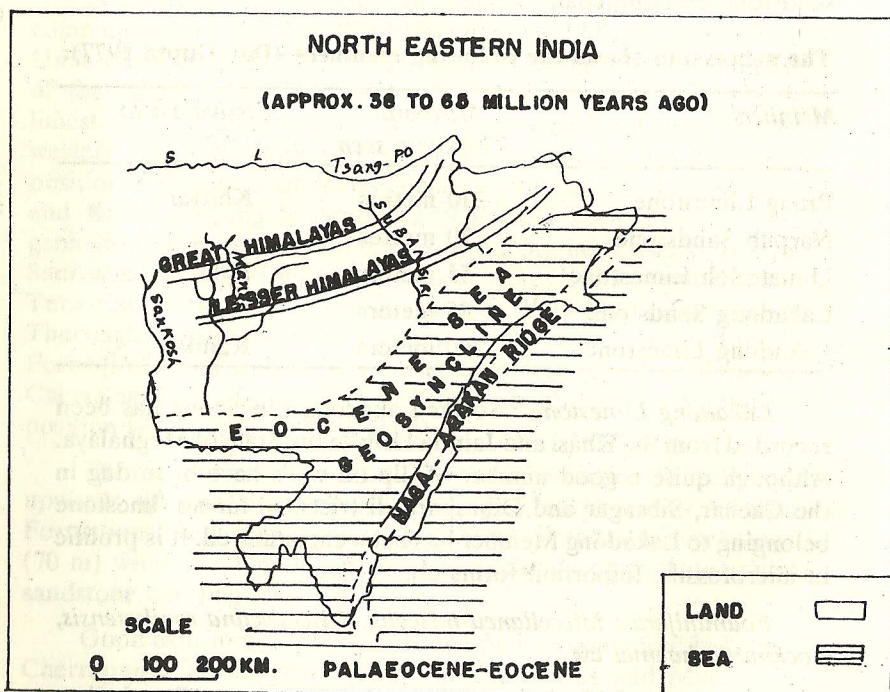
Foaminifera : *Miscellanea miscelta*, *Discocyclina ranikotensis*, *Lockhartia haemei* etc.

Algae : *Lithothamnium andamanensis*, *Mesophyllum meghalayansis*, *Lithoporella melobesiodes*, *Melobesia sp.*, *Distichoplax biserialis* etc.

Phytoplankton : *Operculodinium major*, *collumosphaera fruticosa*, *Cordosphaeridium multispinosum* etc.

The age of the Lakadong Limestone is Landenian and is equated with Ranikot State (Krishnan 1968). The limestones were deposited under marine environment.

Lakadong Sandstone : The Lakadong Sandstone conformably overlies the Lakadong Limestone in the Khasi and Jaintia Hills. Good exposures of this member are seen between Sohrarim and Lower Cherrapunjee along Shillong-Cherra Road in the Khasi and between Mynkre to Lumshnong in the Jaintia Hills along Shillong-Badarpur Road. A part of the Tura Formation is equated with this member. So far no marine element has been recorded from this member in the Shillong Plateau. The palynofossils suggest a coastal aspect.



MAP - 3

In Sibsagar, the Lower Sandstone unit of subsurface sequence which overlies the granitic basement is considered to be homotaxial with Tura Formation of the Garo Hills. At Amguri, lower

nonmarine lithotypes are succeeded by medium grained feldspathic sandstone contains arenaceous forams suggesting brakish water environment (Mohan and Pandey 1973). At Tengakhat the palynological assemblage belongs to Lakadong type. Similar assemblage has been recorded by Sah and Dutta (1967) from the Lakadong coal bearing sandstone of Khasi Hills.

Tewari and Mehrotra (1968) recorded *Miscellanea miscella*, *Nummulites thalicus* etc. from limestone partings in the Tura sandstone near Tura and correlated to lower part of Tura with Lakadong.

The age of the this member is Landenian and was deposited near shore condition.

Umlatdoh Limestone : The next higher member of the Sylhet Formation is the Umlatdoh Limestone. Good exposures of Umlatdoh Limestone are seen from south of the village Siropi (Milestone 75) to near 82/6 milestone on the Shillong-Badarpur Road in the Jaintia Hills. In the Khasi Hills outcrops are seen on the Cherra-Shella Road near Ishamoti and on the bridle path between Buribazar and Komorra limestone quarry.

The limestone is rich in foraminifera. At places more than 50 per cent of the total assemblage is dominated by *Alveolina elliptica* and *A. oblonga*. Important microfossils are :

Foraminifera : *Nummulites atacicus*, *N. irregularis*, *Discocyclusina sp.* etc.

Algae: *Griphoporella arabica*, *Neomeris sp.*, *Trinocladus umlatodohensis*, *Cymopolia sp.*, etc.

The Umlatdoh Limestone is of Ypresian age and is equated with Laki Stage (Krishnan 1968). The limestones were deposited under marine environment.

Nurpuh Sandstone : Nurpuh Sandstone conformably overlies the Umlatdoh Limestone. It consists of ferruginous, medium to coarse grained sandstone, sometimes white in colour while occasionally black. It is friable. In the Jaintia Hills at places the basal part contains coaly layer. The Nurpuh Sandstone is encountered at subsurface in Jorhat, Sibsagar and Dibrugarh districts while outcrops are seen in Karbi Anglong and Jaintia Hills. So far no palynofossil or animal fossil has been recorded from these sediments.

Prang Limestone : The Prang Limestone forms the uppermost member of the Sylhet Formation. This member is most widely distributed in the States of Meghalaya and Assam. Good exposures are found at Tongsang along Shillong-Badarpur Road, Kommorah, South Khasi Hills, around Kopili Hydel Project, North Cachar and at Sibhetta, Kailapahar and Sainalungso in Karbi Anglong. In the Brahmaputra Valley, the Prang Limestone has been encountered in the deep bore holes at Disangmukh, Dikhowmukh and Teok of the Sibsagar district (Metre 1969) and Tengakhat and Deohal of Dibrugarh District.

The important microfossils are :

Foraminifera : *Assilina spira corrugata*, *Nummulites beaumonti*, *N. obtusus*, *N. pangaroensis*, *Discocyclina omphela*, *D. sowerbi* etc.

Algae: *Halimida sp.*, *Lithothamnium aff. bofilli* etc.

Phytoplankton: *Glaphyrocysta divaricata*, *Hystriochokolpoma rigautiae*, *Codosphaeridium exilimurun*, *Spiniferites monilis* etc.

The fossil assemblage suggests Lutetian age for this limestone. This member is equated with Kirthar Stage (Krishnan 1968). These limestones are shallow marine deposits.

Kopili Formation: The uppermost member of the Jaintia Group is known as the Kopili Formation. It is best developed in the southern and southeastern part of the Shillong Plateau i.e. Shillong-Badarpur Road Section in the Jaintia Hills and in the North Cachar Hills. In the Khasi Hills, it is well exhibited at Isamati, Komnorah and in the Shella river section. In Karbi Anglong outcrops of Kopili Formation are seen in Kailajan river section at Kailapahar. It is also recorded in a number of bore holes in the oil fields of Jorhat, Sibsagar and Dibrugarh Districts. It is interesting to note that the first appearance of *Pellatisira* species has been recorded in these sediments.

The base of the Kopili alterations at places i.e. in the Jaintia Hills contains several thin bands of limestone. Important microfossils are :

Foraminifera: *Ammobaculites sp.*, *Cyclamina sp.*, *Guembilina venezuelina*, *Cancris sp.*, *C. mauryae* etc.

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Hytoplankton: *Homotrybium plectilum*, *Glaphyrocystis exultans*, *Hystrichokolpoma unispinum*, *Cordosphaeridium exilirum* etc.

Alfynofossils: *Triorites communis*, *Dandotiaspora uensicorpus*, *Lakollis matamadhensis*, *Palmaepollenites communis*.

The age of this formation is Priabonian. The calcareous facies contains excess of terrigenous material and the associated shales are finely laminated with phosphatinoucles suggesting reduced detrital sedimentation under calm marine environment. The upper part of the formation can be inferred as being subjected to much oscillation (Dutta and Jain 1980).

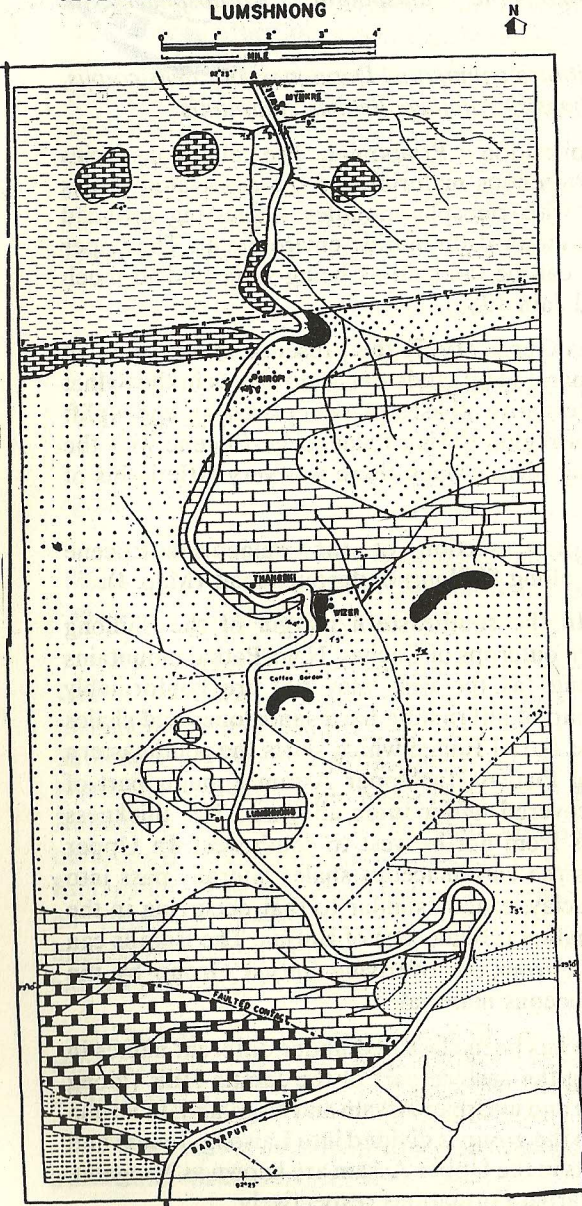
According to Das Gupta (1977) the presence of a number of bands of limestone separated by sandstones and shales in the Shillong Formation suggest alternative phases of peneplanation and uplift in the Shillong Plateau region during Palaeocene-Eocene with the limestones representing phases when there was very little influx of sedimentary detritus.

The most complete section of the Palaeocene-Eocene outcrops are exposed along Shillong-Badarpur Road (Map 4).

Barail Group : In the southeastern margin of the Shillong Plateau, in the northern outcrops of Cachar, Naga Patkai mountains the Barails and Disang (as the case may be) are conformably overlain by a thick group of alternating hard sandstones and shales called Barails after the Barail Range which skirts the southeastern margin of the Shillong Plateau. In Upper Assam a major part of the Barail Group is covered under thick alluvium. The thickness of the group increases from north-west to south-west. In Upper Assam the carbonaceous shales laterally pass into coal blue coloured clay, exactly similar to that occurring in the oil-bearing Pegu Formation (Oligocene) of Burma. The Barails can be easily distinguished from the overlying Surma Group by the abundance of Carbonaceous material.

The Barail Group has been classified under different names in Surma Valley including the eastern part of the Jaintia Hills (along Jowai-Badarpur Road) and in Upper Assam and Nagaland. In Surma Valley the Jaintia Hills the group is divided into Laisong, Jenum and Renji their equivalents in the Upper Assam are known as Naogaon, Boragai and Tikak Parbat Formations respectively.

GEOLOGICAL MAP OF THE AREA AROUND LUMSHNONG



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	COAL
	FAULT
	DIP
	STREAM
	ROAD

	KOPILI ALTERNATIONS
	PRANG LIMESTONE
	NURPUH SANDSTONE
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	LAKADONG SANDSTONE
	LAKADONG LIMESTONE
	THERRIA SANDSTONE

MAP - 4

MAP - 4

Most of the oil pools of Upper Assam are found in the Barail Group beneath the thick alluvium of the Brahmaputra Valley. The Boragolai and Tikak Parbat Formation in the Margherita-Ledo areas contain thick workable coal seams upto 20 m thick.

Amongst the palynofossils, in Upper Assam *Meyeripollis naharkotensis* sp., is almost restricted in the Barail Group while in Central and Lower Assam (Shillong Plateau, now Meghalaya), it is present in both pre- and post-Barails (Banerjee 1975). Another important palynofossil is *Striatriletes macrocostatus*. So far it has not been recorded either from pre-or post-Barails of Upper Assam. In some sediments it comprises 20-30% of the assemblage. *Palaeocaesalpiniacepites* sp., *Foldexina inaperturata*, *Retipilanapites* sp. etc. are almost restricted to Barails. Other important palynomorphs are *Corrugatisporites terminals*, *Polycolpites cooksonii*, *Polypodiisporites oligocenicus*, *Lygodiumsporites lakiensis*, *Palmaepollenites communis*, *Polycolporites* sp., *Retirescolpites* sp., *Stephenocolpites* sp. etc. Baksi (1965) reported the occurrence of *Palaeocaesalpiniaceapites* sp., *Polycolpites coniferipites* form Shillong Plateau. No disaccate grain has been recorded from Upper Assam.

Amongst the forams *Trochammina* sp., *Haplophragmoides* sp., *Miliammina* sp. may be considered as guide fossils for Barail sediments of Upper Assam.

The oil bearing Barail sediments of Naharkatiya oil field were laid down in channels flood plains forming shoe string deposit (Azad *et al.* 1971). Recent work on Barails in the Sibsagar district by the ONGC has shown that the lower sandstone unit of the group is a brakish water delta front deposit containing abundant arenaceous forams. The Upper coal shale alternations was laid down in a tropical, brakish water, back lagoon, swampy environment as evidenced by the presence of arenaceous forams as also by palynomorphs like *Deltoidispora* sp., *Palmaepollenites* sp., *Disulcites* sp. etc. (Ray *et al.* 1973). The age of the Barail Group is Oligocene.

During Palaeogene (Palaeocene-Oligocene) the Assam Valley was the platform shelf of the Naga-Lushai mobile belt which was converted into an intermontane continental basin in Neogene time as the Eastern Himalayan geotectonic cycle was superposed on the geotectonic cycle of Naga-Lushai origin (Raju 1968).

Surma Group : The Surmas, which lie unconformably over the Barails have their best development in the Surma Valley-Chittagong outcrop where these range in thickness from around 2900 m at the northern end of the outcrop to over 400 m (base is not seen) in Chittagong. Further south in the Mayu Range, 7,000 to 8,000 m of Surmas are believed to have been seen without the base having been seen (Das Gupta 1977).

The sediments are seen in the Surma Valley, Jaintia Hills, Garo Hills, North Cachar, Karbi Anglong and Nagaland. In Upper Assam the Surmas are very thin and sometimes even absent and overlapped by the Tipams. The time equivalent rocks of Surma are seen in the Arunachal Pradesh. These sediments of Arunachal Pradesh are described by some scholars as Siwalik while by others as Dafla Formation.

The Surma Group is divided into two formations. The lower one is known as Bhuban while upper one is Boka Bil Formations.

Vredenburg (1921) and Mukherjee (1939) had described the fossils from Baghmara and Dalu of the Garo Hills to indicate that the Boka Bils were Burdigalian. Based on fossil assemblage Krishnan assigned Chattian to Burdigalian age for this Group.

Recent discovery of vertebrate fossils in the Boka Bil in Tripura (Trivedi 1966) thrown interesting light on the age and depositional condition of Surma and Tipam Formations. Amongst the mammalian fossils was a *Dorcathorium* which has been reported only from the Nagri beds of Siwalik and the Nagri Stage and is of Pontian age. The Baghmara and Dalu marine fossils give a Burdigalian age. Thus the Boka Bil which started in Burdigalian as marine sediments ended as estuarine in Pontian. Absence of typical marine plankton in the Surmas of Upper Assam indicates continental condition of deposition which is also supported by an estimated value of low formation salinity ranging from 1000-6000 ppm (equivalent sodium chloride salinity; Handique and Dutta 1980).

Tipam Group : The term "Tipam Sandstone" was introduced by Mallet (1876) for the thick arenaceous sediments that overlie Tertiary Coal Measures in the Tipam Hills. Later in 1932, Evans proposed the name 'Tipam Series' for these sediments. He divided them into three stages i.e. 'Tipam Sandstone Stage', 'Girujan Clay

Stage' and 'Num Rong Khu Stage' in ascending order. Mathur and Evans (1964) did not recognise the 'Num Rong Khu Stage.'

The Tipam Group is divided into Tipam Formation and Girujan Formation. The outcrops of Tipam Formation are seen in the Surma Valley, between Hari and Lubha river, Shillong-Badarpur road section, Nagaland and Karbi Anglong. A small outcrop is seen in the Jaipur anticline. In subsurface both Tipam and Girujan Formations are encountered in Jorhat, Sibsagar and Dibrugarh Districts. In Arunachal Pradesh both outcrops and subcrops of this group have been reported.

The Tipam Formation is a predominantly arenaceous succession with a number of intervening clay and shale bands. The arenaceous formation can easily be distinguished from the overlying predominantly argillaceous Girujan Formation. In Dibrugarh district, there is a marked regularity in the lateral variation of the lithofacies. From north-west to south-east, the uppermost part of the arenaceous formation is gradually replaced by clay/claystone resulting the interfingering of the Tipam and Girujan Formations and thus shifting the upper boundary of the Tipam Formation to successively lower stratigraphic level (Handique and Dutta 1980). In Arunachal Pradesh its equivalent sediments are known as Lower Subansiri Formation. Some scholars described them as middle Siwalik.

From the published data about Tipam Group from Lakwa, Rudrasagar, Geleki and other oilfields it is observed that the Tipam Formations consists mainly of sandstone with intervening clay bands.

The palynological assemblages of Surma Group and Tipam Formation are generally poor in fossils. In most of the cases the recycled Lower Gondwana forms are dominating. Their equivalents from Arunachal Pradesh viz. Dafla and Lower Subansiri Formation also show quite a good number of reworked Permian palynofossils. The reworked forms are represented by *Rhizomaspota* sp., *Platysaccus papilionis*, *Gondwanipollenites* sp., *Cannanoropollis* sp., *Lycopodiumsporites austroclavatidites* etc.

Since the Surma Group and Tipam Formation contain more or less same assemblage they have been described together. The palynological assemblage contains fungal bodies, pteridophytic

spores and gymnospermic pollen grains. Amongst the peridiphytes *Striatriletes sussane*, *Streisporites assamensis*, *S. psilatus*, *Crassitriletes vanradshooveni*, *Lakiasporites sp.*, *Polypodiisporites sp.*, *Corrugatisporites terminalis* are common. The gymnospermous pollen grains find their representation by *Podocarpidites microreticuloides*. Angiospermic pollen grains are *Malvacearumpollis miocenicus*, *Bombacacidites assamicus*, *Rhoipites nitidus* etc.

The Girujan Formation completely devoid of reworked palynofossils. The important palynofossils are *Retipilonapites cenozoicus*, *Polygonacidites frequens*, *Cyathidites minor*, *Nyssapollenites barooahii*, *Polyporina excellens* etc.

Depositional environment : The presence of Permian palynofossils in the Surma, Dafla, Tipam and Lower Subansiri Formations indicate that the sediments are reworked. The sedimentological study also clearly point to the presence of two different clastic sediments. The good representation of *Striatriletes* and fungal bodies in the assemblage indicate prevalence of swampy, humid and warm condition at the time of deposition. The presence of coniferous pollen *Podocarpidites* signifies high altitude in surrounding area.

These Neogene sediments of Arunachal, Assam and Nagaland (Except Girujan Formation) are reworked as is evidenced by the presence of mixed type of flora. The source of the Permian palynofossils in the Neogene sediments must be the Lower Gondwana rocks, now exposed in the foot-hills of Bhutan and Arunachal Pradesh or in earlier sediments which were derived from these areas and later became themselves source for the Surma-Tipam sediments. Complete absence of typical marine elements in these sediments suggest continental condition of deposition.

Namsang Formation : The Namsang Formation was formerly known as Num Rong Khu Stage but as the type section in Mane Bum area (96°10' E : 27°36' N) some 56 Km E.N.E. of Digboi, was found to include soft sandstone, now included in the Dihings, it has been named as Namsang Formation after the river Namsang, a tributary of the Buri Dihing flowing south of Digboi. The most distinctive feature of this formation is the presence of lignite

pebbles. According to Maclaren (1904) if these pebbles were derived from the underlying Coal Measures, they are composed of lignite and not true coal. This formation is equivalent to Dupi Tila of Surma Valley.

In Upper Assam, Arunachal Pradesh and Surma Valley they unconformably overlie the Tipam Group.

In Sibsagar district it is encountered in almost all the oil wells. Banerjee *et al.* (1971) have recorded from their topmost palynological zones which includes portions of Girujan, Namsang and post Namsang Formations the following palynofossils: *Sporites circulus*, *Polypodiisporites sp.*, *Polypodiaceasporites*, *Cyathidites sp.*, etc. They further recorded reworking of Barail forms like *Meyeripollis* and *Foldexina inaperturata* and Palaeogene forms like *Palmaepollenites* and *Disulcites*. Sah and Sing (1977) and Sah and Mehrotra (Personal Communication) have reported the occurrence of reworked Permian and Eocene Palynofossils from the Namsang Formation.

In Naharkatiya oil field the Namsang bed are not recognised while in Moran they are present throughout the field.

Mathur and Evans (1964) assigned Mio-Pliocene age of this formation.

Dihing Group : Above the Namsang comes a thick pebble bed to which Mallet (1876) gave the name 'Dihing Series'. There is a distinct unconformity between these two groups of sediments. In the type area of Dihing river section in the geosynclinal facies the group is about 245-300 m, in the Mana Bum range in the extreme north-east of Arunachal Pradesh, it is 900 m and in Cachar it is about 600-700 m. Its equivalent unit in the shelf facies is known as Dhekiajuli Formation encountered in subsurface.

The Dihing beds having a great thickness of pebble beds with subordinate sandstone and clay bands all fluvial, were laid down on the top of the Namsang Formation after a break of sedimentation in Pliocene time and the disturbances seen in these beds except that in the southeastern portion much have been due to tectonic disturbances after the Dihing sediments are laid down. These sediments may have been derived from the rising mountain ranges from the northeast. The age of this Group is Pliocene-Pleistocene.

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