[A notes on the Geological and Economic Resources of the Southern Area of Hill Tippera]

GEOLOGICAL SURVEY OF HILL TIPPERA 1909 -10

Asok Bose. ESQR
B.Sc (B'ham) F.G.S. M.I.M.E.

Tribal Research and Cultural Institute,
Govt. of Tripura, Agartala.

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INTRODUCTION

In this endeavour to print rare available books on various aspects of life, culture, place relating to Tripura, Tribal Research Institute has taken step to collect such rare books, reprint them and make it available for Historian, Scholars and other Academicians. The reprinting of the books, "NOTES ON THE GEOLOGY AND ECONOMIC RESOURCES OF THE SOUTHERN AREA OF HILL TIPPERA" by Asok Bose is a step in that direction.

ii) The book of Shri Asok Bose deals with physiography, geological notes, economic geology and economic resources of the Hill Tripura, the survey reports pertain to the year 1901 to 1910. The book has described the possibility of occurrence of mineral deposit such as-clay, latertic iron ores, lignitic coal and limestone deposit and identified them as the potential resources available in the State. Despite such finding as mentioned in the book, exploration of the mineral resources has not been taken up on commercial basis. The survey report, I am sure would be of great help to the Geologist, Mineral Scientist and the Planners for taking appropriate steps in regard to exploration of available mineral resources in the State.

iii) Tribal Research Institute is grateful to Shri N.B.K. Debbarma who has been kind enough to hand over the rare book to reprint.
iv) I am also sure that this book will meet felt-need of the students and researchers who are interested in the study of the geology of this small State of Tripura.

D.K. Tyagi
Commissioner to the Govt. of Tripura
Tribal Welfare Department.
Agartala.

Dated, Agartala

FOREWORD

The first edition of the book "geological Survey of Hill Tippera 1909-10" written by Asok Bose, ESQR has already been exhausted.

Considering the demand of the books among the common readers, researchers, educationist, administrators attempt for printing has been made.

Hope, this reprint 2nd edition will meet the demand of the readers to impart knowledge about Geological Survey of the then Tippera.

8/02/2017

Dated, Agartala,
The 8th February,2017.

(S. Debbarma)
Director,
Tribal Research & Cultural institute,
Govt. of Tripura.

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Part - I
PRELIMINARY REMARKS.

Geological Department : The Hill Tippera Durbar invited Mr. P. N. Bose (Lond) F.G.S. Late Deputy Superintendent Geological Survey of India, in December, 1908 to supervise the Geological operations in the State. The actual work was taken in hand in the middle of November 1909 when I was appointed to make a Geological Survey of the State under the directions of Mr. P. N. Bose.

Preliminary Remarks : The Hill Tippera State as the name implies is traversed by numerous ranges of hills ranging in height from about 100 ft. to nearly 4000 ft. These hills are generally covered with thick vegetation and dense jungles; in fact, some parts in the interior the vegetation cluster together so thick that day light is obscured for many miles along. Tracks through these jungles are soon obscured with the fast growing vegetation especially during the rainy months so that one is often trackless in the interior. The low grounds especially in the western portion of the State are marshy and boggy in places which are positively dangerous to traverse.

The interior of the State is very thinly populated and I experienced great difficulty in getting any sort of labour.

The jungley nature of the country disclosed few outcrops of rocks and a proper Geological section was quite a rare thing to meet during my travels except in the streams and even there the exposures were unsatisfactory and ill developed.

Hill Tippera area, however, is drained by a system of rivers

and along these rivers good geological sections and admirable exposures of rocks are frequently seen. I, therefore, at the suggestion of Mr. P. N. Bose, took advantage of the fact, so during most part of my tour last season, river valleys were the chief centre of my operations.

In the year under review, my work was chiefly confined to the southern portion of the State. By that, I mean, that portion of the State lying south of the Gomotee River and north of the Feni river. I also covered some portion of the northern area the ground lying approximately to the west of a line drawn from Agartala through Bisalgarh and Oomrabangmah Dheba to Udaipur. Covering a distance of about 2000 square miles in a country where difficulties of travelling and transport sometimes hamper progress the marches necessarily had to be accelerated. It may not perhaps be out of place to mention here that my general observations of the rocks in the area covered were rather hurried and cursory. This was due to the fact that it was mapped out that I was to cover about the area of the State last season.

A closer and more detailed examination of some of the more important parts in the area, already surveyed, would not only give a more perfect idea of the geology of the area but a closer search than I was able to do last season is likely to disclose minerals other than those already found of economic value specially, petroleum, which I believe, is likely to be met within the Hill Tippera rocks but of which I did not even get a trace last season.

I am happy to note that His Highness has approved of the idea of opening a geological museum at Agartala. I understand a portion of the new building, on the right hand side of the Palace, will be allotted for this purpose. The museum will most-probably be opened sometime next cold weather.

Map : I take this opportunity of offering my sincerest thanks to the Minister, Prince

Navadwipa Chandra Deb Barman and to Prince Brojendra Kishore Deb Barman for the kind assistance I received at their hands.

The Hill Tippera map placed at my disposal is on the scale of 4 miles to the inch. which is too small and inconvenient a scale to be used with much advantage on rapid marches. The Map was published some years ago since then a number of Tippera villages, especially in the interior, mentioned on the map have completely gone out of existence and a larger number of villages are now scattered all over the State and among them some large and important ones of which no mention is made on the map. The marking of some minor hill ranges is not accurate and the situation of a few hill streams and tributaries is misplaced.

It is desirable to have a map on a larger scale, an inch to the mile, is a very convenient scale for survey purposes and one much more up to date.

Part -.II
PHYSIOGRAPHY

Situation : Hill Tippera is situated approximately between 22°.58′ and 24°.31′ north latitude and 91°.15′ and 92°.25′ east longitude.

Population : The Census for the year 1901 shows a population of 1,73,325 in the State.

Area : The total area of the State is 4,086 square miles of this about three fourth is covered by hills.

The State is divided into eight sub divisions or districts namely, Agartala or the Sadar Division, the northern districts are Khowai, kailasahar and Dharmanagar. Sonamura and Udaipur are the two central divisions and situated on the Gomoti river, the two southern divisions are Belonia and Sabroom.

Each division or district is in charge of an Officer who is the head of the executive and judicial departments in his own district.

Boundary : Hill Tippera is surrounded on all sides by British Territory. On the north it is bounded by Sylhet District, west by Tippera and Noakhali Districts, south by Chittagong Division and east by Chittagong Hill Tracts.

Previous Observers : Hill Tippera has never been geologically surveyed before.

Mr. Ball : Mr Ball, in his Economic Geology of India, on page 228, mentions about Tippera. The following is quoted from his book. "The occurrence of gold in Tippera is not indicated by any recent authority but Travernier in his enumeration of places where gold is produced in Asia mentions Tipra for which

we should probably understand Assam". I have as yet got no indications of the occurrence of Gold in Hill Tippera.

Hill Ranges : The main Orographical features of Hill Tippera are fairly simple. The principal or main ranges are those which run north South approximately and observed a rue parallelism with one another.

These ranges chiefly occupy the northern area of the State, the hills increasing in height successively from the west to the east of the State. The valleys which these principal ranges bound are all longitudinal except one namely the Gomati Valley which cuts at right angles to the principal ranges.

As the height of the ranges increase from west to east, the floors of the valleys rise in succession.

These hill systems 'bound the valleys of five important rivers which all flow northward except the Gomati River which flows from east to west and out into British Territory. The principal ranges in Hill Tippera are Baramura, Ataramura, Lonktha, Sakkanklang and Jumpui. All these stretch southwards uninterruptedly from the frontier of the State. The Khowai, Dolai, Manu, Deo, Longai, and Gomati rivers take their rise from the highest points in these ranges. They all flow northward into British territory except the Gomati River.

The general characters of the principal hill ranges in Hill Tippera are nearly all identical.

They usually rise with steep precipitous sides as may be expected from the soft nature of the rocks which compose their flanks and if it was not for the dense mass of vegetation that cover the flanks of these ranges they would have been subjected to greater denudation then they undergo now.

Baramura Range : The Baramura Range, having regard to its extent is the most important range in the whole of Hill Tippera. It stretches from the frontier of the State at Chanipamura which is 504 ft. high almost uninterruptedly down to the Muhuri river at Khulsee Stream at

Lat. 23°_15' north, approximately, in the southern portion of the State, a distance of 56 miles or so. This range at 23°-33'-30" (approximately) north latitude is cut by the River Gomati, forming the Debtamura gorge, commencing from above Chumchomabari on the western extremity to nearly as far as the river Ompi on the east, a distance of about 2½ miles.

It is interesting to note that the Gomati River runs parallel to the Baramura Range throughout the whole length of the gorge, which would here from the line of least resistance in the strata, and this direction here is a fault line, as I shall presently show.

Debtamura Gorge : The scenery of the Debtamura gorge is most picturesque and striking. Here the river has made a clean cut through the rocks which stand out to view on either side of the gorge as huge escarpments, wonderfully wild. The channel through which the river flows in the gorge does not exceed any where more than 50 feet or so. The gorge is covered with a variety of vegetation which form a beautiful contrast with the sections of olive coloured massive sandstones, which stand out boldly, as if, to bottle with the inclemencies of rain and weather and not to succumb to their powers. Waterfalls are met with here and there along the gorge, continually emptying water clear as crystal-white into the Gomati below, add wonderfully to enrich the view and to heighten all grandeur of natural beauty, numerous figures of Indian Gods and Goddesses are seen carved on the clean-cut surfaces of the massive sandstone.

Carvings at Debtamura : Debtamura as the name implies, Mura meaning technically' peak of a hill and Debta of Gods. There is one huge carving in particular of Durga standing about 30 ft. in height. These figures carved probably two or three centuries ago when perhaps, Udaipur was the capital of Hill Tippera, although, much covered by growing vegetation are still wonderfully preserved. And perhaps, what strikes one most at the time, is the exact symmetry with which the figures are carved, and about 20 ft above the level of the river below, on most precipitous sides. Such a scenery as this is perhaps hard to beat anywhere.

The highest peak in the Baramura range is Satsum, which is 813 ft. high.

The southern continuation of the Baramura range, south of the river Gomotee, is bifercated into two main ranges, which are parcelled out into numerous subordinate cross-ranges, the direction of which mainly depend on local circumstances, such as the hardness of the rocks and to such secondary agencies, as vegetation rainfall etc.

The western bifercation of the Baramura range, commences about two miles north of Hatimura peak, strikes due south for a distance of three and a half miles and then takes a south-westerly trend, as far as about four miles north of Kalidas peak of the Tichna range.

The eastern bifercation, starts 4 miles north of Chomchuma peak, strikes southward as far as Shaebmura, where this range is split up into three ranges. One strikes due east from one and half miles due north of Shaebmura peak, the other continues as a thin ridge, as far as the Muhuree River at Khulsee stream and the third, offshooting 1½ miles due north of Shaebmura peak, takes a westerly trend ending in Sogaria peak in 23°.18' north lat. The eastern offshoot of the main range, mentioned above runs due east for a distance of 6 miles, when it curves round and strikes due south, as the Tulamura range, down to the southern frontier of the State, north of Feni river.

The southern continuation of the Baramura range, appears to dip southwards, the height nowhere exceeding more than 495 feet, which is Shaebmura peak. This southern extensions, especially the ranges lying to the northern and eastern portion of the State in the southern area, generally rise precipitously from the level valleys below. These ranges are densely covered with forest and vegetation which act as a protection from denudation. The scenery displayed by these forest clad hills, especially, the Tulamura range, is most gorgeous. These hills rise higher than those in the western area. They are mainly built up of massive sandstones, and sandy slates with concretionary limestone, in the form of tentacular tabular masses, measuring from 2 inches to 6 inches in thickness, usually, running parallel to the bedding of

the slates. This limestone is impure being mainly argillaceous and very hard, tough and tenacious which 'mainly bind together these hills and protect them from denudation. A typical instance to the point is the Tulamura range which is mainly composed of sandy slates with hard concretionary limestone, rising precipitously above the surrounding country.

Approximate Calculations : The latitudes of places given above, are only approximate, and so are the distances given. These distances of ranges etc. in miles, are as the crow flies, neglecting the various curves etc. of the ranges, which are put down on too small a scale on the map at my disposal, to be measured accurately. This will apply to nearly all the measurements of distances and also to the latitudes and longitudes of places which I shall have occasion to mention in connection with this report.

Ataramura range : Ataramura means a hill of 18 peaks, from Atara meaning eighteen and Mura peak. This range stretches uninterruptedly from the northern frontier of the State, down the river Gomotee due south at Dumbur, a distance of about 55 miles.

The area of this range lies north, south, and the absolute straight stretch of the range from north to south is very striking. The straight run of this range is broken about two miles north of Sopeelal peak in 23°.33' north latitude where it is deflected to the south-west. The range again strikes due south for a distance of 1½ miles or so. At Jari peak the range is deflected to south-east. At the southern extremity it is broken up into numerous latitudinal ranges.

The average height of the Ataramura range is, I believe, above a thousand feet. The high peaks in the range 'at Jari 1359 ft, Sopeelal 1132 ft and Ataramura 1421 ft. The highest peak in the range is 1627 ft which is situated about 4 miles due south of Ataramura peak in 23°.57' north latitude.

Numerous low latitudinal ranges strike the western side of the principal range at various angles. In fact, I believe, these subordinate cross ranges are part and parcel of the main Ataramura

range which are merely offshoots of the principal range. These numerous latitudinal ranges are joined on to one another by small longitudinal ranges. The panoramic view of the western flank of the Ataramura range, viewed from the highest peak in the range, would present a network of low lying hills with rather flat tops, and broad shallow valleys between stretching the same cases, as far as the Baramura range. Such a physical aspect gives one strong reasons to suspect, that originally, these numerous, low net work of ranges from one continuous stretch of land, from north to south of the principal range, lying on the western flank of the Ataramura range, with a gentle slow westward. The eastern flank of the Ataramura range has been weathered into crags of the Sharpest and most precipitous character.

South of the river Gomati, the Ataramura range seems to dip heavily, and is continued as small subordinate ranges stretching in all directions.

Lonktha, Jumpui, Sakkanklang ranges : These ranges lie to the east of the Ataramura Range and increase in height in successive order. Jumpui range which is the highest in the State, is situated on the extreme border. The highest peak in the range is Betlein Sib 3080 ft, situated in 23°.48' 30" north latitude. The principal area of these ranges lie north-south, approximately, and they observed a rude parallelism with one another.

Subordinate Hill Systems : The minor orographical features, or the subordinate hill systems and surface arrangement, are a complicated net work of low hills - and valleys, chiefly confined to the western area of the State. I mean, the area lying to the west of the Baramura range, from the northern to its southern extremity.

The hills on the western area are low lying nowhere exceeding a height of more than about 500 ft. The areas of these ranges vary, there being no particular direction in which they seem to lie.

The low ranges cross and meet one another at all angles. They sometimes seem to curve round and meet one another, so as

to completely or partially environ low detached areas. In places, the low ranges appear to shoot out from a central cone, such as, the Lambusara in 23°.55' north latitude, Rokhia 23°.35' 30" north latitude and Eta 23°.25'30'' north latitude.

Gojalia Range : This range forms the western boundary of the southern portion of Hill Tippera. The range commences from about Bindapateela village, about 6 miles south east of Belonia Town and continues down to the southern frontier of the State, as far as the Feni river. It is partly broken up in parts and parcelled out into a number of small lateral ranges. The principal axis of the range lies north-south approximately. The Highest peak in the range is - Gojalia 466 ft. The streams which descend the eastern flank of the range flow into Manoo Suree stream which again debauches itself into the Feni river. Those which descend the western flank flow into the Muhuree river. I believe, the Sogaria range, which is a southern extension of the Baramura range, and which lies immediately north of the Gojalia range, is also a part of the latter range, which has here been curved into by the Muhuree river, flowing approximately in an east-west direction. The rocks composing the Sogaria and Gojalia ranges are similar and the hills display similar physical characters. This being so, the Gojalia range would be a part of the southern extension of the Baramura range.

Tichna Range : These ranges run down the western portion of the State. It is low lying the highest peak is Kalidas 261 ft. It commences from south of Bytongbaree village and continues uninterruptedly down to southern frontier, forming the leg of mutton shaped area which forms a part of the south western borders of Hill Tippera. I believe, Tichna range is a part and parcel of the Baramura range, as the rocks composing both in this area are lithologically similar and the hills display identical physical features. They are usually flat-topped with gently sloping sides and composed mainly of soft rocks such as clay and soft sandstones.

At Bytongbaree the range wavers to the north-east and joined by the southern continuation of the Baramura range. Eta range, which

lies to the north of the Tichna range, is probably a discontinued portion of the Tlchna range.

An important lateral offshoot of the Ataramura Range : About 28 miles from extreme north front of the Ataramura range, a lateral range commencing from the eastern boundary of the State, at latitude 23°.45' north, strikes the eastern flank of the Ataramura range at right angles. This lateral range runs for a distance of about 8 miles, having its principal axis in an east-west direction and probably is an - offshoot of the Ataramura range. This lateral range practically forms the watershed of the Gomati and Dolai rivers. The former flows down its southern flank while the latter the northern. The ground, on either side of this range, slopes north and south, at a high angle, and this is the main reason of the present drainage system, on either side of this small range. In time when this range is denuded down sufficiently, so that the level of the tributary streams descending on either side, stand nearly at the same height, there will most probably be a change in the present drainage system. In consequence of such a change, the Dolai river will most probably be the sufferer, as its tributaries, at least some of them, would reverse their course and feed the Gomati River. This would probably - be the case, as the northern slope of the range is much gentler than the southern, which is at a much higher angle.

Rokhia Range : This range which commences at Rokhia at the north western borders of Hill Tippera, where it forms a cone from which several minor ranges shoot out at all directions, runs due east as far as Neng Peak, a distance of 9 miles or so. After leaving Neng, the range takes a north easterly trend as far as Jamu peak. From a little above Jamu peak it takes a north easterly course for a distance of about 12 miles, when it strikes the Baramura range at an acute angle, a little above Sasium peak. This range during its course especially between Rokhia and Neng shoots out a number of small longitudinal - ranges and at various angles. This range is probably a part of the Baramura Range, and one of its numerous lateral offshoots.

PHYSIOGRAPHY

River System : The rivers that flow through hill Tippera have their origin in the State. They give accessibility to a large area of country in the interior, and from great highway down which all timber, bamboos and other forest produce, as well as, cotton etc. find their way to the various markets in the British Territory. These rivers, therefore, are a great asset to the State and it is important that from time to time, they should be looked after and cleared of the immense mass of fallen and rotting timber which infest the bed of the river. These have been mainly brought down by the swift flowing rivers during flood times and deposited inconvenient resting places which not only hinder navigation but sometimes make navigation positively dangerous. The Hill Tippera Rivers are liable to periodical floods due to excessive rainfall, which this area yearly receives and also to the large extent of the low lands which lie along the river valleys.

Northern River : The Northern area is traversed by five rivers namely, Khowai, Dolai, Manu, Deo and Longai. The flow along the valleys formed by the principal longitudinal ranges in this area and run almost parallel to the ranges. Sakkanklang and Longtha ranges give rise to Manu river, which is the largest river in the northern area, traversing a distance of about.55 miles before it leaves the State and flows out into British Raj. The Longai River is important, in the fact that, it forms the eastern boundary between Hill Tippera and the British territory. All the above mentioned rivers and navigable all throughout the year except in their upper reaches during the dry season.

Gomotee River : The river Gomotee flows through the centre of the State from east to west, dividing Hill Tippera into two nearly equal halves north and south.

This river is the largest in Hill Tippera and perhaps the most

important. It forms a great highway down which an immense quantity of Timber, bamboo, raw-cotton and other forest produce are brought down to the ready market at Comilla. A large amount of paddy and mustard seed also find their way down to Comilla chiefly from tracks lying along the Gomotee valley below Udaipur.

Udaipur ruins : Apart from other consideration the Gomotee river is important historically, in the fact that the ancient capital of Hill Tippera was Udaipur, situated on the banks of this river. The grandeur of the once busy and flourishing town is perhaps still traceable in the existing ruins and the immense tanks which are visible near Udaipur. Some of the buildings, specially the Jagannath temple although much covered and obscure by growing vegetation, still remains intact, which perhaps proves the excellent and thorough workmanship of the ancient Tippera. Some of these structures especially the temples near about Udaipur, which however are cleared of the jungles from time to time, have stood the crumbling effects of weather and vegetation of ages.

The architecture displayed by the ruins near about Udaipur is similar to what is seen in the ruins at Gour in the Malda District.

Evidences of flourshing towns when perhaps Udaipur was the Capital are found higher up the Gomati river at Maharanee and Amarpur.

At these two places some interesting ruins and tanks are seen. When these ruined structure once stood up, to form beautiful and gorgeous Palace, we can imagine boats plying up and down the Gomati river in large numbers busy in carrying a busk trade with the capital.

Udaipur tanks : The huge tanks at Udaipur, some of which are over a mile in length, are now mostly covered with water lilies and other aquatic plants. The water of same is, however, crystal clear and pure. The immense tanks

perhaps reminded one of the immensity and gorgeousness of the past city.

The Gomati River takes its rise from among the hills situated on the eastern flank of the Ataramura range. The small lateral range which I have already noticed, strikes the Ataramura range at 23°45' north latitude approximately, in fact, I have suggested that it is a lateral offshoot of the principal range. The range in this area forms an important watershed. The streams flowing down its southern face, give rise to the Rima and Sima streams, which are the main tributaries of the Gomati river in this area.

The water brought down by Rima and Sima and other tributaries south of them flow into a deep reservoir called Dombur, a name given by the Tipperas from the supposed rumbling noise the water makes; in flowing down on inclined plane into the reservoir or lake. This fresh water lake is about 4000 sp.yds in area and about 40 ft deep (average). The source of the Gomati River is Dombur. The water from the lake is discharged in a rapid into the Gomati Channel, due west of the inclined fall. The river is navigable right up to Dombur, the upper reaches with same difficulty during the dry seasons. The channel which the Gomati River has curved for itself is narrow, nowhere exceeding a breadth of 50 ft to 60 ft or so. The channel, however, generally gets wider, when it closes through the flat level plains below Udaipur.

It flows westward from Dombur in a singularly sinuous course and after traversing a distance of about 60 miles, immerges out of the State into British territory below Sonamura.

The Gomati valley, between Sonamura and Udaipur, is mostly flat alluvial country, remainding one of the Ganges alluvial tracts, of course on much smaller scale. The river between these two points (Sonamura and Udaipur) takes a very sinuous course. In fact in some places it winds about so much as to form loops, the nearest bends of which at places, are

only 200 yds short of being united. This sinuosity is due to the diminished slope of the river bed in this area. It will not be very long probably, before there is a change in the present course of the Gomati River in this part of its valley. The nearest bends of the loops will be curved into by the river, thus causing a number of short circuits, which will give these to more or less a straight channel through which the river would flow down more swiftly than it now does.

This portion of the Gomati valley is mostly composed of alluvial soil, and forms an excellent cultivable land, where a large quantity of paddy and mustard are turned out yearly. The ground on either side of the main banks is low lying in this area. These depressions, moreover, are fringed at a distance by low hills. Whenever the river overflows its banks during flood times, the water from the spill is more or less ponded in these areas and, moreover, little water is lost through percolation, as the soil is more or less impervious.

This is the cause of frequent floods that occur in this part of the Gomati valley. Similar tracks also occur above Udaipur. In fact, they seem to occur whenever the hills do not approach the river, but lie at a distance, running usually more or less parallel to the course of the river.

Above Udaipur the Gomati takes a east-west course, running more or less along the dip of the rocks as far as Cham Choma bari. The southern extentions of the Barmura range are seen as escarpments, along the river a little above Udaipur.

These escarpments are mainly composed of laminated sandy shales with concretionary limestone usually in form of nodules.

When these escarpments are passed, the country as far as Photamatee village, is flat, fringed with low hills at a distance. This level tract of country is well cultivated, for oil seeds and in places I saw luxuriant growths of tobacco plants. The river is generally shallow here. The eastern bifurcation of the

southern extension of the Barmura range is exposed as clean cut escarpments a little below Maharanee.

Above Maharanee the Gomati valley is mostly broad level tracks, as far as a few miles below Dakmura, after which the Gomati River traverses a hilly country, composed of the various offshoots of the Barmura range, as far as below Cham Choma bari. At Cham Choma bari, the river changes its east-west course, and runs north-south approximately, forming the picturesque Devtamura Gorge as far as a little below Ompi river. Over this distance the Gomati river cuts the main Barmura range, the gorge, as I have already mentioned runs - parallel to the main range for a distance of 2½ miles or so. Above the Ompi river, it takes a southwardly course as far as Dalak stream. The country in this area is usually flat, and excellently suited for Agricultural purposes, although I did not see much being done in this direction. The slope of the river channel is very gentle through this flat tract of country as is indicated by the meandering course the river takes.

Above Dalok stream the channel strikes due south, for a distance of about four miles, along the strike of the rocks. This straight north-south direction, probably indicates a fairly large fault in this area. This fault line would perhaps coincide with the longitudinal valley lying between the Baramura and Ataramura ranges. Unfortunately, the rocks in this area are ill exposed, due to vegetation and their being badly developed, so I did not detect any indications of a fault occuring in this area.

At the end of the straight run, the river course is generally east-west, which continues as far as Dombur. The Gomotee cuts the Ataramura range about 2½ miles above Natun Bazar here the channel is a narrow gorge about half mile in length. The sides of the gorge are mainly composed of massive yellowish sandstone.

Rapids : Numerous rapids occur along the course of the Gomotee river. These rapids

probably indicate the rise in the floor of the valley which is between Baramura and Ataramura ranges, and also the disappearance of the offshoots of the main longitudinal ranges, under the channel of the river.

Amarpur rapid : One noticeable rapid occurs about 2 miles above Amarpur, which probably indicates, sudden rise of the floor of the valley between Baramura and Ataramura ranges.

Narayanbari rapid : Another interesting rapid occurs at 23°.27'.30" (between approximately near Narayanbari). The rocks just above Narayanbari dips south-west in the opposite direction to the dip of the rocks below the river which is north-east. This rapid probably indicates the dip of the Ataramura range under the Gomotee and its consequent small development on the southern side of the river.

Natun Bazar rapid : Another rapid occurs a little below Natun Bazar. This also probably indicates the southerly dip of the Ataramura range under the river.

As I have said before, the Gomotee River is liable to frequent floods. This river apparently is more busy depositing a large quantity of silt periodically, when its channel is - insufficient for occasional floods, than - excavating its own channel.

Southern River

1. Muhuree River : The navigable rivers in the southern are the Feni and Muhuree. The Muhuree river takes its rise from among the hills situated on the eastern border of the southern area of the State; these hills are the southern extension of the Barmura range. The river courses south-westward from Khulsi stream which is its main and important tributary to its upper reaches as far as Khendola.

It then courses northward for a distance of 4 miles as far as

Lohang stream. This nearly straight north south direction is most likely due to a fault in this area. The fault line coinciding with the direction of the valley between the small longitudinal ranges in this area. Below Lokang the river courses westward till it flows out into British Territory, a little below Belonia. This river is navigable all the year round as far as Kamalabari, one and half mile below Khulsi stream. In the Muhuree valley large tracts of level country occur, similar to the alluvial country in the Gomati valley. One such area is found about 5 miles below, Kamalabari, and which stretches as far as the mouth of the Khulsi stream. These plains are fringed by low hills at a distance. The Muhuree river is liable to heavy floods during the rainy season. It has especially above Lungtong curved for itself a narrow channel not exceeding 30 ft or so.

A number of rapids occur usually in its upper reaches, which in this area, judging from the nature of the country and the shallow channel with swift flowing current, indicate a successive rise in the bed of the river from the western to the eastern borders of the State. The Muhuree is at present more busy depositing than excavating its channel.

2. Feni River : This river forms the extreme southern boundary as well as the south-eastern boundary of Hill Tipperah. It takes its rise from among the Tulamura range of hills, flows southward running parallel to the range for a distance of about 21 miles. It then courses south westward for a distance of 25 miles or so, after which it imerges out of the State into British territory at Amlighat.

The river is navigable all the year round as far as Potee Saree. Large tracts of level country looking like the plains of Bengal, alternate with hilly tracts with steep precipitous sides which are exposed as escarpments along the river. The valley is covered with thick vegetation and in places with dense tall forests, which make the scenery wild and gorgeous. The flood plains of the Feni river is rather extensive, consisting of more

than half the total area of its valley. These areas, lying on either side of the river, afford rich cultivable lands. A fairly large quantity of oilseeds is grown in the Feni valley. Cotton is also grown by the Tipperas by a system, which is locally known as "Joming".

PHYSIOGRAPHY

Bogs and Marshes Hill Tippera : Swampy and bogged areas are rather in extensive in Hill Tippera. They are mainly confined to the western area of the State which is a complicated net work of low hills, with broad, shallow valleys between, and to the valleys of the principal hill Tippera rivers. More than half the area lying to the west of a line drawn from Bisalgarh through Udaipur to Belonia, is boggy and swampy ground.

When these boggy tracts occur among the low hills coursing the western area of the State, they are nearly always found in depressions, which are partially or completely environed by the hills. So that, the depression or low lands from catchment areas, where the streams etc. descending from the surrounding hills debauch themselves. A fairly large quantity of water falling on the main western flank of the Barmura range, also find its way down to these - depressions.

Very little water is lost through percolation in these areas, as the ground below the surface soil, is usually thick sandy clay, which is more or less impervious. A typical instance of such a swampy tract which is mainly the outcome of nearly complete environment of a low tract of country by hills, and thus causing imperfect drainage is the Burgola marsh. Bura meaning big, and gola stretch of water in corrupt Bengali.

The Burgola marsh lies south of Charilam village, which is 3½ miles south east of Bisalgarh as the crow flies. It is about 10 Sq. miles in area. This area is completely enclosed, except

to its western extremity, where the Bijay stream which flows through this boggy tract, has curved one exit for itself. The Burgola tract is completely environed by the low range north of Charilam which strikes east west, and the Rokhia range, which curves round above main peak, and meets the northern lateral range about 4 miles due west of Jamu peak. It also meets the northern lateral range at its western extremity above Buxanagar village. The Burgola marsh slopes gently from east to west. It is possible that this low tract was originally an opened shallow water reservoir which has been gradually silted up. This was perhaps mainly due to the water in this catchment area, being drained by the Bijay stream, which flows sluggishly through the area. Simultaneously with the silting up of the original lake, by the washings brought down by numerous streams from the surrounding hills, the water level in the shallow lake, slowly commenced to rise till a point was reached and the rising water forced an entrance through a convenient point in the northern lateral range near Bhalua para, which gradually gave rise to the channel through which the Bijay stream now flows. The eastern portion of the Burgola marsh has completely silted up forming rather firm ground. In this area a few Tippera villages are found scattered here and there and cultivation carried on. If we include the Charilam marsh which is separated from the Burgola marsh by a small range of hills, the boggy tract in this part of the country, I mean between the two lateral ranges mentioned above, would measure close upon 40 Sq.miles.

Such boggy areas, which are mainly the outcome of depressions or low tracts being completely or partially surrounded by low hills, so as to course imperfect drainage of the area and found scattered all over the south western area of the State. They occur inabundance between Udaipur and Belonia, west of the southern extension of the Barmura range.

I have pointed out that, low wet tracts also occur along the valleys of the Hill Tippera rivers. By a well known law of all rivers

flowing through a flat level country, the banks of rivers rise higher than the ground in its immediate vicinity, which usually lie in depressions; these depressions in the river valleys are more over fringed by hills ranges at varying distances. These low tracts, therefore; form catchment areas, where the streams descending the surrounding hills debauch themselves and also pond the rain water which fall over these areas. I have noticed that the Tippera rivers are liable to frequent floods. When the rivers overflow their banks, the water from the "spills" are caught in these depressions. Very little water is lost through percolation.

Sook Sagar Jola : A good instance of a wet boggy tract, which is the outcome of such a cause is the Sook Sagar Jola, which lies south of Udaipur town. This low wet tract is situated about a mile south of the Gomotee river, and about three fourth of a mile north of the lateral range, which stretches from the Hatimura peak due west and approaches the Gomotee river at Kakrabon village. This wet tract which is about four square miles in area was originally a shallow water lake.

There are some old men living near Udaipur who told me, they have seen Sook Sagar Jola as a large lake and which was only 70 to 80 years ago. The original stretch of Sook Sagar Jola probably extended nearly over the whole of the low area between the left bank of the Gomotee river and the lateral range mentioned. The gradual drying up of the originally extensive shallow water lake is due mainly perhaps to the drainage of the area by two streams, which flow into the Gomotee river, and also to the silting up by the washings brought down by the streams, which descend the northern flank of the lateral range. The original extent of the Sook Sagar Jola was probably close upon 20 sq. miles.

Honoree Jola : The largest stretch of low wet land in Hill Tippera is the Honoree Jola which is about

10 Sq. miles in area. Portions of this area are shallow water lake and the rest is very boggy impossible to travel over anywhere. It is covered with vegetation by a species of tall grass which cluster together thick. Honoree Jola is situated on the southern flank of the east-west range mentioned in the case of Sook Sagar Jola. The southern limit of the Jola is a range of low hills which is the northern extension of the Tichna range. It is bounded on the east by the Baramura range, its southern extension and the west it is bounded by the left bank of the Gomotee River. So this depression is completely environed on the north, south and east by ranges of hills and west by the high bank of the Gomotee river. Numerous streams from the surroundings of the hills empty themselves into this depression which forms a large catchment area.

Originally Honoree Jola had been much more extensive than now and was probably a large shallow water lake. This extensive shallow water lake, probably stretched from the Ganga Surra stream and its eastern extremity right up to a point opposite Sonamura and running along the Gomotee River.

The shape of this huge shallow water lake was somewhat conical, with the base lying somewhere near Ganga Surra and the apex near about a point opposite Sonamura. The northern boundary of this shallow water lake was the lateral range mentioned above, and the high left bank of the Gomotee River from Kakrabon to right up to its western extremity where it emerges out of the State into British territory. Its eastern boundary was formed by the southern extension of the Baramura range, and its southern limit was the northern extension of the Tichna, which was much less denuded at that time. Its western boundary was the left bank of the Gomotee River below Bairagipur where the river changes its east-west course to south-west and the numerous small offshoots of the Eta range. The large shallow water lake which measured close

upon 30 Sq. miles in area gradually commenced to get up by the washings brought down by the numerous streams descending the surrounding hills. Simultaneously with the silting up of the shallow lake, the water level of the lake slowly began to rise, till a point was reached, when the water of the lake overflowed the banks of the Gomotee at convenient places. The overflow took place at several points along the river, which gradually gave rise to a number of narrow channels, along which small streams overflow and which now drain the area and empty themselves into the Gomotee River.

Together with the more or less perfect drainage of the area, it is also getting slowly silted up by the deposits brought down by the numerous hill streams some of which have carved a channel through this boggy tract, and flow into the Gomotee River.

Another large boggy tract is situated on both sides of the Kasse Gang stream, where it approaches Lothee Jola.

These boggy and swampy tracks in Hill Tippera are too numerous for me to notice all of them. I might mention here that some of these boggy tracts are very deceiving and treacherous.

Sometimes rather firm ground alternate with sinking boggy tracts, which on the face of them look alright, but one finds out one's mistake, when he finds himself sinking fast and oftentimes the mistake is discovered too late.

It was, while crossing one of these deceiving boggy tracts in the Burgola area that I almost lost two elephants attached to my Camp with bag and baggage and the Mahoots. I should also have accompanied the rest disappearing with them for good, one of the elephants nearly sank down to her neck and it was with the greatest difficulty we managed to save her and the rest of us. Whenever I think over the incident I always think that our escape was destined and providential.

Some portions of the boggy and swampy tracks in Hill Tippera, especially along the river valleys have already been converted into firm and dry ground which form rich and cultivable lands.

The tracks which still remain boggy, which generally lie in the interior among the low hills, are generally getting silted up, and will in time be converted into dry lands, and as such, would afford excellent agricultural possibilities.

Lakes : The Hill Tippera lakes are situated in the north-western area, south of the Rokhia range and north of the Gomotee River.

The three fresh-water lakes in this area are Omrabangmah Dheba, Lukhum Dheba and Lothee Jola the last mentioned being the largest in extent, but perhaps, it can hardly be called a lake in the strict sense. These lakes are the remaining portions of large shallow water lakes which originally flourished in this area. The portion of the western area of Hill Tippera is completely environed by low hills. Therefore, this area forms a large catchment area for water descending the surrounding hills, and such that fall on the main Baramura range on its western flank and find its way down into this area. The extensive catchment area is bounded on the north by the Rokhia range and on the south by a low range of hills which runs parallel to the Gomotee River. On the east it is bounded by low longitudinal range, which strikes the Rokhia range a little above Jamu peak and on the west by an offshoot of the Rokhia range striking - north-west and south-east and running down as far as the Gomotee river.

The once extensive lakes, which were situated in this large catchment area, have been largely dried up and converted into more or less boggy tracts; which surround the present lakes. These are situated in the lowest depressions in the boggy area which is now drained by the Kaseegang stream.

Omrabangmah Dheba : This fresh water lake is close upon a square mile in area, and about 30 ft.

average depth. It is situated immediately below the Rokhia range and forms a large catchment area, for the water flowing down its southern flank immediate to the lake, and the water which descend the low hills lying to the east of the lake. There is a gradual slope in the floor of the lake southwards. The lake is getting slowly silted up in places, as indicated by the shallow margins of the lake, especially, on its northern end, and the easy overflow of its banks especially during the rainy season, on its southern extremity. It discharges the overflow water by a small stream into the Kaseegang stream.

Lothee Jola : This is probably the largest stretch of fresh water in Hill Tippera, measuring over two square miles in area. Its original extension must have been much more than its present area. Portion of Lothee Jola are boggy tracts, and others a fast-getting silted-up by the washings brought down by the Kaseegang stream. The discharge of Kaseegang into Lothi Jola receives a sudden check, which causes it to deposit most of the silt in suspension. The silt is mainly deposited at the - northern end. This stretch of fresh water is mainly kept alive by the water which Kaseegang continually discharges into. The shallow nature of Lothi Jola is perhaps proved by the continuous overflow at its southern end, where it discharges by the Lothi Jola stream into the Gomotee River.

GEOLOGICAL SKETCH.

The following formations occur in Hll Tippera in descending order.

I. Recent.

II. Pleistocene.

III. Tartiary system (a) Pliocene (b) Miocene.

1. Alluvium	1. Sands and Gravels. 2. Alluvial silt with peaty deposits. 3. Bogs and marshes with Carbonaceous deposits.	Recent
II. Agartala Group.	1. Laterite 2. Ferruginous concretions.	Pleistocene.
III. Upper Gomoti Group	1. Bisalgarh clays with subordinate bands of ferruginous sandstone, Kaolin clay, and Carbonaceousclay deposits. 2. Gomotee sandstones with salicified fossil wood and subordinate bands of conglomerate. 3. Rishamuke sandstones with concretionary impure - limestone and pockets of lignitic coat.	Pliocene.
IV. Lower Gomoti Group	1. Gojalia shales with concretionary impure limestone subordinate bands of ash-coloured clunchy clays. 2. Debtamura sandstone. 3. Ompi calcarious sandstone.	Miocene.

Part - III

GEOLOGICAL NOTES

Method of description : In the flowing description of the Geology of the area surveyed last season, I will proceed in order of the various rock formations met with the Hill Tippera, according to the tabular statements of the rocks, which I have sketched and in descending order. At the end of the description of the Hill Tippera rocks, their nature, manner of occurrence and extent, which I shall deal with in a summary manner, I will correlate the Hill Tippera rocks with other Indian rock systems, the age of which, more or less, has been definitely fixed. This, I think, will be a convenient method of procedure, especially as it is not my intention to turn out this description of the Geology of Hill Tippera, I mean in this report, of a purely scientific and technical character.

Preliminary remarks : The Hill Tippera rocks are perhaps better seen in the Gomati valley, than anywhere else. The Gomati river, during its course from east to west of the State, runs mostly at right angles to the strike of the rocks. This area affords an opportunity of studying the rocks, their manner of occurrence, extent, and gives more or less an idea of the geological structure of the whole State. I have put the Hill Tippera rocks in a single group, namely, the Gomati group and divided this into an upper and lower, although I must confess, that it is difficult to draw an absolute line between the sub-divisions. But, I have done so, for what I consider not insufficient grounds. The general character displayed by the rocks in the upper Gomati group, point unmistakably to their being of fluviatile fresh water, and comparatively shallow water origin. While those

in the lower Gomati group, show deep water characters and probably formed under marine conditions.

I. Alluvium : Under this head I include all recent deposits whether laid down by the action of rivers, rain wash, or through any chemical process etc. They may be divided into the following heads :

1. Gravel and sands
2. Silt.
3. Deposits in swamps and marshes.

Gravel : These mainly occur in the upper reaches of the Hill Tippera rivers and streams. No gravelly deposit was met within the lower reaches of the rivers, in Hill Tippera. This may prove, that the rivers after descending the hills flow gently, and this is amply proved by the sinuous course, the rivers generally take while flowing through the State. The gravelly deposits, which do occur, are confined to the actual bed of the rivers. The pebbles are mainly composed of soft sandstone and clay.

Sands : The sandy tracts in Hill Tippera are not extensive. I mean the recent sand deposits. They are mainly confined to the existing valleys of the rivers and chiefly occur in their lower reaches. In the lower reaches of the Gomati and Feni rivers, when they emerge from the hilly tracks and flow through the plains, extensive deposits of sand occur.

Silt : The Hill Tippera rivers are liable to periodical floods. When these rivers overflow their banks, they deposit silt in the low lying tracts. The flood plains of the Gomati and Feni rivers are rather extensive and mainly composed the level tracts which come between the ranges, which strike north and south. I mean the valleys, which come between the main ranges. The flood plains continue from the banks of the rivers, I mean the ground

in the immediate vicinity of the main channels which rise higher than the land lying more remote which law applies to all rivers flowing through a level country, to the low hills at a distance. The alluvial deposits in Hill Tippera cover an area which may be roughly put down as 1000 Sq. miles. The silt, from the overflow of the Hill Tippera rivers, is mainly composed of homogeneous clay, somewhat sandy. Associated with the alluvium, peaty deposits occur in places as mere pockets. The peat is black and crumbly and look somewhat like course cut tobacco. It is exposed along the bank of the Howrah river, and Bureemyh, which flows through Bisalgarh area.

Bog and Marsh deposits : I have noticed the extent of the boggy and marshy deposits in Hill Tippera, and also the immediate cause of their origin, under the head of Physiography. So, I shall here mainly confine my remarks to the - general composition of the deposits, and their manner of occurrence. The deposits in boggy and marshy areas, are mainly composed of black carbonaceous clay, usually sandy, and mixed with ferruginous matter. The carbonaceous component is chiefly derived from the dense mass of vegetation that flourish on these tracts. The ferruginous and sandy components are derived from the surrounding hills, which are composed mainly of reddish coloured ferruginous clays, and to a subordinate extent of ferruginous concretions, and laterite. The marshy deposits usually met on sandy strata of post pliocene age, almost horizontally. Such sections are well exposed along the banks of Kassegang stream. Deposits peaty in character occur in the boggy and marshy areas. The peaty deposits are only local and occur as mere pockets. They are black, very loose and friable, in which the vegetable structure is clearly visible.

II. AGARTALA GROUP

Tippera Laterite : Laterite occurs in Hill Tippera, and is chiefly confined to the western area of the State.

It is rather extensively developed in the Agartala division, and is - usually found in patches, here and there, on the top of low lying hills and their flanks. I did not meet with a single instance of laterite occurring "at low level "in Hill Tippera.

Hill Tippera laterite is usually found associated with ferruginous concretions, and occuring on the top of the Bisalgarh clays. The ferruginous concretions are probably lateritic origin, as indicated by their similarity of structure and composition. I came across only one instance of laterite occurring in beds of seams. In the Belonia area huge blocks of laterite, measuring 12 ft to 15 ft in length, and from 5 ft to 6 ft thick, and weighing several tons in weight are seen scattered in some of the streams descending the Bindapatila hill. In the stream on which Bindapatila village is situated, exposures of laterite are seen, in situ, measuring 7 ft to 8 ft in thickness and seem to occur as disjointed beds.

In the Bisalgarh area, in the range of low hills lying to the east of Chandernagar village, numerous outcrops of laterite is seen, especially on the flanks of the hills. These outcrops of laterite, it is interesting to note, appear to strike in a definite direction, usually north east and south west. I did not come across any bed or seam of laterite in this area.

In the hills to the south east of Bisalgarh, on the way to Charilam, I noticed several sections of ferruginous sandstones (which I have named Charilam sandstone) occuring below reddish clays, ferruginous - concretions and laterite. The ferruginous sandstones have dark bands, which are evidently due to the presence of iron ores. In this area the laterite is extensively developed and found associated with red clays and ferruginous concretions.

It is interesting to note that the laterite mainly occurs in the low hills in the western area of the State. These hills are chiefly composed of red and yellow ferruginous clays and ferruginous sandstones to a subordinate extent.

Quite the largest proportion of laterite in Hill Tippera occur as more patches, scattered all over the low hills, and as such, the laterite is mainly a superficial formation.

A sample of laterite from Kunjaban hill near Agartala gives the following analysis. The sample may be taken as a fair average of the different qualities of laterite, which occur in the State. The chemical analysis is as follows :

1.	Alumina	8.96%
2.	Ferric Oxide	30.30%
3.	Ferrus Oxide	.70%
4.	Oxide of Manganese	2.10%
5.	Lime	.44%
6.	insoluble silicious matter	45.65%
7.	Moisture & Combined water	11.85%
		100%

As may be observed from the analysis, the laterite is poor in iron ores.

The hill Tippera laterite is not an original product, but derived most probably, from the mass of red and yellow ferruginous clays, and ferruginous sandstones, both of which contain rather a high percentage of iron, by atmospheric agencies, especially by the difference in temperatures, or the "monsoon" conditions, which prevail in Hill Tippera. The rainy season is exceedingly wet and moist, the rainfall being rather high, while the summer month is very hot and dry.

The laterite deposits at Bindapa tilla, which appear to be bedded, are perhaps a special instance of the same phenomenon.

I did not meet with any outcrops of laterite occuring at a higher level than 700 ft or so. The high hills to the east which usually

rise about 600 ft seemed to be free from laterite deposits. The reason of this non-occurrence may lie in the fact that the high hills are mainly composed of rocks which are not favourable to their growth. These high hills are chiefly composed of sandy shales and massive soft sandstone, which do not contribute to the formation of laterite. The difference in temperatures is not so great and does not fluctuate so much in the eastern portion of the State, as it does in the western. The hills in the eastern area are usually covered with dense vegetation, which remain in a more or less moist condition all throughout the year.

The eastern area again, receives more rainfall yearly than the western. The high hills in the eastern area probably attribute to this cause. These may also account for non-occurrence of laterite in the high hills in the eastern area.

The superficial character of the deposit is perhaps well proved by the fact that the low hills in the western area are fairly well wooded.

Trees and shrubs are seen to flourish, rather luxuriantly, on the tops and flanks which is usually not the case in a purely lateritic country which is generally bleak and barren.

The red and yellow clays, and ferruginous sandstone which occur at the base of the laterite, are probably of pliocene age. So the laterite must be younger in age, than these formations. The Hill Tippera laterite is most probably of recent origin and pleiostocene age.

Ferruginous Concretions : At the base of the ferruginous concretions red and yellow ferruginous clays are usually found. Excel lent exposures of ferruginous concretions are met in the low range of hills lying to the south east of Bisalgarh. In the low hills on the east of Chandarnagar village which is about 2 miles east of Bisalgarh, layers of ferruginous concretions are observed to rest on reddish clays. The ferruginous concretions are developed exensively in the range of hills on the south east of Bisalgarh and

seen on the way to Charilam. In this area at the base of the ferruginous concretions, red and yellow clays are seen.

The concretions are pisolitic and vary in size generally up to about 2½ inches in diameter. The concretions occur in a loose brown argillacious matrix. The matrix also contains a proportion of sand and is much stained with iron. The concretions and the loose matrix occur as layers or beds. I saw a clean cut section of ferruginous concretions by the side of the Kamalasagar- Bisalgarh road, where it had evidently been mined for the purpose of road metalling. The sections measured about fifteen feet long and seven feet in thickness. Hill Tippera ferruginous concretions consist mainly of limonite and are probably the decomposed products of laterite.

III. UPPER GOMOTEE GROUP

The great thickness of clays, usually various shades of red and yellow, which form the highest member of a newer tertiary series in Hill Tippera, are found covering the hills everywhere in the State.

These clays are found abundantly developed in the western area of the State. The low ranges of hills, with flat tops and gently sloping sides, lying in the western area of the State, I mean, west of a line drawn from Old Agartala, through Jamu peak, Udaipur to Belonia, are mainly composed of red and yellow clays.

Bisalgarh Clays : They are also extensively developed in the Bisalgarh area and Belonia Division, composing the low hills. Since, these red and yellow clays are typically developed in the Bisalgarh area, I name them, (various shades of red and yellow clays) Bisalgarh Clays.

The colour of the clays chiefly depends on the amount of ferruginous matter, taking part in the composition. The composition of these clays varies. They are mixed with varying

proportions of silica in the form of round grains of quartz, and in places they are found to be decidedly loamy, in others they tend to be an ochre, chiefly red, yellow and orange.

Charilam Sandstone : The ferrugenous sandstone at the base of the Bisalgarh clays, is well developed the range of hills lying to the south east of Bisalgarh, on the way to Charilam. The sandstone is rather hard yellowish in colour, and composed of large grains of round quartz in a ferruginous argillaceous matrix. The sandstone is traversed by dark bands, which is due to the presence of Iron ores. Outcrops of this sand stone are seen on the flanks of the hills, near Charilam. The Sandstone lies almost horizontal, with a slight dip perhaps to the s.w.

Bisalgarh Clays : Red and yellow clays, similar in composition structure to the Bisalgarh clays, also occur below the ferruginous sandstone, but not to such a large extent. A grey clay, with a large percentage of sand, is found extensively developed, below the Charilam Sandstone. Sections of this grey aronacious clay, are well seen on the flanks of the hills crossed on the way to Charilam from Bisalgarh. The Charilam Sandstone occurs as a subordinate band among the Bisalgarh clays.

Clays and sandstone, similar to those mentioned above, are found extensively in the Belonia area. Excellent exposures of these clays are seen above Lungtong village, along the Muhuree river. At Bolinarayan- Digi, on the left bank of the Muhuree river, an excellent exposure of yellow and reddish clays are seen for a distance of 200 yds or so. At the base of these clays, rather hard, yellowish ferruginous sandstone, similar to the Charilam sandstone is seen. The clays rest nearly horizontal on the sandstone with a slight dip south west. The section at Balinaray an digi is as follows in descending order :-

1. Yellow clay, sticky and unctuous about 15 ft in thickness.
2. Reddish clay 9 ft in thickness.

3. Ferruginous sandstone massive 12 ft and continued under the water level of the Muhuree river.

The reddish clay on the top of the ferruginous sandstone contained soft red concretions of the size of a pea. These red concretions which are scattered throughout the clay, are probably, derived from iron ore contained in the clay, through some chemical action.

Chapamura kaolin Clay : At Chapamura, which is about 3½ miles south east of Agartala, there occurs a distinct bed or seam of Kaolin clay, exposed in a dried up gulley, at the bottom of the tilla. The seam is 2 to 5 in thick, which appears to lie perfectly horizontal. There is another exposure of Caolin clay, on the eastern flank of the hill, on which Manipurbari village is situated. This is about a mile due east of the Chapamura exposure, both exposures of Kaolin occur in the Chapamura range. The Manipurbari kaolin seam is 3 ft 4 inches in thickness and appears to strike north south approximately, and has a gentle dip about 5 degree east. Both these seams of Kaolin, occur below a thickness of Bisalgarh clays. The thickness of Bisalgarh clays, in the case of the Chapamura Kaolin clay deposit, measures about 30 ft. Immediately above the seam of kaolin clay, there is a thin plate of ferruginous sandstone, similar to the charilam sandstone, which seems to lie horizontal and about 5 inches in thickness. Below the kaolin seams, loose sand is met with in each case.

Origin of Caolin Clay : In the absence of older crystalline rocks in situ, in the State, from which the kaolin could possibly have been derived, its occurrence among comparatively younger rocks, is interesting, at the same time difficult to explain. The probable solution to the question which I can offer, is that, the China clay was deposited, as such, together with clays among which it occurs, and was obtained from the decomposition of felspars, occurring in the older crystalline rocks, such as gneiss, and schists, lying to the north in Assam, especially in the Shillong area.

Narayanbari Carbonaceous Clay : Seams of black carbonaceous clay, occur associated with the Bisalgarh clays, and only as subordinate bands, situated nearly at the base. This black carbonaceous clay is typically seen near Narayanbari above Lamachera, and exposed on the right bank of the Gomati River. This clay in situ, is rather unctuous and soft, but hardens on exposure. The carbonaceous clay is full of vegetable remains, being small pieces of soft, black, shiny, then - woody fibres.

The section of the carbonaceous clay, is exposed for a distance of about 40 ft, resting on soft yellow sandstone, with a dip of about 6 degrees south west. The following section, in descending order, is noticed in connection with the carbonaceous clay at Narayanbari :-

1. Yellowish clay - 18 ft 7 inches thick.
2. Sandy yellowish clay - 3 ft thick.
3. Black carbonaceous clay - 4 ft 3 inches thick.
4. Soft yellow sandstone, which continued below the water level, in the Gomati - channel.

Sonamura Carbonaceous Clay : A similar deposit of black carbonaceous clay, with soft, shiny woody fibres, is exposed on the left bank of the Gomati river near Sonamura, and occurs at the base of the Bisalgarh clays. The deposit measures 3 ft in thickness and exposed for a distance of 6 ft or so.

Amarpur Carbonaceous Clay deposit : About 2 miles above Amarpur, there is a very noticeable exposure of a carbonaceous clay deposit resting on tops of yellow sandstone, and occurring at the base of the Bisalgarh clays.

It is perhaps interesting to note in connection with these carbonaceous clay deposits, in the Gomati valley, that they

all occur, where the river becomes suddenly shallow, in consequence of the rise of the bed of the river, and where the river flows in rapids.

Atubari Carbonaceous Clay : Between Atubari and Jolibari in the Muhuri valley, frequent exposures of black carbonaceous clay are seen which, however, did not seem to contain any vegetable remains, as the other deposits in the Gomati valley. These exposures measure from 6 inches to 1 feet 6 inches in thickness, and occur at the base of the Bisalgarh clays.

Gomati sandstone : At the base of the Bisalgarh clays, a soft yellow and grey sandstone occurs, which having regard to its superficial extent, is the most important rock in the whole of Hill Tippera. Nearly three fourth, the entire length of the Gomati river, the yellowish and grey sandstone is seen in situ, along the banks. It is also seen outcroping in the Muhuri and Feni valleys where it occurs very abundantly.

The greyish and yellow sandstone, is mainly composed of large round grains of quartz, in an argillaceous ferruginous matrix. The colour of the sandstone, mainly depends on the amount of ferruginous matter taking part in the composition. The sandstone is rather soft and usually occurs massively bedded. Typical exposures of this sandstone are seen in the Feni valley, where sections of the sandstone are seen in escarpments of hills, which run down to the river. At .Burdo, near Chotakhil on the left bank of the Feni river the following section is well seen in descending order.

1. Bisalgarh clays.
2. Yellowish sandstone about 120 ft thick.

The upper parts of the Gomotee sandstone, in places, seem to occur in thin beds or laminae measuring from one inch to five inches in thickness. An exposure of this is well seen at

Bairagitila, about three miles east of Sonamura where it is exposed in a section on the southern flank of the hill measuring about 40 ft. in thickness.

Perhaps the most typical section of this thinly laminated sandstone is seen at Kalapani, seven miles east of Sonamura, on the right hand side of the Sonamura-Udaipur road, in an escarpment of a low hill facing the Gomotee river. The section of the sandstone here measures about 100 ft. or so and is seen to occur under a thin bed of Bisalgarh clays.

Sections of grey and yellowish sandstones are well seen in escarpment of low hills which come down to the river from north and south. The sandstone stretches, except for a few breaks caused by clay deposits, and an exposure of sandy shales coming in near Kakrabon from above Sonamura to Udaypur, a distance of eighteen miles as the crow flies.

This sandstone comes in again above Udaipur a little beyond Maharanee and runs as far as Malbhasa. There is a break in this deposit between Malbhasa and Chandgang. Above Chandgang the sandstone appears again, and continues as far as below Laban charra. So nearly three-fourths of the entire length of the Gomotee valley is composed of these soft and yellow sandstone.

Gomoti sandstone : Below Sonamura, beds of soft and yellow and grey sandstone much decomposed, occur with subordinate bands of dark clay, which are seen exposed along the banks of the Gomotee river. Above Sonamura, the sandstone becomes more and more prominent, going up the river. The subordinate bands of clay occuring less and less, till at Jamjuri, sections of yellow sandstone are visible in escarpments, measurring up to about 50 ft in height and they appear to become harder and more massive in structure. The strike and dip of this rock keep constant throughout the area. Between Sonamura and Udaipur, these beds strike N.W and S.E. and dip S.W. about 10 degrees.

Above Chandgang the dip of the sandstone changes to N.E. and S.E., the amount remaining the same about 10 degrees.

This sudden change in the direction of dip, possibly, indicated an anticline in this area. This dip is again changed to S.S.W. to S.W. at Narayanbari, above Lamacharra, which is probably due to a syncline.

Exfolitation structure is developed in this sandstone in places, along the Gomotee valley. It is best seen perhaps in Natun Bazar. These indications of the sandstone being subjected to pressure, is more or less local, occurring in the eastern border of the State among the high hills. The Gomotee sandstone is seen outcropping in the Feni river, occuring abundantly on the west of Manusaree stream and it runs along with breaks here and there, as far as Boga chatal. In the Belonia division the Gomotee sandstone, occupies about three-fourths of the entire area, covered by the Muhuree valley.

Good exposures of these sandstones are seen along the Muhuree river. At Bonekor ghat a little above Belonia, a section of this sandstone with subordinate bands of dark clay is seen occuring at the base of the Bisalgarh clays. The dip of the sandstone here is about 10 degree S.S.W.. The Gomotee sandstone in the Muhuree valley, stretches from above Belonia to Manoogang. The dip and strike remain almost constant The strike eing N.N.W. and S.S.E. approximately and dip from 10 degree to 12 degree S.S.W. to S.W. Near Sogama stream the dip and strike appear to change, to dip N.W. and strike N.W. and S.E. approximately. The original dip is again regained below Takumbeeree stream where the sandstone is seen to rest directly on massive sandy shales. The latter dipping is about 14 degree S.W.

Above Gorum stream the sandstone is frequently seen massive and without any distinct beddings as far as near Lungtung. Above Lungtung and as far as Kamalapu bari the sandstone is ill developed except in just one or two places and appears to be overlapped by Bisalgarh clays.

Sogania anticline : With regards to the change in dip of the Gomoti sandstone near Sogania stream, the change in the direction of the dip, possibly, indicates an antecline in this area. The principal axis of the antecline stretches north to south and possibly correspond to the main axis of the Sogania range. The Gomotee sandstone occupying the flanks of this range.

In the Gojalia range in the Rishamuk area, soft, yellowish sandstones similar in every respect to the Gomotee sandstone, are seen exposed in the numerous streams, which descend the western flank of the Gojalia range, in the lower reaches of the streams, where they more or less emerge out of the hilly tracts. The sandstone in this area dips about 10° S.W.

The Gomotee sandstone which occurs so abundantly in Hill Tippera, occurs at the flanks of the Baramura and Ataramura ranges and form the highest member of the sandstone formations in Hill Tippera, and occurs at the base of the Bisalgarh clays.

The original extent of the Gomotee sandstone must have been much greater, than it now displays.

But owing to their soft, friable nature, it has been greatly worked upon by rain and weather. The thickness of the sandstone does not exceed 200 ft or so anywhere in Hill Tippera. The more or less superficial extent of the sandstone, covers close upon half the area of the whole State.

Silicified fossil wood : In Hill Tippera, silicified fossil wood is found in the upper portions of the Gomotee sandstone and occurs rather extensively in same areas. Above Amarpur, in the Gomotee valley, an abundant deposit of silicified wood is found.

In places, large logs 7 ft. to 10 ft. in length and usually from 6 inches to 10 inches in diameter are seen, what appears to be in situ, lying horizontally and embedded in decomposed

yellowish sandstone, which dips from 50 to 60 N.E. I did not come across any silicified logs, in an exact position. Most of the logs are not wholly silicified; their central cones are in a semi-carbonised condition.

Angular fragments of silicified fossil wood are found scattered all over in loose sand. These fragments are evidently derived from large logs, by probably, simple fracture, along original lines of weakness. The silicified fossil wood in Hill Tippera appear, oxogenous wood, during my whole tour last season. This, however, is not conclusive, that fossil endogenous wood, does not at all occur in Hill Tippera. They probably, occur in Hill Tippera, but very sparingly.

It is interesting to note, that silicified fossil wood is only found, in the upper portions of the Gomotee sandstone, in more or less decomposed loose sandstone, which seems to be the main depository of the silicified fossil wood in Hill Tippera.

The distribution and the manner of occurrence of the silicified wood especially in connection with the Amarpur deposit, probably proves without any doubt, that the silicified fossil wood, were originally transported as logs of wood by flowing water, and embedded mainly in the upper layers of the Gomati sandstone, to which they are contemporaneous, and which were subsequently silicified, in situ.

Beds of rather hard, thinly laminated, well bedded shales occur as subordinate bands among the Gomati sandstone, and as such, it is well developed at Kankrabone, in the Gomati valley, where it is exposed on the right bank of the Gomati River for a distance of about 200 Yds striking N.W and S.E., and dipping about 10 degree S.W.

In the Feni valley, in the Dhoba stream, near Bogachatal village, laminated sandy - shales are seen associated with the Gomati sandstone. Beds of sandy shales with concretionary limestone, in this area, occur both above and below the Gomati sandstone.

Silicified Fossil wood : I came across an interesting deposit of silicified fossil wood deposit in the Bisalgarh area. There is a stretch of sandy tract about 2 Sq. miles to the east of Chandernagar village near Bisalgarh, which continues to the bottom of the range of hills, running north south, approximately, which lie about 2 miles east of Chandernagar.

In this sandy tract I picked up fragments of silicified fossil wood, scattered about in loose sand. I did not see any in situ in this area. The sandy strata occur below the Bisalgarh clays.

Eshurah conglomerate : About half way between Eshurah and Natun Bazar, a band of course conglomerate, about 15 feet thick, is exposed for a distance of 50 to 60 Yds. The pebbles consist mainly of clay and soft sandstone.

The conglomerate band appears to occur nearly at the base of the Gomati sandstone. Other exposures of conglomerate, ill developed, and more or less in patches are seen in places in the Gomati valley, occurring both in the upper and lower Gomati groups.

Rishamuke Sandstone : At the base of the soft, yellowish sandstone, mean the Gomati sandstone, occurs a massive iron-grey sandstone, soft and friable, and without any distinct bedding. It is seen abundantly developed in the Gojalia range, in the Rishamuke area. It is perhaps typically seen in the Momoy stream, which descends the western flank of the Gojalia range, and empties itself in the Muhuree river, a little above Sonurgazee in British Territory.

Huge sandstone sections are met with exposed in escarpments of hills which run down to the Momoy stream. The sandstone is iron grey in colour, very soft and friable, so that it is difficult to get a proper hand specimen. It is mainly composed of large - round grains of quartz, in an argillaceous silicious matrix.

Exposures from 100 feet to 150 feet high are seen, in places, along the Momoy stream. The sandstone outcrops about 1½ miles from Ram Babu Typhang para village, which is about 3½ miles from Rishamuke Thana, and continues for a distance of over a mile along the Momoy stream, without any noticeable break. No contact section, between this sandstone and the Gomati sandstone was met with anywhere.

The Rishamuke sandstone dips at an angle from 12 degree to 14 degree S.S.W. to S.W. The peculiarity of the sandstone is that it usually forms an outer layer or crash, which is about one inch, to an inch and a half in thickness and fairly hard. When the crust is broken into, the inside is soft, and friable. This crust, moreover, is calcareous, and is probably derived from the concretionary limestone, occuring in the sandstone. The concretionary limestone occurs in the form of nodules of all sizes up to 10 feet in diameter, and as lenticular tabular masses measuring from 3 inches to 6 inches in thickness generally lying parallel to the bedding of the sandstone. In one section, in the upper reaches of the stream, I noticed 4 to 5 layers of these tabular masses of limestone lying absolutely parallel to one another and to the bedding of the sandstone, and separated from one another at varying distance, from 10 feet to 15 feet, the tabular limestone is sometimes seen sticking out in the waterfalls which empty themselves into the stream below, while the soft Rishamuke sandstone is seen worn down. The concretionary limestone in the Rishamuke sandstone is dark, impure, very hard and tenacious. It is distributed rather sparingly in the sandstone. Deep pot holes measuring up to about 10 to 12 feet in diameter are seen curved in the sandstone, originally due to the limestone balls being let loose, by weathering of the soft sandstone, round the nodular limestone, and its subsequent rotation in the cavity by water action. I noticed a block of limestone resting in a scooped hollow in the sandstone, in the Duchari stream which flows down the western flank of the Gojalia range, north of

Momoy stream. The limestone block would measure close upon 8 ft in diameter. In the bed of the Momoy stream, I picked up flat calcarious fragment of rock measuring from 1 inch to 2 inches in thickness and was fortunate enough to trace it in situ. I found this calcarious rock, forming a thick crust from 2 inches to 3 inches in thickness over the Rishamuke sandstone.

This calcarious crust, as I have already noticed, is probably derived from the concretionary limestone, by the well known theory of the action of water charged with carbonic acid.

Beds of sandy shales occur associated with the Rishamuke sandstone. The sandy shales are similar to those found in the Gomati sandstone.

A fault is noticed in the Momoy stream about 3 miles from Ram Babu typhangpara Bari on the right bank of the stream. The sandy shales in the proximity of the fault dip at high angles from 55 degree to 40 degree S.W., and along the fault line appear crust and deep almost vertical. The shales are seen in contact with the Rishamuke sandstone, along the fault line. I have tried to show this fault in the section along Momoy stream. The Rishamuke sandstone forms the base of the upper Gomati rocks in Hill Tippera.

Lignitic Coal : In the Rishamuke sandstone in the Feni valley lignitic coal is found near Sonarampara in the Tinochari stream, where the sandstone forms its bed. The lignitic coal does not occur as a regular bed or seam, but found in pockets embedded superficially in the sandstone. The distribution of the lignitic coal in situ, suggest the idea of twigs, branches, and trunks of trees transported by flowing water and deposited contemporaneously with the sandstone. All the lignitic fragments are found lying in the horizental position and none occurred in an erect posture. Moreover, the lignitic coal seem to be oxogenious wood. Some pieces of the coal are black, shiny, hard and compact and possess the character of bituminous coal.

PART III

LOWER GOMATI GROUP

Gojalia Shales : At the base of the Rishamuke sandstone beds of rather hard, thinly laminated, well bedded shales occur.

These shales generally contain a large percentage of sands, so it is perhaps more accurate to call them sandy shales. This rock has the appearance of the deep water deposit, accumulated under tranquil conditions, and seem well adopted for the preservation of fossils.

But, it has as far as I have examined, proved entirely unfossiliferous. I even fail to get the slightest trace of any vegetable or animal remains.

The Gojalia shales are typically developed in the Gojalia range, especially in the Docharri stream, descending the western flank.

About quarter of a mile from Brojamohan Tippra bari, the Dochari stream has curved a gorge about half a mile long. The gorge is formed by the Dochari stream making a clean cut section, through a hill formed of laminated shales, fairly soft, with bands of hard argillaceous limestone, which occur as concretions. These concretionary limestones are similar in composition and manner of occurrence, to those found in the Rishamuke sandstone, which I have already noticed. The limestone contains roughly 40 percent of carbonate of lime. It is very irregularly distributed, in some places it occurs abundantly, in fact and individual deposit, sometimes, looks like a coarse conglomerate.

In the Dochari gorge, the space between the two opposite walls, in places, does not exceed 12 ft or so. The walls which

are composed of sandy shales mainly, with bands of hard argillaceous limestone, measure - about 120 ft in height. The scenery displayed by the narrow forest flat gorge, is most picturesque. No concretionary limestone in the form of nodules is observed in this area. The shales seem to dip here at about 18 degree S.S.W. to S.W. Just as we emerge out of the Dochari gorge, stalactite masses, from 1 ft to 4 ft in length, are seen hanging on the right wall. These stalactites are evidently derived from concretionary limestone, contained in the shales. The occurrence of these stalactites, perhaps, proves that the concretionary limestone in this particular area, is richer than that found elsewhere. The Dochari gorge has probably been formed by a gradually retreating waterfall, each succeeding waterfall discharging from a bed composed of the hard argillaceous limestone, higher up in the series, in the sandy shale formation

In the south eastern portion of the State, the Gojalia shales occur in abundance, especially in the Feni valley. The base of the Tulamura range is mainly composed of this rock, and measures about 200 ft in thickness, which is greater than anywhere else, I have yet come across in Hill Tippera. The strike of the Gojalia shales here is N.E and S.W. and dip about 10 degree N.W.

Excellent exposures of the Gojalia shales are seen between Udaipur and Maharanee, in escarpments of hills, which come down to the Gomati River.

Concretionary limestone occurs very sparingly here. The tabular masses do not seem to occur here at all and the nodular forms of limestone are never larger than the size of a football.

In this area, the Rishamuke sandstone does not appear to be represented. This is probably due to an overlap by the Gomati sandstone. The sandy shales appear to come directly under the Gomati sandstone. The dip and strike of the shales occurrying between Udaipur and Maharanee, keep rather

constant, the dip is about 10 degree to 12 degree S.W. and the strike N.W. and S.E. Just above Dakmura the Gojalia shales are perhaps seen at their best in the Gomati valley. A clean cut section appears on the right bank of the Gomati River, dipping at about 10 degree S.W.

Below Laban stream in the Gomotee valley, the shale deposits appear much disturbed, dipping at about 22 degree to 24 degree from S.S.W. to S.W., and have assumed a slaty character. These deposits have bands of hard argillaceous limestone about 4" thick, and occur as varying distances.

Lignitic Coal : Pockets of lignitic coal occur in the Gojalia shales. These lignitic coal deposits are not extensive anywhere, and occur more sparingly, than similar lignitic coal in the sandstone formation, I mean, in the Rishamuke sandstone.

Near Belchuri on the Feni River, about four miles from Bogachatal, lignitic coal in the form of trunks of trees measuring from 6 ft to 7 ft long, and standing almost erect, are seen embedded in the shales. The shales here are highly disturbed dipping almost vertical, the strike being N.N.W. and S.S.E.

The distribution of the lignitic coal here suggests the idea of parts of Gneiss being transported by flowing water and deposited contemporaneously with the sandy shales. The more or less vertical positions of the partially carbonised trunks, are due to their being subjected to the same movement, which disturbed the Gojalia shales in this area.

GOMOTEE LOWER GROUP

Photamatee clay : This clay occurs as a subordinate band in the Gojalia sandy shales. The clay in situ, is ash-coloured, soft and without any distinct bedding. The colour of the clay changes on exposure, and it also becomes hard and tenaceous.

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This deposit is exposed for a distance of 100 yds. or so, on the right bank of the Gomotee river, at Photamatee village. The character of the clay seems admirably suited for the preservation of fossils, but I did not even get the slightest trace of any organism. It is evidently a deep water formation, accumulated under tranquil conditions.

Similar deposits are found in the Feni valley, one above Koila, and the other below Ramgar.

Debtamura sandstone : When the Debtamura gorge is entered from - Chum chomebari side, Rishamuke sandstone with concretionary limestone is seen exposed on the banks of the Gomotee river, and appears to dip 7 degree to 8 degree S.W. When the actual gorge is entered, huge sections of yellow, massive sandstone, measuring 300 ft to 400 ft high, are seen exposed in escarpments of hills, which form the main Baramura range. It is interesting to note that the yellow massive sandstone is only seen exposed on the right bank of the river. The Gomotee here runs along the strike of the rocks approximately. So no contact section between the massive sandstone and the overlying rock is seen. The sandstone is massively bedded, and forms the base of rocks of the Baramura range at Debtamura. The sandstone is yellowish in colour, hard and compact, and mainly composed of grains of quartz in a homogenous, sandy, argillaceous matrix. The sandstone resemble the famous Pore- bunder stone, which is so largely employed as a building stone on the Bombay side. The Debtamura sandstone, in situ is rather hard but fairly easy to work. It is interesting to note that the sandstone gradually hardens more on exposure.

Ompi calcareous sandstone : Just as we emerge out of the Debtamur gorge on the Ompi side, we come upon quite a new kind of rock, not seen anywhere else in the State as yet.

The rock is hard, massive, olive-coloured, no dip or bedding is

seen. This calcareous sandstone is composed of quartz mainly, in a calcareous matrix, it also contains chlorelised biotite with some white mica. This is the oldest rock of the newer Tertiary series met with the Hill Tippera, and occupies the base of the Debtamura sandstone. No evidence of unconformity between this and the overlying rock, the Debtamura sandstone, is seen. A little below Changang village the Gojalia shales much crushed assuming the character of shales, are seen to dip from S.E. to N.E. and not S.W., which, direction of dip, has been noticed all the way up the Gomotee river. This sudden change in the direction of dip is very noticeable, and is probably due to an antecline. This dip S.E. and N.E. occur all along from Changang to Narayanbaree.

The calcareous sandstone may be taken to form the apex of the antecline, against which, the Gojalia shales and the Debtamura sandstone lie on either side. It may be further discussed that the Ompi sandstone although it forms the apex, does not appear to have been disturbed in any way. The rock appears one solid mass without any cracks or fissure or marks of denudation which would surely have been the case, if the calcareous sandstone and the overlying rocks were uncontemporaneous.

Note. No fossils have been yet found in this rock. So its age is uncertain. All we can say is that it is older than the Debtamura sandstone.

Debatamura fault : I have noticed before that the Debtamura gorge is covered by the Gomotee river in the Baramura range. The river course here, runs parallel to the main Baramura range, for a distance of 2½ miles. This straight north and south run of the river, must evidently lie in a line of least resistance in the rocks, and the line of least resistance in this area is most probably along a fault line here. Evidence of a fall existing in this area is perhaps seen from the fact that, about three-fourths of the entire lenght of the gorge,

exposures of Gojalia sandy shales are seen, appearing gently crushed, so that, they look like thinly laminated slates. They are also seen to dip at comparatively high angles.

About half way in the gorge, the Gojalia sandy shales are clearly seen on the left bank of the river, while on the opposite bank, huge sections of massive Debtamura sandstones stand out to view, on the same level. These, perhaps are ample proofs of the existence of a fault in this area, in which the Gojalia shales, have been let down against the Debtamura sandstone, which occurs at a lower horizon.

PART III
(Geological)

Anteclines and Synclines in Hill Tippera : I have already noticed that the dip of the rocks change from S.W. direction to N.E. and S.E. after the Ompi calcareous deposit is passed. The N.E and S.E. dips of the rocks continue from a little below the Ompi River, just after the Ompi calcareous sandstone is passed, right up to the Narayanbaree carbonaceous deposit, a little above Lama charra, where the dip again diverts to S.W. This S.W. dip in the rocks is seen from here to Dumbur.

It is noticeable that, although, the direction of dip changes, the amount from 10 degree to 12 degree remains pretty constant all over Hill - Tippera. These changes in the direction of dip, are most probably due to anticlines and synclines which coincide with the original flexures in the main ranges. So the case of the Gomotee valley, the change in the direction of dip below Ompi river is probably due to an anticline, while, the change above Lamacharra is probably due to its syncline. The dip probably again changes, when the other main ranges lying to the north eastern border of the State is approached. I have noticed the dip changes in the rocks that occur in the Muhuree valley, which, in the case of the Sogania ranges, I mentioned, occur on either side of the flanks of the range. Dip changes,

and occurs in the Feni valley, which are probably also due to the same cause.

These dip changes are too numerous for me to describe, and connect up with any individual range in Hill Tippera, they (dip changes), however, generally occur on the flanks of the principal ranges.

Correlation : At the outset let me observe that in relegating the rocks, in the area covered last season, to the upper tertiary system, I do it, with some amount of unwillingness, and hesitation. As I remarked in the previous chapter, that my observation of the rocks in the area covered last season, were hurried and cursory. The dense mass of vegetation covered in the interior, disclose rocks imperfectly, and no proper geological sections are seen. Over and above this what makes it very difficult to determine the age of the rocks, and the fact itself is not without some amount of interest, is that during my whole survey last season, I did not come across any fossil except some vegetable remains, although I looked for them closely, in rocks which seem excellently suited for their preservation. Whether fossils are entirely absent in the Hill Tippera rocks, further investigations can only prove. Whether they were once present in the rocks, but have now been entirely obliterated, from some cause or other, it is difficult to say. Why the flora of the time should be carefully preserved, and the fauna that flourished contemporaneously, for it is extremely unlikely, that the Hill Tippera area should have been absolutely devoid of all animal life, should be entirely unrepresented in the Hill Tippera rocks, it is difficult to explain

Under these circumstances, I am thrown back upon the few vegetable remains, and lithological characters disclosed by the rocks for the determination of their age. But such a system although it may apply to a particular group of rocks, cannot safely be extended beyond certain limits and therefore is in itself imperfect.

As regards the flora, evidence found in Hill Tippera, silicified fossil wood is found in abundance in the Gomati sandstone. The age of the Burmese rocks, in which silicified fossil wood is found, has been more or less definitely determined by Mr. Theobold. The Mauchar beds in Sind, which are of fluviatile origin and in which fossil wood is found, are like the Hill Tippera rocks devoid of animal and vegetable remains, except a few bones of mammalia, which are very fragmentary and ill preserved. It is possible, nay, probable that if any portion of the Hill Tippera Strata is a representative of the maucher beds in Sind, the rocks like the latter may contain a few animal remains which awaits discovery.

The occurrence of the silicified fossil wood in the Gomati sandstone, which is rather extensively developed in Hill Tippera, helps one materially in determining the age of the Hill Tippera rocks.

Silicified fossil wood has been found in Burma abundantly, and to some extent in the Sind deposit. The Burmese rocks in the Pegu Division, have been included in the tertiary system by Mr. Theobold, Memoirs Volume X,. The "fossil wood" group, Mr. Theobold determines to correspond to more or less the pliocene epoch, and the highest member of the tertiary series in Burma. The "fossil wood" rests conformably on the "Pegu group " which consists of shales and sandstone with fossils, and of Miocene age. In Sind rocks of the pliocene epoch are the Mauchers, which conformably overlie the Gaj group of Miocene age. (Memoirs, Vol. XVII, 1879).

The Gomati sandstone with silicified fossil wood, undoubtedly corresponds to the "fossil wood" group of Burma, and like the latter of pliocene age. The Rishamuke sandstone, which conformably underlies the Gomati sandstone, at least no evidence of an unconformity has yet been noticed, and of similar fluviatile origin, as indicated by the coarse character of the sandstone with pockets of lignitic coal, perhaps cannot be later than pliocene in age.

The Bisalgarh subdivision of the upper Gomati group, consists mainly of red and yellow clays with subordinate bands of sandstones, i.e., the Charilam sandstones. If this subdivision is placed side by side with the beds composing the upper Mauchars, the lithological similarity is striking. The upper Mauchars subdivision consists of a great thickness of orange or brown clays, with subordinate bands of sandstone and conglomerate, while the lower subdivision consists mainly of rather soft grey sandstones. The conglomerate beds in the Mauchar series mainly consists of nodules of clay and of soft sandstone. Precisely similar rocks compose the upper Gomati group. The thick mass of orange coloured clays, and the characteristic soft sandstone, which mainly compose both the Mauchar series in Sind, as well as, the upper Gomati group in Hill Tippera are perhaps striking evidence of lithological similiarity. Further, the conglomeretic beds both in the Mauchar series, and upper Gomati group, consists mainly of nodules of clay, and soft sandstone.

No evidence of a break in time, between the upper and lower Gomati groups, has yet been noticed. In Burma, the Pegu group on which the fossil wood group rests, contains marine fossil, and have been determined to be of Miocene age by Theobold. Although no fossils have yet been found in Hill Tippera rocks, the lithological similiarity between the rocks composing the Pegu group, and those in Hill Tippera, is noticeable.

The Pegu group consists "shales and sandstones, occasionally calcareous". The rocks mainly composing the lower Gomati group, are the Gojalia shales with concretionary limestone, and the Debtamura sandstone, and the Ompi calcareous sandstone at the base.

The lithological similiarity, between the Pegu group and the lower Gomati group, cannot be passed over, and moreover, the latter is lithologically similar to the rocks composing the Gaj group, which mainly consists of sandy shales, and sandstones

towards the base. Therefore, the rocks, composing the lower Gomati in Hill Tippera, are probably of Miocene epoch.

Origin of Hill Tippera rocks : The general characters of the rocks in the lower portion of the upper Gomati group, clearly point that they were deposited under rather shallow water conditions, and probably of fluviatile origin. The floor on which these were deposited, was depressed considerably during the time the Bisalgarh clays were laid down.

I have yet observed, no break in time between the upper and lower Gomati groups. The character of the rocks composing the lower Gomati group, point to deep and tranquil water conditions, under which they were deposited.

The point is, whether they are of fresh water or marine origin. In the absence of any fossils in the lower Gomati group, such as question, can only be speculated upon and different theories as to their mode of origin, be advanced. In all probability, the lower Gomati rocks, like their representatives, the Gaj group in Sind and Pegu group in Burma, are of marine origin.

GEOLOGICAL.

Occurrence of older rocks - among the newer, tertiaries in Hill Tippera : The Rishamuke area is, perhaps, the most interesting, geologically in the whole of Hill Tippera. In the beds of the numerous - streams, which descend the western flank of the Gojalia range, pebbles of older rocks such as quartzite and gneiss are met with.

Quartzite : Quartzite is found abundantly in the bed of the Dochari stream, scattered among rocks of newer tertiary age. The quartzite is of three noteable varieties namely,

(1) Unrolled fragments (usually) of hard, compact, greyish white quartzite.

(2) Pebbles of liver colour quartzite, hard, and compact.

(3) Brown quartzite with large sand - grains, not so hard and compact as the two former varieties. This is intermediate between a quartzite and a hard compact sandstone.

Gneiss : The pebbles of gneiss contain besides quartz, hornblende, white mica, and felspar. These pebbles are found rather abundantly in the bed of the Dochari stream.

Probable derivation of older pebbles : The occurrence of these pebbles of older rocks among newer formations, is interesting, at the same time, rather difficult to explain, from the fact that, I did not meet with any of these rocks, in situ, in this area.

There are probably two ways of explaining their (pebbles) presence among the Gomotee group rocks. Firstly, interest of older rocks occurs in the Gojalia range, from which these pebbles have been derived.

The pebbles have been derived from a conglomerate bed, which probably forms the highest members of the upper Gomotee group.

I am myself inclined to believe the latter as being the more probable explanation of the two. For, if the pebbles are derived from interiors in the Gojalia range, these interiors cannot be situated very far inland, as indicated by some of the unrolled fragments of a greyish quite quartzite.

But judging from the nature of the rock formations, and their mode of occurrence in this area, no such evidence could be derived. In the second case, the pebbles would be originally derived from rocks of pre-tertiary age, which were undergoing denudation in the latter part of the upper Gomotee period. Such a conglomerate would be coarse, containing pebbles of all manner of rocks of unknown origin. Such a conglomerate bed would moreover correspond; by correspond I mean, homotaxial

to the coarse conglomerate bed capping the upper subdivision of the Mauchar series.

Rishamuka conglomerate : Large angular blocks of conglomerate are found in the beds of several streams, which descend the western flank of the Gojalia range.

In the Duchari and the Goria streams, especially in the former, these conglomerates are met within their upper reaches. The conglomerates are found in big masses measuring up to about 5 ft in length, and strewn all over the bed of the streams. The conglomerate is compact, the pebbles are of all sizes up to the size of the duck's egg, and embedded in a fine compact calcareous matrix. The pebbles are composed of all manner of rocks, among which were clay. Soft sandstone, dark, impure limestone, specks of mica and grains of quartz are seen disseminated through the matrix, and pseudomorphous.

I did not come across any piece of conglomerate containing quartzite and gneissic pebbles. Whether these pebbles (which I have noticed on a previous page) which lie among the large conglomerate blocks have been derived from the latter, it is difficult to say without stronger evidence than I was able to gather. I am, however, inclined to believe that the quartzite and gneiss pebbles have been derived from the conglomerates. They have been generally separated from the matrix of the conglomerate, during transport of the masses, owing to their size and their hard resisting nature.

I did not, as far as I proceeded along the streams meet with these conglomerates, in situ. There being no sort of tracks whatsoever, and traversing along the bed of the streams being a physical impossibility in their upper reaches, owing to their precipitous and rugged nature, I was unable to follow up my hunt for these most interesting rocks, as I had much desired. The season being well advanced, and the interior among the hills being scorchingly hot, and full of a species of large cattle-fly, a good sting from which, I was told by the Tipperas, brings on illness. I could not make another attempt at getting further inland, by any other attempt at

getting further inland, by any other possible route, to get to the bottom of the mysterious occurrence of the conglomerate, and the quartzite and gneiss pebbles among newer rocks.

Tippera tableland : Such as surface arrangement, as is presented in the western area of the State, could only arise perhaps, from one continuous land surface, which has been curved and riddled into its present complicated net-work of the hills and valleys from the effects of denudation.

I have noticed some instances of hills coursing to meet the principal longitudinal ranges. A typical instance to the point is the Rokhia range, which when traced from the western borders, is seen to course eastward, and is ultimately lost in the western flank of the Baramura range. Moreover, lithological similarity exists between the rocks composing the Rokhia range, and those lying in the western flank of the Baramura range.

I have also pointed out that, the southern continuation of the Baramura range is a complicated system of hills, which traverse the southern area of the State. In fact, the southern area of the State is mainly built up of hills, which have been parcelled out from the main original Baramura range. This being so, it is perhaps, not original Baramura range. This being so, it is perhaps, not difficult to perceive, that the low lying flat topped hills in the western area of the State, originally formed one continuous land surface, lying on the western flank of the Baramura range, with a gentle slope westward. This slope is indicated by the gradual diminution in height of the hills, as the western border is approached. What is true as regards the western flank of the Baramura range, is also true of its eastern flank. The complicated system of hills lying on the eastern side of the range, originally formed one continuous land surface, lying on its eastern flank.

So, the Baramura and the Ataramura ranges are parts of an original table-land, sloping westward as indicated by the average height of the Ataramura range, which is higher than the Baramura range.

These arguments, which hold good in the case of Baramura and Ataramura ranges, are also true in the case of the other longitudinal ranges, which traverse the State.

It has been pointed out that the ranges increase in height from west to east, and Jampui range which is to the extreme eastern border of the State, is the highest. It is also seen that all these ranges send out lateral ranges or offshoots, which closely approach others sent - out from the successive main ranges. The floors of the valleys rise in succession from west to east, as indicated by the flow of the Gomati river, irrespective of the drainage of the country.

These facts give strong reasons to suspect that the ranges in Hill Tippera, originally connected up, forming one large tableland, sloping from east to west.

The original tableland was probably upheaved during a single period of upheaval, and no geological irregularities, in the manner of occurrence of the Hill Tippera rocks, have yet been met with in the State, disproving this.

The Hill Tippera tableland was, however, upheaved with irregularities on its surface. The subordinate hill systems, and surface arrangements, which are a complicated net work of hills, are mainly due to the potent influence of atmospheric denudation.

In fact, the present configuration could easily have a reason from an original tableland area. The flanks of the Baramura range are mainly composed of clays and soft sandstone, which are easily attacked by the denuding agents, while the central or the main range is built up of hard resisting rocks, such as massive sandstone and sandy shales, protected by bands of very hard argillaceous limestone.

What is true of the Baramura range, is also true of the Ataramura range, and the same arguments hold good. I have already mentioned that the Ataramura range sends out numerous lateral offshoots, on its western flank. These in some cases, nearly join up with the lateral offshoots of the Baramura range, on its

eastern flank. In fact, these subordinate hill systems coming from east and west, originally formed one continuous ranges, but have now been curved into, by the Khowai and Ompi rivers. These disjointed portions, or breaks, are seen as escarpments of the same range, on either side of these rivers in many cases. The present valley between Ataramura and Baramura ranges is, moreover, shallow and mainly consists of a complicated system of low hills and broad shallow valleys.

The original Tippera tableland was not an absolutely smooth surface. There were original inequalities on the surface of the uplifted platform. These inequalities and flextures in the original Hill Tippera crust, have mainly contributed to the present main orogenic features.

The uplifted Hill Tippera platform with - flextures probably running north south, as the principal ranges, and the two main valleys, do now, has been subsequently subdivided and parcelled out into the complicated system of hills and valleys, which make up the subordinate hill systems etc.

This has been mainly due to the potency of atmospheric denudation, the shape and - direction of these subordinate hill systems, depending on local circumstances, such as, the nature of rocks, the manner of their occurrence, and geological irregularity in dip, fault etc. and such subordinate agencies as rainfall, vegetation etc.

High dips and Plications. : On the whole as the eastern extremity of Hill Tippera is approached, the rocks appear crushed and plicated, and dip at comparatively high angles. In the upper reaches of the Gomati river, the rocks especially in the case of the Gomati sandstones near Natun Bazar, and Gojalia shales below Laban stream, both of which, I have noticed, appear much crushed and plicated, and dip at comparatively high angles. Similar high dipping and crushed rocks are seen as the eastern extremity of the Feni valley is approached. These are paobably indications of the centre of the force of elevation which uplifted the Hill Tippera platform, coming from an easterly direction.

Part - IV
ECONOMIC GEOLOLOGY

1. Pottery clays.

Chapamura Kaolin : At Chapamura, a low lying tilla, which is about 3½ miles south-east of Agartala, a deposit of Kaolin clay is exposed at the bottom of the tila in a dried up gully. The position of the Chapamura Kaolin exposure, is about 1/8th mile on the right hand side of the road, which runs from new to old Agartala There is a bridle tract running from Sandagar bridge. This path follows the Sandagar bridge. This path follows the Sandagar stream for some distance, where the track is just about to run to the top of the tilla. This Kaolin exposure is on the left. It is not visible from the path as it is hidden by vegetation.

Physical Properties : The Kaolin clay at Chapamura occurs as a regular seam. The clay in situ, is dull white in colour ; when freshly cut, it maintains the dirty white appearance and is soapy to the touch. But after exposure for about 48 hours, it turns perfectly white, and resembles ordinary chalk in appearance and becomes rather hard. It does not easily crumble into powder, as the Cornish China clay is apt to do.

Manner of occurrence : The clay in situ, appears to be a continuous seam exposed for a distance of 25 yds or so, in horse-shoe shape fashion. I had these diggings made at the spot and the following section was noticed. The following figures are taken as an average. The seam appears to lie horizontal - no dip is noticed.

1. Top soil reddish brown, ferrogenous sandy clay.

By top soil I mean the soil lying immediately above the Kaolin seam.

2. Kaolin clay of good quality say, No. I Kaolin for "Nam- ka-waste" 1 ft. 8 in.
3. Kaolin clay mixed with a large % of Silica in the form of free Quartz (say, No. II)-11.
4. Loose sandy soil with nodular lumps of Kaolin, generally of the size of a pea, 2 ft. and below, went down up to 3 ft. The loose sandy soil seemed to continue below 3 ft.

No. I Chapamura Kaolin : No. I Chapamura Kaolin is rather free from sand and other mechanical impurities. Its physical properties and Chemical composition go to show, that it would perhaps be - excellently suited for china- ware.

The Chemical analysis of a picked sample of Chapamura Kaolin is as follows :-

Silica	56.55 %
Allumina	28.29%
Oxide of iron	1.51%
Lime	None.
Magnesia	.22%
Moisture & combined water	10.85%
Alkalies	2.58%
	100%

No. II Chapamura Kaolin : No. II Kaolin, which is found under No.I Kaolin at Chapamura, is about 11" in thickness and occurs as a continuous seam. In situ, it has a dull grey appearance, and is stained yellow due to ferrugenous matter.

It is not so pure as No. I Kaolin being mixed with a large % of silica in the form of free quartz, but seems to be free from other impurities. The quantity of silica present, can most probably be

got rid of by some process of mechanical washing and the yellow stains removed by chemical reaction.

So No. II Kaolin with some trouble and expense could be turned out well.

Kaolin in nodules mixed with sand : Under No. II Kaolin at Chapamura, loose sand occur, containing nodules of Caolin of the size of a pea. The nodules seem to decrease according to depth. These nodules in themselves, are fairly free from chemical and mechanical impurities. They are mixed with a large % of quartz and occur very sparely in the loose sandy bed, so that, it would not pay to extract them, by any process of mechanical washing.

In the above description of the different qualities of Kaolin, met with in this area, it must not be understood, that they are form separate bed in the same that, they are separated by any foreign material. The Chapamura Kaolin is one seam, but the quality seems to become inferior as the depth increases. The total thickness, therefore, of workable Kaolin sense at Chapamura, is 2 ft 7 in.

Manipurbari Kaolin : A deposit of white Kaolin clay occurs, on the eastern flank of a tilla, on which Manipurbari is situated. This exposure of Kaolin is about 1½ miles due east of the Chapamura deposit. The tilla on the flank of which - the Manipurbari Kaolin seam is situated, is included in the low flinge Chapamura range.

Manner of Occurrences : The deposit is exposed as a seam for a distance of 12 ft or 10. In situ, the clay has a distinct white appearance, seems much decomposed, being traversed by several cracks and is stained yellow due to iron. When mined, exposed and dried the colour turns perfectly white and the yellow stains do not appear so worried.

The seam appears to have a gentle dip eastward and strikes north and south approximately. I made a few excavations, to get an idea of the lateral extent and depth of the seam. The following

figures are taken from - the largest of the diggings being 10 ft X 6 ft. 5 ft deep

1. Kaolin seam - 3 ft 4'' in thickness.
2. Kaolin clay in smaller nodular lumps decriminated through sand - 10"
3. Brownish sandy soil, met with below the - thickness of sand containing nodular - lumps met with up to 5 ft from the surface and seemed to continue.

The Kaolin occurring as a 3 ft 4'' seam, is slightly mixed with quartz grains but - appears to be free from other mechanical impurities. The clay after washing and some chemical purification, could, I believe, be utilised for making superior chinaware.

As regards the Kaolin occurring in limps, the Kaolin is too sparingly deposited, and is of no consequence.

Manipurbari Kaolin seam : The lateral extent of the seam, was traced to a distance of 12 ft or so, being the length of the opening. On either side the seam ran into the tilla. The breadth along the dip, was traced for a distance of 6 ft, after which, the kaolin seam appeared to dip under the soil.

The top soil is yellowish ferruginous sandy clay, homogenous in composition and structure.

The possibility of working the Kaolin deposits a commercial scale : The important question to be discussed, is whether, the Kaolin clay found near - Agartala, could be worked on a commercial scale, so as to yield a revenue to the State. For this, it is necessary to consider every point carefully. The method of procedure must be slow and cautious, so as not to launch on a large undertaking hurriedly, which may find us in difficulty afterwards. The first question be considered is, whether the quality, as well as the quantity of kaolin occurring near Agartala, would justify the working of the clay on a commercial scale, for the manufacture of pottery work.

Quality : As regards the quality of the Chapamura and Manipurbari kaolin deposits, the clay

occurring on the surface in both cases, seems rather well suited for making good class pottery ware. It is necessary, to test carefully the quality of the kaolin at any depth, and see whether the quality remains the same.

Quantity : Another important question, which remains to be carefully worked out, is whether the quantity of kaolin available near Agartala, is sufficient to supply a large demand.

To these questions, (as regards the - quality and quantity of kaolin available) from the nature of the country and the mode of occurrence of the deposits, both of which furnish insufficient data, to work upon. I am not prepared to give a definite answer, without further investigation into the matter. This, I hope to do, next cold weather, especially by sinking a few trial shafts or borings, in the area in which the kaolin deposits occur.

Manipurbari Kaolin Seam : From the mode of its occurrence it does not appear to be one continuous seam. I mean I am doubtful as regards its lateral extent. The seam is not continuous in the sense, that the kaolin occurs in large vests or is "pocketry"

Its pocketri nature, is perhaps admirably disclosed in the large excavation 12ft × 10ft × 5ft. made on the seam. Here the seam has a tendency to discontinue or occur in vests.

It is possible that what appears pocketri is only local, and due to weathering, and subsequent removal of patches by rain wash.

But from the "look" of the deposit, I do not feel very confident of any large supply. In this matter, borings or trial shafts would be the only means of ascertaining, the approximate quantity available.

Chapamura Kaolin : On prima facie evidence the quantity available from this seam although only - 2 ft 9 in. in thickness looks hopeful. But in this case also it would perhaps be best to be guided by results obtained from borings. Mining considerations. Question of purely mining importance, I will not elaborate upon here. I shall only make a few passing

remarks on some points, which deserve notice here and such as are not of a technical character.

Timbering : The top soil in the case of both Chapamura and Manipurbari Kaolin deposits, is sandy class, soil fairly loose in parts. In the case of the kaolin being mined in a large quantity for commercial purpose, this (the clay soil) would form the root of the mine and the desirability, or otherwise of a system of timbering for protecting the roof from falls, would have to be considered. But timber could be obtained in abundance from the jungles close by.

System of working : The best method to be adopted in extracting the kaolin in large quantities for commercial purpose, would mainly depend on the lateral extent of the seam, and the manner, in which the kaolin seam behaves in traversing the country. The best way of working the Chapamura deposit, would be perhaps by sinking circular shafts, at distance (on the seam) from points near the top of the tilla, and driving main level along the - strike and cross-levels along the dip. The thin nature of the Kaolin seam, would necessitate a large quantity of the top soil, in case levels are driven, to be extracted and dumped, to give height to the levels This would form an extra item of cost.

Labour : I found labour pretty scarce at Agartala In case mining be taken in hand on a large scale, labour would have to be imported.

Price of Agartala Kaolin at Calcutta market : A sample of Chapamura kaolin was brought down to Calcutta, by Mr. P.N.Bose to test its prices in the market. The market value given by Babu Srikali Ghose, of the firm of Ghosh Mitter & Co. 2-4, Radhabazar Lane Calcutta, was Rs. 2/- per maund and the Kaolin was declared to be of excellent quality. The sample, however, was a picked one, a larger quantity, which would be liable to contain impurities, would fetch a lesser price.

Twenty maunds of Chapamura Kaolin was sent by me in May

last to Babu Srikali Ghosh to test the market value at Calcutta.

Cost of Kaolin per md : I made an approximate estimate of the cost per md. I, herewith, attach figures obtained in working and transporting the 20 mds of Kaolin, from Chapamura to Calcutta.

i.	Cart hire from Baldakhal (near Agartala) to Akhaura for carrying 20 mds of - kaolin ..... Rs	4 -0-0
ii.	Ry freight for 20 mds of Kaolin from Akhaura to Calcutta	10-5-0
iii.	Coolies at Akhaura.....	0-10-0
iv.	Cost of working 20 mds of Kaolin at Chapamura	2-8-0
v.	Bags for packing 20 mds of Kaolin.....	2-0-6
vi.	Strings &c.....	0-3-9
	Total cost of 20 mds.....	19-11-3

Therefore, the average cost roughly - worked out at Re 1/- per md. Over and above this, an allowance has to be made for contingencies, which may be roughly put down at 2 ans per md. So the average cost of - working and transporting Kaolin, per maund, from Agartala to Calcutta, works out @Re 1-2 ans per md.

Capital necessary for floating a pottery works : The capital required for floating a - Pottery works, will of course chiefly depend on the size of the industry. A pottery works of rather a moderate size, having a commercial basis, could I believe, be - floated with an initial capital of about Rs. 50,000/- (fifty thousand rupees). I attach a rough estimate of a Pottery works on the next page.

Situation of the Pottery works : The question as to whether the Pottery works should be situated in a convenient place somewhere in the State, is an important one. It is perhaps, too premature, to discuss such a question at the present stage.

So I shall defer it to a latter - period, when it is necessary to look into such a matter.

A Rough estimate of a Pottery Works.

Machinery.

1.	Engine and Boiler	Rs. 7000/- (seven thousand)
2.	Blunger	
3.	Pulverising Cylinders	
4.	Pump	
5.	Kneading Machine	
6.	Stirrer	
7.	Filter Press	Rs. 16000/- (sixteen thousand)
8.	Pug Mills	
9.	Crushing Mill	
10.	Pot Mills	
11.	Edge runner	
12.	Shafting, fitting, Pulley Etc.	
13.	Potter's wheel, Tolly & Jigger etc.	
	Total	Rs. 23000/-
Furnace.	Muffle Kiln Round kin two storied	Rs. 7000/- (seven thousand)
Building & & Laboratory		Rs. 15000/- (fifteen thousand)
Contingencies		Rs. 5000/- (five thousand)
	Grand Total	Rs. 50.000/- (Fifty thousand)

Bangeswar Clay : Along the river Bangeswar, which flows into the Howrah River, yellowish unctuous clay is seen exposed in places, on the bank. The percentage of the alumina is small in this clay, with a large quantity of sand, and other impurities. This clay, I believe, would be suited for making common pottery ware such as pots, jurs, gobbles. A good exposure of this clay occurs on the right bank of the River at Jorijoreamura. The exposure measures 27 ft in length 3 ft in height and seems to occur as a regular seam.

Muhuree Clay : Similar clay deposits, but purer in quality occur rather abundantly in the Muhuree valley above Lungling, and as far as below Kamalafrue Bari.

Photamatee Clay : Interesting looking dark ash coloured clays occur at Photamatee in the - Gomati Valley. This clay is locally known as Photamatee. As the name implies "phota" technically in Bengali name marking the forehead, and "Matee" meaning mud or clay This clay is locally used by high caste Tipperas for taking "Photas". The deposit of clay so exposed a little above Photamatee village, on the right bank of the Gomati river. The exposure seems for a distance of 100 Yds or so and about 30 ft height. The clay in situ, is ash coloured, soft, unctuous. The colour of the clay changes on exposure, and becomes rather hard and tenacious. This clay, judging from its physical properties, would, I believe, be suited for making rather good class pottery ware.

There is another such deposit, a little above Photomatee, similar in composition and structure exposed for a distance of about 150 yds or so, and about 40 ft high.

Smaller exposures of similar clay also occur near Photamatee.

Koila Clay : At Koila in the Feni Valley, a deposit of clay, similar in character to the Photamatee clay, is seen exposed on the left bank of the River Feni. The exposure measures about 120 Yds in length, and 20 ft or so in height. Ramgurh Clay. About half a mile below old

Ramgurh, deposits of clay, similar to Photamatee clay, are seen. These are, however, not so extensively developed, as the Photamatee deposits.

Iron Ores

Lateritic Iron Ores : Lateritic iron ores, occur rather abundantly, all over the western area of the State, from north to south. These iron ores, are generally found scattered in patches, here and there, on top of the low tillas and also occurring along their flanks. In the Agartala area, they are found to occur more or less superficially, and of limited extent.

Bisalgarh Laterite : In the Bisalgarh area, however, laterite is met with in rather a large quantity specially in the range of hills running N.E. & S.W. (approximately), about 2 miles south east of Bisalgarh. Crossing, the valleys low range of hills from Bisalgarh to Charilam, which is situated 3 miles south-east of Bisalgarh, as the crow flies, lateritic iron ores are met with in rather an abundance, on the top and the flanks of - these hills. Those deposits decrease in extent south of Charilam, up to Udaipur.

Belonia Laterite : Laterite is found scattered on the low hills in the vicinity of Belonia. The Hill Tippera laterite, is perhaps, seen typically developed at Bindapatilla hill, which is about 4½ miles south east of Belonia town, in a straight line. Here large blocks of laterite, measuring several feet, and tons in weight, are seen in the streams descending Bindapatilla hill. In the stream on which Bindapatilla village is situated, laterite is seen in situ, and seems to occur in irregular disjointed beads. Here, the deposit seems to assume a regular bedding, and runs in a particular direction. The band of laterite in places, measure 8 ft to 10 ft, and huge blocks of laterite are found scattered in the stream. Of all the areas, I have examined in Hill Tippera, the Bindapatilla laterite deposit is the most extensive.

A sample of laterite from Kunjaban near Agartala gives the following analysis :

Chemical Analysis :

Allumina	3.96%
Ferric Oxide	30.30%
Ferrus Oxide	.70%
Oxide of Manganese	2.10%
Lime	.44%
Moisture & combined water	11.85%
Insoluble silicious Matter	45.65%
	100%

As may be gathered from the above analysis, the laterite is rather poor in iron ores. The above sample, moreover, may be taken as a fair average, of the lateritic iron ores deposits in Hill Tippera. Strings and pockets of rich iron ores, occur in the lateritie in places. These, however, are not extensive.

Evidences of a part iron industry in Hill Tippera : Evidence of iron sucking from the laterite iron ores, on a fairly large scale, are obtained in the vicinity of Agartala and in the Belonia area.

Large masses of heavy flags, which at first sight look like anterops of rich iron and manganese ores, are seen in a dried up gully at Jarejoremura near Agartala. A few bits of these block slags, were picked up by me on the southern flank of Kunjaban Tilla. These flags are black, heavy, metallic looking. They usually contain large percentage of metallic iron. The flags are perhaps of historical interest, in the fact, that, they are evidences of a died out industry. An industry, which may have been rather extensive, during the time of the ancient Tipperas. But, the rough and ready way in which the ancient Tipperas handled the industry, is proved in the imperfect manner, in which they smelted the iron ores, so as to have a large percentage of metallic iron in the slag.

Such indications of a past enterprise on the part of the ancient Tipperas, to extract iron from the laterite, are met with nearly all over the western area of the State, wherever laterite occurs in any abundance.

Coal

Lignitic Coal at Tinochoree : Lignitic coal occurs near Bogachatal in the Sabrum Division. About 3 miles from the point, where the Tinochoree stream falls into Mabhrum stream, a deposit of lignitic coal occurs embedded in the massive sandstone, which forms the bed of the Tinochoree stream, in that area. No regular seam or bed of coal is seen anywhere in this area and most of the coal is lignitic in structure and composition. In situ, a large proportion of the coal deposit, appear to be of good quality, but when cut and exposed the fragments assume a characteristic brownish colour, and the vegetable structure becomes clearly visible in them. Some of the coal, however, are shiny black in colour, rather hard and compact in structure and appear to possess the characters of bituminous coal. The coal deposit here is only superficial. A few shallow diggings, up to 4 ft in depth, showed clearly, that the fragments of lignitic coal decreased in quantity, according to depth, up to about 3 ft, after which no trace was found of them. The lignitic coal deposit here occurs for a distance of a furlong or so. A few experiments were tried with this coal.

It gave little heat, and was found, to contain a large quantity of shaby matter, which was left behind as ash. After a careful examination of the area, the quantity was found to be too limited, to be workable on a commercial scale.

Lignitic Coal at Kaptolee : Just above Kapatolee village in the Feni valley, about four miles from Bogachatal, lignitic coal, in the form of trunks of threes occurs embedded in the shaby sandstone, and exposed on the right bank of the Feni River. Diggings were made to find out the extent of the deposit, which after examination, was found to be too limited. The coal

does not occur as a seam, but merely as pockets, which run for a distance of 5 ft or so superficially, and then disappear.

Shaby Coal : Indications of shaby coal, were encountered in the Gomati valley, in the Sonamura and Udaipur Divisions. These will have to be followed up, possibly, next season.

Pest : Deposits, which are somewhat peaty in composition and structure, are found scattered over Hill Tippera, chiefly in the western position of the State. These deposits generally occur, in the boggy marshy tracts, and are also seen exposed in some Rivers. Peaty deposits are seen in places along the Burremogh River, which flows through Bisalgarh area. A deposit of peat is seen well exposed, on the left bank of the Howrah River, about a mile and a half from Old Agartala Town. True peat does not occur in Hill Tippera, and the deposits seem to occur as "pockets", and appear to be merely local. The Hill Tippera peat is black and crumbly, and somewhat like coarse cut tobacco. The evidence available shows, that the deposits are merely recent vegetable accumulations, in which the woody structure is clearly visible. Both, the quality and quantity of available peat in Hill Tippera would not justify working the deposits, for the purpose of manufacturing into an economical fuel.

Limestone

Udaipur and Sabroom Limestone : Limestone is found in all the Divisions except Sonamura. The Limestone deposits in Hill Tippera occur only as concretions in the form of nodules, and lenticular tabular masses. As concretions in the form of nodules, the masses vary in size from a small pebble to large boulders, measuring several feet in diameter. The tabular masses measure from 1 inch to 6 inches in thickness, and - these usually run parallel to the bedding of the

rocks, in which they occur. The Limestone is dark, massive, very hard and compact. The deposits of Limestone in the Udaipur and Sabroom Divisions, are poor in quality and the quantity taken on the whole, is small.

The chemical analyses of a sample of Limestone occurring in the Gomati - valley, which may be taken as a fair average, of the quality of concretionary Limestone occurring in Hill Tippera gives the following analyses :

1.	Carbonate of lime	39.75 %
2.	Sulphate of lime	.37 %
3.	Lime as silicate	.42 %
4.	Carbonate of magnesia	3.84 %
5.	Magnesia as silicate	.36 %
6.	Silica	36.45 %
7.	Oxide of iron and allumina	10.25 %
8.	Moisture @ 212° F	.50 %
9.	Combined water	1.60 %
10.	Salts of alkalies & c	6.40 %
		100%

From the above analyses, it will be seen, that the percentage of carbonate of lime is rather poor, and the quantity of impurities large.

Rishamuke Limestone : The Limestone occurring in the Belonia Division in the Rishamuke area, is perhaps richer in quality and the quantity greater than any other such deposit, I have yet come across in the State. The limestone is seen exposed in the numerous streams, which descend the western flank of the Gojalia range. The limestone occurs as concretions, in the form of holders, which vary in size up to about 10 feet in diameter and also as lenticular tabular masses, measuring from 2 to 6 inches in thickness. These concretions

usually occur in the Gojalia shales. I met with fragments of stalactites in the bed of the streams, and traced them to masses in site. These stalactites are not developed, on any large scale, although, their presence in this area, shows the fairly rich nature of the limestone.

The quality and the quantity of the limestone deposits which I had occasion to examine last season, would not justify working the deposits, for the purpose of manufacturing lime on a commercial scale.

Nummulitic Limestone : It will perhaps be not out of place to mention here, that during my stay at Udaipur, I picked up a piece of nummulitic limestone, similar in character to the Khasi hill (Assam) limestone, which turns out the famous Sylhet lime, which is perhaps the best lime in the whole of India,

At the time I thought, I had made a great discovery. The piece of limestone I picked up, being a clue to its parent bed occurring somewhere near. I am sorry to have to note that during my whole tour last season, I did not even get the slightest trace of this limestone occurring anywhere although I looked for it closely in likely areas.

The fact of this limestone being found among the ruins, perhaps proves that the limestone was employed in the buildings. That the ancient Engineers employed a superior quality of lime in the buildings, is perhaps amply proved, in the fact that, the structures, although, much fractured and broken into by the mass of vegetation, growing on top of them, yet remain on the whole fairly intact.

It is interesting to note, and argue, as to where, this limestone could have been brought from.

That the ancient Tipperas carried this limestone all the way from Khasi hills seems almost incredible. So, there is just a possibility, that the ancient Engineers mined the limestone somewhere in Hill Tippera, and if this be so, it is likely to be discovered sooner or later.

Red & Yellow Ochres : These occur in large quantity in Belonia and Agartala Divisions. Most of the ochres are mixed with a large proportion of impurities, especially in the form of quartz. The process of their purification and concentration, would I believe, be elaborate and expensive, and it would not on the whole, pay to work the deposits, for the purpose of manufacturing paint on a commercial scale. Deposits of red and yellow ochres of superior quality, occur in some places. These, however, are not expensive and appear to be merely local.

Bindapatilla Ochres : Hard darkish looking nodules, of the size of a ducks egg, are found embedded in a seam of dark grey clay, in the valley below Bindopatilla hill in the Belonia Division. These nodules, when broken and ground, gives a dark reddish brown to a chocolate mass, which would make an admirable paint.

From some diggings, I made on the spot, the deposit appear superficial. It is possible, that a closer search in the area, than I was able to do at the time, may disclose a valuable find.

And if that be so, it would be worth working the deposit on a commercial scale, for the purpose of manufacturing paint.

Building Stones

Sandstones and limestones, suitable for building purposes, occur in several River valleys in Hill Tippera, but especially in the Gomati valley and Rishamuke area.

Devtamura Sandstone : The sandstone found in the Gomati valley in the Devtamura Gorge, is a yellowish grey sandstone, which is rather soft, and easy to work, but gradually hardens on exposure. This sandstone is seen employed, as massive columns, in the rivers at Amarpur. Even now, these massive columns stand in their original positions, while the rest of the structure is more or less in ruins. The sandstone somewhat resembles the famous Porebunder sandstone, which is so extensively employed on the Bombay side, as a building stone.

Limestone : Limestone, in the form of lenticular tabular masses, are excellently suited as building stone.

The limestone is hard, durable, and possesses enormous crushing strength. The limestone occurs abundantly in Belonia Division, in the Rishamuke area. This limestone is employed in the Jagannath Temple at Udaipur, and it is hardly necessary for me to mention here, how well this stone has stood the crumbling effect of age.

Road Metal

The concretionary limestone, found in the several river valleys of the State, and the ferruginous concretions, which occur in Agartala and Belonia Divisions, would be excellently suited for road metalling. The limestone is hard, massive and possesses an enormous crushing strength. These qualities would enable it to stand any amount of wear and tear, and would make an economical road metal.

Rishamuke Quartzite : In the several streams do scending the western flank of Gojalia range, I met with pebbles, and angular fragments, of hard greyish, white and liver coloured quartzite. I did not meet with any of these, in situ. I am rather confident, that the parent bed exists somewhere in the Gojalia range, and not very far from the upper reaches of the streams. These parent beds are possibly hidden away, by the dense wall of vegetation growing in these parts. The quartzite possess, all the essential qualities, of a first class road metal.

Brine : The water discharged by Laban stream into the Gomati river, was reported to be saltish in taste, (Laban in Bengali meaning salt), and a " Lick " much resorted to by wild animals. A quantity of water from Laban stream was examined for salt, but was found not to contain any.

This is a small stream flowing into Sogaria stream, in the Muhuree valley, the water of which, was reported to contain salt, and a "Lick" much resorted to by deer and elephants.

I examined the stream in question and although, I did see plenty of foot-prints of elephants and deer, some of which were very fresh, in the stream and along its banks, I failed to detect any salt in the water.

Although, I did not come across any brine streams, during my tour last season. This occurrence among the Tippera rocks is very likely.

Edible Earth : Unctuous clayey deposits, which are supposed to possess medical virtues, and chiefly eaten by women folk in the villages, are found in "pockets", scattered along the banks of Bangeswar and Bureemyh rivers in Agartala Division.

Glass Manufacture : Sand, which may be suitable for manufacturing glass, occur extensively in Hill Tippera.

A stretch of good quartz sand, occur on the right bank of the Gomati River opposite New Udaipur Town. Quartz sand is also met with at Champamura near Agartala, about 5 ft below the surface of the ground. It would be interesting to carry out a few experiments, to test the quality of glass, the Hill Tippera quartz sand, is able to turn out.

Petroleum : Although this mineral oil, was not met with during my geological work last season, it will not be perhaps out of place to mention here that the nature and the distribution of the Hill Tippera rocks, give strong reasons to suspect the occurrence of petroleum in the State.

The Hill Tippera rocks are similar to the Burmese strata, in which petroleum has been found in such abundance. Petroleum has also been found, to the north of the State, in Assam.

This is perhaps strong evidence, that the petroleum belt possess through Hill Tippera.

A close and prolonged search for mineral oil, in likely areas, through the interior of the State, may prove successful.

Jore-jhoree Waterfall : It was suggested by Mr. P. N. Bose that the power obtained from the fall at Jore-jhoree in the Gomati valley, may be utilised in developing electricity, which could be made use of at Agartala, for lightening purposes etc.

I was deputed to enquire into the question, and look into the feasibility of such a scheme. I visited the fall in the early part of this April, which a dry season in Hill Tippera. I managed to climb height up to the fall and take measurements.

This was done under difficulties, and some amount of danger. The sides of the fall are rather precipitous, and the channel of the fall slippery, with the water rushing in the centre with tremendous force. In fact, while I was taking the top measurement of the fall, my feet happened to slip, and had it not been for a strong overhanging root of a tree, which was handy and to which I clung on for dear life, till I managed to swing to the side, I would have been precipitated down below. Those, who were in the boat, viewing me form below, among them Babu Mahim Chandra Dhar, Sub-Inspector of Police, who accompanied me during most part of my tour, last season, thought my last day had come.

Situation : The Jore-jhoree waterfall is situated on the left bank of the Gomati river, and 6 miles from Sonamura as the crow flies, and about a day's journey by boat, up the river.

The water descending the fall is fed by the Jore-jhoree stream, which takes its rise from the Eta range and descends the northern flank of the range, and flows through a boggy and marshy area for a distance of about 4 miles, after which it discharges its water in a fall, (Jore-jhoree), into the Gomati River below. The Eta peak is situated in lat. 23°26' north and 345 ft. high.

Jore-Jhoree There are three cause for entire drops in the Jore. Jhoree fall, arranged in a step like fashion, before the water ultimately drops into the Gomati River below.

I took the following measurements of the height of the fall, breadth of the channel through which the water flows etc., on the 3rd of April, 1910.

1. Height of the topmost drop - 6 ft
2. Height of the middle drop - 11 ft
3. Height of the lowest drop - 12 ft.
   Therefore total height of the fall - 29 ft.
   discharge into Gomati River.
4. Breadth of topmost channel in - 3 ft.
   which the water flows
5. `` `` `` `` (total) cut by the fall - 21 ft.
6. Breadth of lowest channel in - 2 ft 10``
   which the water flows,
7. `` `` `` `` (total) cut by the fall - 14 ft.
8. `` middle channel in which water flows - 4 ft.
9. Average depth of water in the channel - 4``

Description : As I have mentioned, that these measurements were taken in April, a very dry month in Hill Tippera, so the force and volume of water discharged by the fall into the Gomati River, during the rainy season, must be very much greater.

Available power from Jore-Jori Waterfall For an accurate determination of the power available from the fall, further and closer investigation, than was able to carry out last season, is necessary. The whole length of the Jore-Jhoree - stream would have to be traversed, and any peculiarities, that may occur during its course between Eta range and the waterfall which are likely to interfere with the flow of the water, will have to be very carefully seen into. I tried to go along the stream from the waterfall, but I found this impossible, owing to the dense mass of vegetation that cover the stream, and the deep pools of water that occur in this part of the stream. I don't know whether without some sort of special device, the whole course of stream from the waterfall to the Eta range, can be traversed, owing to the very boggy nature of the ground in this area. Moreover, for

accurate calculations the Eta range would have to be carefully examined. For the purpose of noticing the exact height from which the Jore-Jhoree stream takes its rise among the hills and any other irregularities that may occur during the descend of the stream.

Under these circumstances, my determination as regards the available power from the Jore-Jhoree fall, can only be taken as rough, and only approximate.

The beginning of April when the measurements, mentioned in a previous page. I would roughly correspond to the Bangalee month Chait, a comparatively dry month in Hill Tippera.

The average rainfall for the five rainy months in Hill Tippera, during the year 1318 T.E. corresponding to 1908-09 A.D., as given on the Administration Report for the year 1318 T.E. Appendix XVIII, is roughly 13 inches. The seven dry months given on average of about 1.5". So, the amount of water falling over Hill Tippera during the rainy season, is roughly 8 times more than in the dry months. The channels curved in the rock of the top, middle, and bottom steps, show that when the water flows at its greatest, that is, during the rainy season, it is roughly seven times the Volume, which - flows during the dry season.

Taken the average increase in the quantity of water roughly at seven times during the rainy season, and the average height from which the water falls into the Gomati River at 300 ft. the force derived from the fall would develop a horse power, which would most probably be sufficient, to transmit the required quantity of electricity from Jore-Jhoree to Agartala except perhaps a few months during the dry month, when a special engine would be required to develop the required power.

This being so, it is important to look into further possibilities of transmitting electricity from Jore-Jhoree to Agartala, for its utilisation there.

Now the advantage, connected with producing electricity from the power developed from the fall at Jore-Jhoree, would be the following :

1. Firstly, the cost of fuel, which I understand, is a serious item at the Agartala electric works would be greatly minimised.
2. Comparatively few machineries will be required.
3. Establishment expenses in some directions will be reduced.

On the otherhand the disadvantages connected with transmitting electricity from Jore-Jhoree waterfall to Agartala, a distance of about 24 miles, as the crow flies, will perhaps be the following

1. Firstly, the difficulty of laying the mains from Jore-Jhoree to Agartala will be considerable, as the mains will have to be carried through a difficult tract of country, which is very hilly, and the valleys are generally very boggy.
2. The initial expense in laying the mains over such a distance, over and above the cost of the mains, would be considerable.
3. The mains, when once laid, will have to be carefully supervised, from time to time, by a responsible officer.
4. Any serious injury to the mains, would cause considerable delay and expense in restoring them.

Taking both sides of the question into consideration, I believe the annual working cost of carrying the electric current from Jore-Jhoree to Agartala, after paying all initial cost, and interest on the capital, would not perhaps justify us, in undertaking such a scheme. I might mention in connection with this matter, that it is very desirable to approach some electric firms, who are likely to take up such a scheme on their own behalf, and on terms favourable to the State?

The power derived from the fall, may however, be profitably utilised in the following ways :-

Firstly, if the electric current produced at Jore-Jhoree, could be sold at Comilla. The distance is comparatively small, and the mains could be easily carried along the Comilla-Udaipur Road.

Secondly, if the power of the waterfall be utilised in the vicinity, for working a cotton mill, oil mill, or some such industry, which I shall directly enumerate under the head of economic resources of the State.

For some such purpose, the power that can be obtained for Jore-Jhoree waterfall, would, I think be of the greatest value, and economy, as the enterprise would be practically independent of fuel.

Part - V

ECONOMIC MEASURES OF THE STATE OTHER THAN MINERAL PRODUCTS.

What I have to say under this head perhaps really falls outside my province of work. But I state a few facts and practical suggestions for what they may be worked, as I think these may be beneficial to the State, economically.

During my troubles in the interior of the State, I saw various indigenous industries existing side by side, worked on very rough and ready principles, yielding a very precarious output. These industries, if taken in hand, and looked after properly and systematically, and gradually developed on scientific and up to date methods by private enterprise or otherwise, may prove a useful source of income to the State in time.

Private enterprise, which I understand was rather loath to come forward and invest capital in the State, a few years ago, and this I have no doubt, as Mr. P. N. Bose rightly puts it, was due to want of confidence more than anything else, is at present slowly, but steadily flowing into the State from all quarters. I firmly believe, that if these men, who have invested this capital in the State, mainly I understand on Agricultural ventures, can show signs of success, a host of individuals would come forward and engage their capitals, on various ventures in the State. In fact, the careers of those who have already entered the State with their purse, are I believe, keenly being washed on all sides, and the capitalist outside, are simply awaiting results. It is, I think desirable, for the development of the State and intellectual, moral, social and financial bases that private enterprise should flourish in the State, in certain definite directions, but within certain limits.

It goes without saying that the private capitalists at the start

require to be helped and encouraged by the State. The State however, ought to be on their guard, to see that the individual, who is desirous of investigating his capital in the State is a man of some financial position, and if possible, of some social status, and understanding I mean a man, who has had some training in the particular industry, he is going to busy himself with. Unless of course, a capitalist is only a sort of sleeping partner, who merely advances money to exports, who carry on the particular industry for him.

This, I think, is necessary for the future of the State, for I want to drive home the fact, that the success of the present venture will mean more capital flowing into the State and success to the private capitalist, means a corresponding advantage to the State.

Agriculture : Foremost among the industries which may be turned to good account, comes the cultivation of paddy. Extensive stretches of flat alluvial soil, which would be admirably suited for agricultural purposes, occur along the main river valleys in Hill Tippera. Those lying in their lowest reaches have already be turned to good account, but large tracts are still lying idle in the upper reaches of the rivers. These tracts, if cleared of its immense vegetation, would turn out very useful. The Hill Tippera rivers, as I have already noticed in a previous chapter, are liable to heavy floods. The individual, who is about to lease land for agricultural purposes along any of the river valleys, ought I think to be made by the State, to study and survey the ground thoroughly, before entering on a lease, and it is moreover, to the interest of the State to help the individual, as far as possible, in carrying on a proper inspection.

During my tour through the Gomati valley, I heard that a certain lessee is suffering heavy loss, owing to his lands being frequently flooded by the river. The area in question, I understand, is a system of depressions with few high tracts between. The depressions are easily overflowed by the Gomati. In this case, if all I heard be true, the lessee could not have inspected and surveyed the grounds in question, before entering on a term. If he had done so, it would have saved him loss and an indirect loss to the State.

Cotton : There is rather good soil in the State for growing cotton. The low hills with greyish looking soil, situated in the interior of the State, and also to some extent along the principal river valleys, are admirably suited for growing cotton. The industry is now carried on by the Tipperas, in a very crude and unsystematic manner. They have a system of cultivation, which go under the name of "Joming". This merely consists in burning the vegetation, chiefly bamboo jungles, which commence to bear fruit, and then seeding the area, without preparing the ground, in fact, not troubling any further till the plants bear cotton. After the Tipperas have plucked the cotton, they leave the area and "jome" on a new tract of land.

Although "joming" is a very rough and ready method of growing cotton, I have seen quite a good crop teemed out in some places in the interior.

The ashes, derived from burning the bamboo vegetation acts as a rich manure.

It goes without saying that, if this industry is worked on a mere scientific and up to date methods, the possibilities would be large, and the output would perhaps supply the demand of a large ginning press, erected in some suitable position in the State.

Tobacco Cultivation : Fairly extensive tracts of soil along the River valleys, especially in the Gomati valley, would I believe, be suited for growing Tobacco. In fact, an inferior kind of Tobacco is grown by the Tipperas, in small patches, here and there. Babu Brojendra Kumar Datta, when he was Sub-divisional officer of Udaipur, tried a few experiments in the direction of Tobacco cultivation. He told me, he was able to turn out fairly high class Tobacco and the results were encouraging

It is, I think, worthwhile going into the question of Tobacco culture, and trying experiments on a scientific basis. I am fairly sanguine of good results.

Forest. I find from the Administration Report of 1318 T.E., that there are 20 sq. miles of

reserved forest, and 3,861 sq.miles of unclassed forest. During my knockings about in the interior, I came across large stretches of land covered with valuable timber.

In some areas, I found useful and valuable timbers, being hacked about by the villagers, and wasted on all manner of odd works.

I believe, there are great possibilities for forest produce, if there was closer supervision, and greater care in preserving the trees from ruthless destruction.

Oil Seeds : There are extensive tracts in Hill Tippera admirably suited for mustard growing. There are extensive areas in Bisalgarh, Sonamura, Udaipur and Belonia, where mustard is grown by the villagers. This industry, more perhaps than any other, has a great future in the State. Already, I believe, the output of this industry from any of the above mentioned areas, is large enough to supply the demand of a fairly large oil mill.

I think, with more care and attention, given to the cultivation of mustard in some areas, it ought to be possible to erect a large oil-mill, in some convenient spot in the State.

Tea Cultivation : The soil of some of the low hills in the western area of the State, especially in the vicinity of Ishanchandranagar, would most probably, be well suited for the cultivation of tea. It is worth going into this question, and trying a few experiments which could be done without much expense and trouble

Sericulture : During my stay at Agartala, I seized an opportunity of visiting the sericulture farm near Agartala. The articles turned out seemed to be of good quality. There, however, appeared much room for improvement, and with proper care and supervision, the farm ought to be extended, and be a source of revenue to the State. The soil near about Agartala, seems admirably suited for the cultivation of Mulberry plants.

Jute : This product may be extensively cultivated

in Hill Tippera, along the numerous river valleys, and in the interior. The cultivation of this article is very crude and unsystematic as it now exists. There is plenty of room for improvement.

Paper Manufacture : Hill Tippera abounds in bamboo jungles. Now-a-days a superior class of paper is manufactured from a species of bamboo.

Some of the species of bamboo, which grow in Hill Tippera, may be suited for this purpose

A few experiments ought to be tried in this direction, by sending different species of hill Tippera bamboo to some of the large paper manufactures and see with what result.

Sugar Cane : Large tracts in the interior and in the river valleys, especially in the Gomati valley, are I believe, admirably suited for sugarcane cultivation.

Development of Industries : As regards the development of the industries, I have just mentioned, and those which I have noticed under the head of economic geology, I think the best way, the State could tackle the problem, would be by creating a new department in the State, called, say the Commerce and Industry Department with a responsible Officer at its head, understanding the manufacturing and mining industries concerned.

The duties of the officer would - perhaps broadly fall under the following heads :

I. He will make extensive tours through the State, and note particular areas favourable to the growth of special industries, fixing their boundaries, as far as practicable.

II. He will closely supervise the existing - Industries, keep figures of lands under cultivation in each District of the State, and look into there turns carefully. He will gradually introduce reforms in the existing methods of produce, wherever that may be possible, putting them on a scientific basis.

III. He will closely inspect the forest produce, divide the whole

forest area into numerous ranges, in each district, reserving the promising portions containing valuable timber, fixing their boundaries, and preparing working plans. He will keep a quick return from each area.

IV. He will carry out practical experiments on a small scale, with a view to introducing fresh industries in the State, in areas, favourable to their growths.

Whichever, successful, he will try to develop these on a commercial scale, either through private enterprise, or by State grant, which would mainly depend on circumstances.

I think, it would be highly interesting, if such a scheme were tried for a few years, and see with what results. I am fairly sanguine, that such a scheme if properly and systematically worked would lead to material benefit to the State.

I might say in connection with the above, that technical and industrial classes may be opened at the College at Agartala, and possibly at the sub-divisional centres, where young Tipperas may be trained on practical lines in the various departments of industries, which already exist in the State, and those which are likely to be introduced. This would not only give employment to young Tipperas in the State, in the various industries, but it would also equip them to introduce a new spirit of reform among the mass, which is highly important, as without their (masses), industrial and intellectual advancement, the State as a whole can not advance. And by such an advancement, as the Minister, Prince Navadwip Chandra Dev Barman, once wisely remarked, when I was having a talk with him over these matters

"keep pace with the times".

THE END

R. Dutt. / 9.6.33.