

CHAPTER - III

GEOLOGY AND GEOMORPHOLOGY OF THE STUDY AREA

3.1 BOUNDARY

West Bengal is bounded on the north by Sikkim and Bhutan on the east by Goalpara district of Assam and Bangladesh, on the south by the Bay of Bengal, and on the West by Balasore and Mayurbhanj district of Orissa, Singhbhum, Ranchi, Hazaribagh, Santal Paraganas and Purnea district of Bihar and the kingdom of Nepal. Thus the state has land frontiers on its three sides and the southern frontier is limited by the Bay of Bengal.

3.2 AREA

The State of West Bengal stretches from the Himalayas on the north to the Bay of Bengal in the south situated between latitude $21^{\circ}25'24''$ N and $27^{\circ}13'15''$ N and longitude $85^{\circ}49'20''$ E and $89^{\circ}53'04''$ E. The present state covers an area of 87, 616 Sq Kms which is about three percent of the total land surface of India

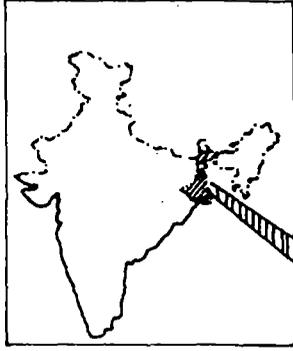
3.3 GEOLOGICAL BACKGROUND

(i) Tracts of the Himalays in the north

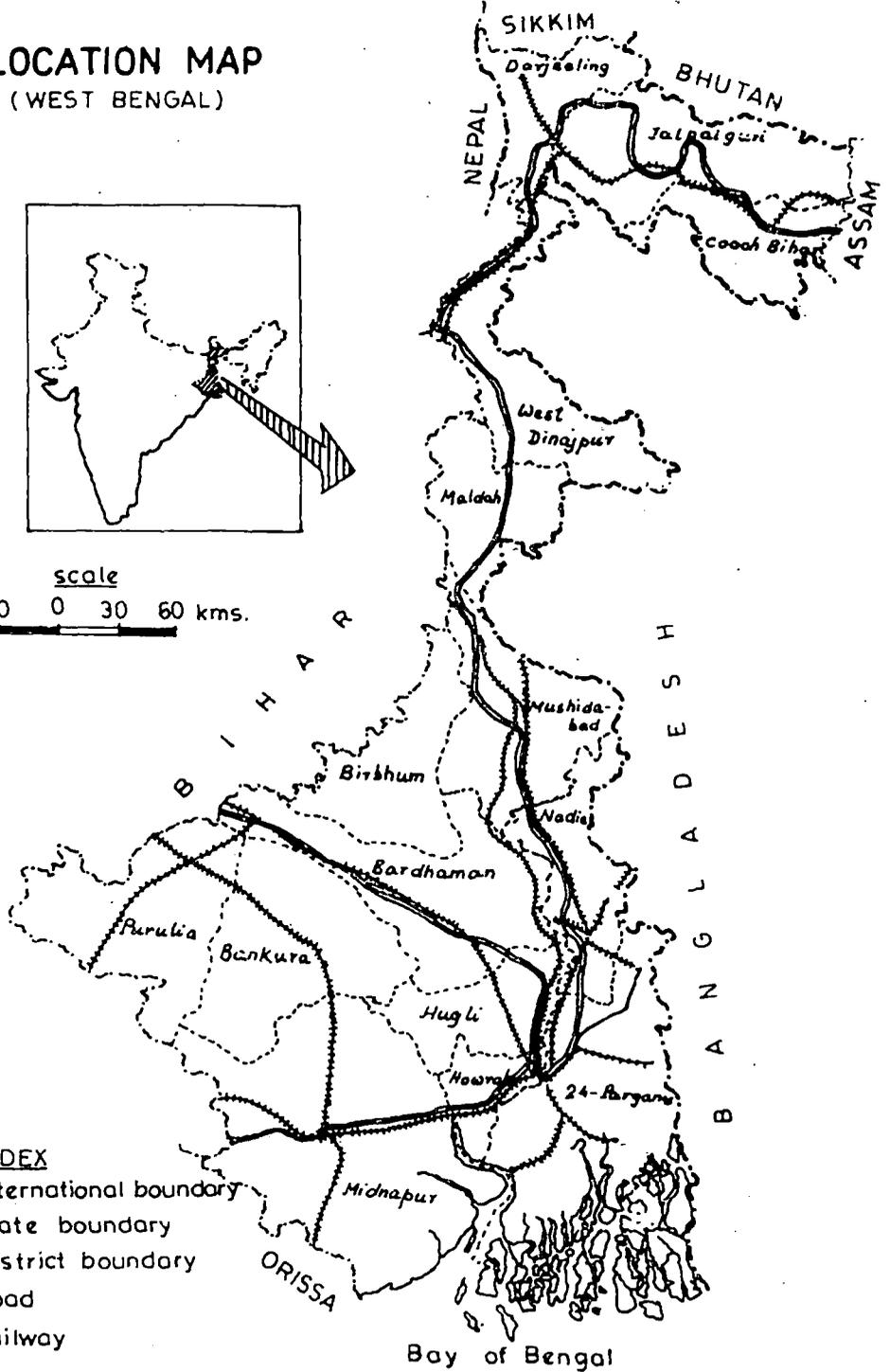
Since the Dalings practically always underlie the Darjeelings and show a different grade of metamorphism. The two were formerly considered to be distinct series separated by a hypothetical thrust zone. J.B. Auden regards the presence of a thrust zone improbable (Rec G.S.I. LXIX, P. 123-167, 1935).

The Darjeeling seem to be merely the granite - injected and highly metamorphosed upper part of the Dalings. The granitic constituent of the Darjeelings, and that a similar granite has given rise, by disintegration to the felspathic sandstone of the middle siwaliks of the Darjeeling Nepal foot hills

LOCATION MAP (WEST BENGAL)



scale
30 0 30 60 kms.



- INDEX**
- - - international boundary
 - - - state boundary
 - - - district boundary
 - == road
 - ++++ railway

The Daling and Darjeeling series have been thrust over the gondwana with which they are sometimes intercalated as thrust slices. They form a large recumbent fold thrust to south. In the core of the fold are the Kanchanjunga, Parnri and some other massifs, while Mount Everest is in its upper limb.

The Darjeeling and Daling series continue into the sub Himalayan area of Bhutan and also farther east. Argillaceous schists and gneisses are predominant. The gneisses are very finely foliated of heterogeneous composition, the different schistose planes being characterised by material of different composition. The gneiss is often closely associated with schists of various composition.

The gneiss is often dioritic, owing to the larger proportion of the plagioclase present. Numerous intercalated beds of limestones, dolomites, hornblends rock, epidote-rock, corundum rock etc. occur among the gneiss. There is an abundance of accessory minerals, contained both in the rock itself and in the accessory beds associated with it, such as magnetite, ilmenite, schorl, garnet, Calcite, lepidolite, beryle, apatite, epidote, corundum, micas and sphens. In all the above characters the rocks commonly designated Bengal gneiss-differ strikingly from those commonly named Bundelkhand gneiss.

The Weathering of some parts of the gneiss of North Bengal is very peculiar, it gives rise to semi-circular, dome like hills, or ellipsoidal masses, by the exfoliating of the rock in regularly circular scale. From this peculiarity the gneiss has received the name of Dome gneiss.

A strip of gondwana adpressed against the siwalik foot hills in the Darjeeling sector of West Sikkim. There is an interesting occurrence of a lower gondwana coal field with thick coal seams, underlying the dolomite and phyllites of the Daling series. In the Ranjit Valley north of Darjeeling, the coal field is exposed from underneath the eroded cover as a window. Intercalated in the fillites and boulder beds of Talchir affinities and underlying the coarse sandstones and shales containing glossopteris, vertebraria and schizoneura are marine hands with fossil spirifer productus, Uridesma, conularia and chonetes.

Regional scheme

The regions has been divided into two second order regions (a) Darjeeling Sikkim (b) Bhutan, Darjeeling-Sikkim Himalaya is further divided into sub-regions. (1) Singalila range (ii) Donkhya range (iii) Darjeeling region (iv) Kalimpong region.

Among the four divisions a considerable parts of the regions are within the administrative area of West Bengal.

Tista Valley

Directly opposit the Ganga Delta, the Tista Valley, like the Kosi reproduces on a vast scale de Martonne's schema of a mountain torrent. The upper basin is 50 miles wide and occupies easily eroded slates, phyllites and schists along the axis of an overfolded anticline, at the core of which lies Kanchenjunga". The river cuts through the Darjeeling ridge (2,135-2,440 m) in a narrow gorge to spill on to the plain in a vast fan or para delta seamed with old course.

Western Undulating Plateau

The western plateau and the undulating topography of West Bengal is very much closely intercalated with the different rock structures of the various characters. Purulia is holding the main system the chatonagpur plateau. Purulia becomes a part of the Singhbhum region of the plateau and may be considered as purulia upland. This area includes the Bagmundi plateau which is an extension of the Ranchi plateau. The land slopes gradually towards the east until it merges with West Bengal plain.

The Rarh plain of West Bengal consists of Birbhum, Bankura, Western part of Burdwan and Midnapur district holds major experiences of gondwanas, which form generally low undulating terrian. The Midnapur area of Bengal is continous with Dhalbhum (Eastern Singhbhum and Contains gnesisses and schists known as Bengal gneisses).

Bengal Gneisses

Highly foliated, heterogeneous, schistose gneisses and schists, of Bengal, Bihar, Orissa, Carnatic and large tracts of the Peninsula.

Types of Bengal Gneiss

Besides the foregoing varieties stated earlier some other petrological types are distinguished in the Bengal gneiss, the most noted being the Sillimanite-gneiss and Sillimaniteschist of Orissa, known as Khondalites (from the Khond inhabitants of Orissa). These give clear evidence of being metamorphosed sediments (para schists) and are discussed in the next chapter. A large part of the schistose and graniferous gneiss of south India, commonly designated "Fundamental gneiss" or "Peninsular gneiss" belongs appropriately to this division. The Bengal gneiss facies is revealed in the gneisses of Bihar, Manbhum and Rewah, and some other parts of the Peninsula also. The Carnatic and Salem gneisses are examples, Carnatic gneiss is schistose, including micaceous, talcose, and hornblendic schists. The wellknown micabearing schists of Nellore, which support the mica mines of the district, belong to the facies of the Bengal gneisses. The schistose type of Bengal gneiss is regarded as probably the oldest member of the Archaean Complex. The Peninsular gneiss of Karnataka, covering 64,750 square Km, is now believed to be a granitic gneiss intrusive into an older Dharwar complex. What have been called the Closepet and Champion gneisses are also later granites intruded in the same basement complex. Recent work in the Archaean Complex of South India has shown that many of the fine-grained gneissic rocks are actually granitoid phases of recrystallised pre-existing formations and do not represent the crushed or foliated phases of true cruptive granites (Records M.G.D., Vol. 42, 1944).

Damuda Series

The Talchir series is succeeded by the second division of the lower gondwana, the Damuda series, the most important portion of the gondwana system. Where fully developed as in the Domuda area of Bengal, the series is divided into three stages, in the descending order.

Raniganj - 1,500 m.

Ironstone Shales (Barren measures) 400 m.

Baraker - 600 m.

The Barakar Stage along the Damodar rivers rests upon the Talcher Series, and consists of coarse, soft usually with white massive sandstone and shale with thick variable coal seams.

The stage is met with the Jharia and Karanpura coalfields but when followed west wards it merges into the overlying Raniganj series. The group is of a most inconstant thickness and appears only at a localities in the Damuda area, being altogether missing from the rest of the Gondwana area. This is succeeded by the Raniganj stage of the Damuda series, named from the important mining town of the West Bengal. The Raniganj stage is composed of massive, false bedded, coarse and fine sandstones and red brown and black shales with numerous interbedded coal seams. The sandstones are felspathic, but the feldspar in them is all decomposed i.e. kaolinised. The kaolinised ore is also extended in the Birbhum district of West Bengal a few km. of the district Headquarter Suri - the name of the location is Patelnagar.

The Damuda fossils are nearly all plants. The flora is chiefly cryptogamic, associated with only a few spermatophytes. It is exceedingly rich in pteridosperm leaves of the netveined type.

The Damuda Flora

The Damuda fossils are nearly all plants. The flora is chiefly cryptogamic, associated with only a few spermatophytes. It is exceedingly rich in Pteridosperm leaves of the netveined type, the genus *Glossopteris* here attaining its maximum development, while *Gangamopteris* is on the decline. The following are the most important genera :

(Pteridosperms) - *Glossopteris* with *Vertebraria*, at least nine species, several of them confined to the Raniganj stage, *Gangamopteris*, *Belemnopteris*, *Merianopteris*, *Sphenopteris*, *Pecopteris*, *Palaeovittaria*.

(Ginkgoales) - *Rhipidopsis*.

(Cordaitales) - Noeggeratbiopsis, Dadoxylon.

(Cycadophyta) - Taeniopteris, Pseudoctenis.

(Filicales) - Cladophlebis.

(Equisetales) - Scbizoneura, Phyllothea.

(Sphenophyllales) - Sphenophyllum.

(Lycopodiales) - Bothrodendron.

(Incertae) - Barakaria, Dictyopteridium, scales, seeds including Samaropsis and Cordaicarpus.

Raniganj Series

The Raniganj series is represented by the Bijori stage in the satpura by Kamithi beds of Nagpur and wardha valley in chanda, the Pali beds of south Rewa; the Himgir beds in the Mahanadi and Brahmari valleys; the almod beds occuring just south of the Panchmari scarp; and the chintalpudi sandstone of the godavari valley.

From the geological point of view the Raniganj coal field is the easternmost field in the Damodar valley and is situated around Asansal about - 210 km. North of Calcutta. It covers about 1550 sq.km. of proved coal bearing area. It is surrounded on three sides by Archacan rocks but on the east it passes beneath alluviam and laterite where its extension is a matter of speculation to be proved by driking. The table below shows the succession of the formation exposed in the field.

Formation	Description	Maximum thickness Mtrs.
Supra panchets	Red and gravy sand stones and shales	300
Panchet	Micaceous yellow and grey sandstones, red and greenish shales	600
Raniganj	Gray and greenish soft feldspathic sandstones shales and coal seams	1,050
Ironstone shales	Dark carbonaceous shales	

<u>Formation</u>	<u>Description</u>	<u>Maximum thickness Mtrs.</u>
Barakar	Coarse and medium grey and white sandstones, shales and coal seams	630
Talchir with boulder bed at the base	Coarse sandstones above and greenish shales and sandy shales below	300

The Raniganj Coalfield is faulted down on the south and west, the southern boundary being a series of fault, indicating a throw of 2,700 m near the panchet hill. Over the greater part of the northern side. The goundwana boundry is one of original deposition, modified of course by later erosion. The oldest beds are found in the north, and are overlapped by younger beds in a southward direction, the general dip being also south wards, Besides the boundary faults, there are also oblique and cross faults in the field. The main dislocation probable took place in the Jurassic. The field is traversed by many dolerite and micaperidotite dykes, the latter having produced much damage to coal as stated earlier. The intrusives are later than the faults and may be of Raniganj or Deccan trap age.

Coal

Coal seams, most of which have two or more local names, occur both in Barakar and Raniganj stages.

This coalfield has been worked since about 1800, the total amount raised to 1980 450 million tones from the secondary statistics.

It is only the Raniganj and Jharia fields which have been mapped satisfactorily. There are now some data for reserves at depths of more than 600 m. Our knowledge of the other coalfields in still unsatisfactory. It is however certain that the present estimates of reserves will be appreciably increased as a result of detailed investigations.

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Barakar Series

The name is derived from the Barakar river which cuts across this stage in the Raniganj coalfield. It consists of a thickness of 750 m of white to fawn coloured sandstones and grits with occasional conglomerates and beds of shale in the Jharia coalfield. The sandstones often contain more or less decomposed feldspars. Because of their uneven hardness, the sandstones weather with a rough surface and produce potholes in stream beds. This stage contains much carbonaceous matter in the form of streaks, lenticles and seams of coal. In the Jharia coalfield, the Barakars include at least 24 seams of coal, each more than 1.2 m in thickness, and it has been calculated that over 75 m of coal are present in the total thickness of some 660 m of strata.

This is the chief coal bearing stage in practically all the Lower Gondwana areas of India, including Darjeeling, Buka Duars and Abor Hills. In the last mentioned place the base of Barakars shows intercalations of marine beds containing anthracolithic fauna. The Barakars consist of sandstones with false bedding shales and coal seams which appear in this order and are repeated over and over again. The sandstones sometimes contain trunks of trees but generally they lie flat. The Barakar seems are best developed in the Jharia coalfield, where the ratio of the thickness of coal to the of the strata is as high as 1: 8. Occasionally very thick seams occur, such as the Kargali seam of Bokaro and the Korba seam of Hasdo valley each of which is about 100 feet thick. In several cases the coal seams are associated with beds of fire-clay.

The Barakars seem to have been laid down in a series of large shallow lakes probably connected by streams. The coal appears to be due to the accumulation of large amounts of debris of terrestrial plants accumulated under quiescent and stagnant conditions. Though coal is no abundant in the Barakar strata, plant fossils are found only in some localities and animal fossils seem to be rare.

Among the more important fossil plants in the Barakars are :

Equisetales

Sphenophyllales, Pteridospermae

Cycadophyta

Cordaitales

Ginkgoales

Incertae

In the Darjeeling area the Barakars are found, with occasional coal seams, at Pankabari and other places. A glacial boulder bed has been noted at Tindharia at the base of the Gondwanas.

The Barrakars in the Himalayan foot-hills are generally thrust over the Siwaliks or other Upper Tertiary (e.g. Tipam) sediments, and are in turn overridden by more ancient rocks such as the Buxa and Daling Series.

Barren Measures (Ironstone Shales)

The Barren Measures, which intervene between the Barakar and Raniganj series in the Jharia coalfield, are about 600 m thick being entirely barren of coal seams, but containing streaks of carbonaceous matter. They consist mostly of sandstones, which are somewhat less coarse than the Barakar type. They are represented in the Raniganj coalfield by the Ironstone Shales whose thickness is about 420 m. Their representatives are thinner still in the Karanapura fields and farther west. They consist generally of carbonaceous shales with clay-ironstone nodules which are sideritic at depth, but when oxidised at and near the surface become limonitic. These are, in places, rich enough to form workable iron ore which was used in the blast furnaces of the Bengal Iron Co. (since amalgamated with the Indian Iron and Steel Co.) situated at Kulti. But the use now have been consolidated. The ironstone contains about 35-40 percent iron. The Barren Measures are seen in the Jharia and Karanapura fields but when followed in the coal fields farther west, they merge into the overlying Raniganj Series which are also barren of coal seams.

The fossils plants found in the Barren Measures are :

Lycopodiales

Pteridospermea

Cordaitales

Rajmahal Series

The type area is the Rajmahal hills at the head of the Ganges delta near the border of Bihar and Bengal. This series consist of 450 to 600 m of basaltic lava flows with intercalated carbonaceous shales and clays, some of these being silicified and porcellanoid. Two of the flows near Taljhari are of pitchstone. The total thickness of these intercalated sedimentary beds is only 30 m, each bed being 1.5 to 6 m thick. The intertrappean sediments between the lower four or five flows contain plant remains, fossil wood and unionids. The more important plant fossils found in the chert beds near Nipania (24°36' : 86°33') Amajhola, Kalajhor, etc. are :

Equisetales

Lycopodiales

Filicales

Pteridospermae ?

Cycadophyta

Coniferales

Caytoniales

Gymnospermous steams and cones

Incertac

The Rajmahal Traps, resembling to the Deccan Traps in composition extend to the east and southeast but have been faulted down and covered by Cretaceous and Tertiary strata in the Ganges delta. The thickness of the sedimentary cover increases eastwards to over 3,600 m, probably as a result of step faulting.

A radiating columnar structure due to "prismatic" jointing is produced in the finegrained traps at many places. It is probable that

these superficial basalt-flows through the step faults of the Rajmahal series are connected internally with the dykes and sills that have not copiously permeated the Raniganj and other coal fields of the Damuda region, as their underground roots. The latter are hence the hypabyssal representative of the subaerial Rajmahal eruptions. Among these dykes mica-peridotites, lamprophyre, minette and kersantite types have been found.

The low lying plains and the deltaic regions of the Ganga in the east :

Underneath the alluvium of Bengal and the Gangetic delta, borings for petroleum deposits have revealed a thick series of Eocene strata over 1000 m thick, resting over a SE shelving platform of Rajmahal trap and some Cretaceous beds and underlying a thick succession of estuarine and marine Oligocene to Pliocene formations, aggregating 1,700 m. This Tertiary series becomes thicker in southerly direction, reaching over 4,600 m near Port Canning.

The types of alluvium concerned may be considered as :

The Bhangar or older alluvium of Bengal and of Uttar Pradesh, corresponds in age with the middle Pleistocene, while the Khadar gradually passes into the recent. The former generally occupies the higher ground forming small plateaus which are too elevated to be flooded by rivers during their rise. As compared to Bhangar, the Khadar, though to be newer in age, occupies a lower level than the former. This, of course, happens in conformity with the principle that as a river becomes older in time, its deposits become progressively younger, and if the bed of the river is continually sinking lower, the later deposits occupy a lower position along its basin than the earlier ones. Such is the case with all old river deposits (e.g. river terraces and flood plains). Remnants of the Bhangar land are being eroded by every change in the direction of the river channels, and are being planed down by their meandering tendencies.

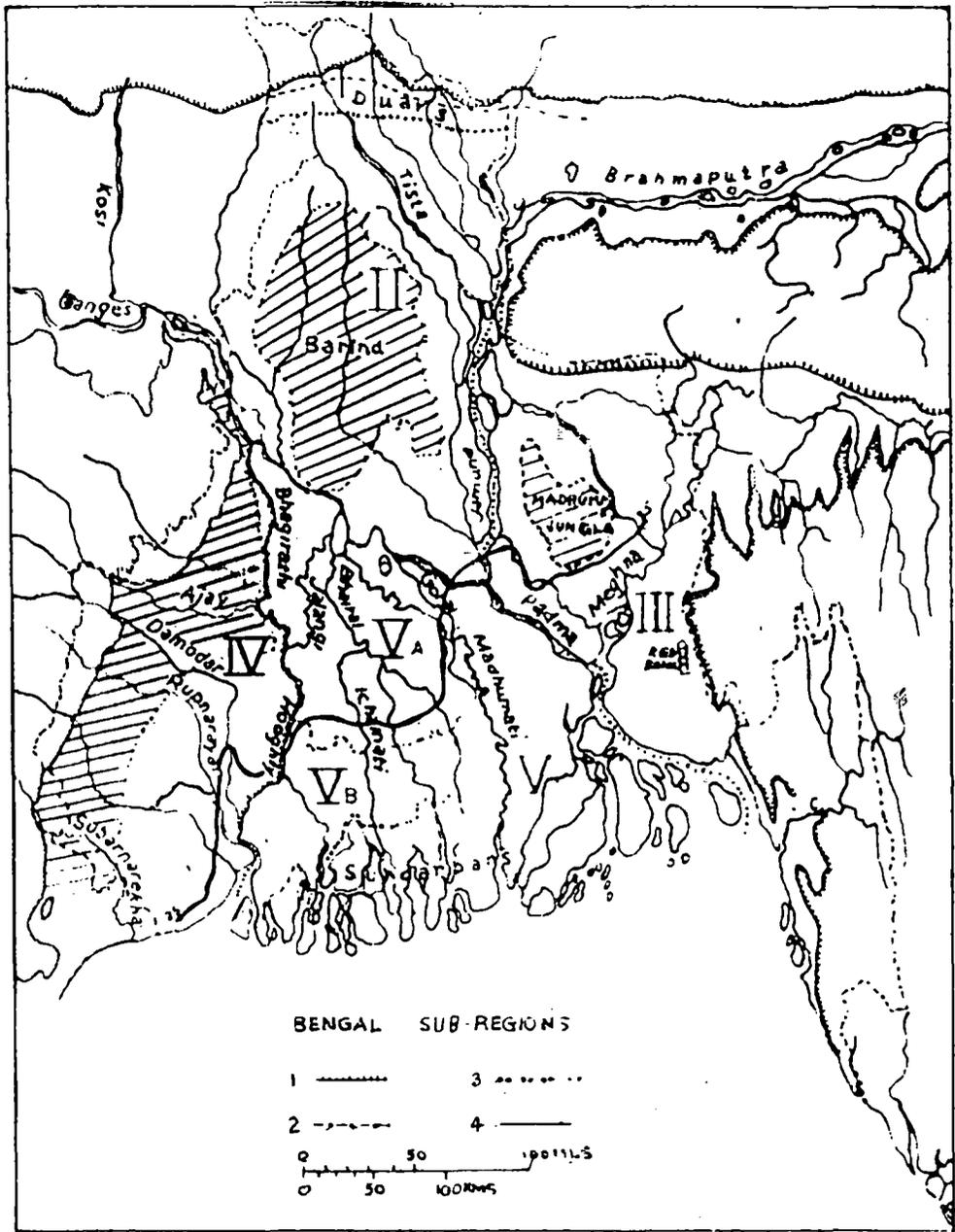
The Khadar, the Ganga delta - The Khadar deposits are, as a rule, confined to the vicinity of the present channels.

The clays have less kankar, and the organic remains entombed in them all belong to still living species of elephants, horses, oxen, deer, buffaloes, crocodiles, fishes etc. The khadar imperceptibly merges into the deltaic and other accumulations of prehistoric times. The delta of the Ganga is merely the seaward prolongation of the khadar deposits of the respective river valleys. It covers an area of nearly 70,000 sq. km. composed of repeated alternation of clays, sands, and marls with recurring layers of peat, lignite and some forest beds.

Southern Bengal has been reclaimed from the sea at a late date in the history of India by the rapid southward advance of the Ganga and Brahmaputra delta through the deposition of enormous load of silt. J. Fergusson has stated that only 5,000 years ago the sea washed the Rajmahal hills and the country round Shylhet was a lagoon of the sea, as was also a part of the province of Bengal at a later date. The cities of lower Bengal became established as the ground became desiccated enough to be habitable, only about 1,000 years ago. The diversion of the Brahmaputra to the east of Madhupur some centuries ago and its later deflection again to the west in the middle of the nineteenth century are well recorded events. This diverted portion which broke away from its course to join the Ganga was named Jumuna. The eastern sea face of the delta is changing at a rapid rate by the formation of new ground and new islands, while the western portion of the deltaic coast-line has remained practically unchanged since Rennell's surveys of the 1770's.

Bengal Delta

The main bulk of the region is taken up by the true Delta and the great mass of alluvial fans - Strickland's paradelta to the north. There have been many attempts at defining the Delta, most of which appear decidedly old to a geographer. No purpose would be served by reviewing them here; this has been done by Bagchi, and on the whole his delimitation and sub-division appear valid, and in fair conformity with Strickland's distinction between the area of transcendent deposition, the delta, and that of corrasion, the paradelta we have then :



Map No. 3

- I. The sub-montane terai, here known as Duars.
- II. The northern paradelta, or Ganga-Bramhaputra Doab and the Barind.
- III. The eastern margin, the surma valley the plains along the Meghna and along Chittagong coast.
- IV. The western margins (i) The largely lateritic piedmond plain between the Hooghly and the peninsular Block (ii) Contai Coastal plain.
- V. The ganga Delta proper (hereafter the Delta) between Hooghly Bhagarathi, Padma-Meghna and the Sea, further sub-division into (A) Moribund (B) Mature (C) Active sections. Of these all of III, all of II except Jalpaiguri and Cooch Behar in the north and the Malda are in west, and all of V except the western margine of V (A) and V (B) are in Bangaladesh. For convenience, the non-deltaic country of the Chittagong Hill Tracts is treated in the Bangaladesh portion.

Bengal and Ganges Delta

Western and Eastern Bengal formed the shelf area of a marine basin which stretched from the eastern coast of Orissa to Upper Assam and the geosynclinal facies lay to the southeast of the southeast of the shelf. The succession of strata in West Bengal is now known from information provided by boreholes put down in connection with exploration for petroleum by the Indo-Stanvac project in the early fifties (B. Biswas, 1959, 1962). The strata dip gently in a S.S.E. direction (Map No. 3). It is found that the Rajmahal Traps which are exposed in the Rajmahal hills have been stepfaulted and are encountered in boreholes at increasing depths to more than 3,500 m in the south. The Dauki fault more or less terminates the continuity of the beds into the Assam plateau, while in the surma valley and Upper Assam the older strata are thrust over the younger in a series of thrusts directed northwest ward. In table 68 the maximum thickness of the formations is given

Tertiary Succession in Bengal Basin

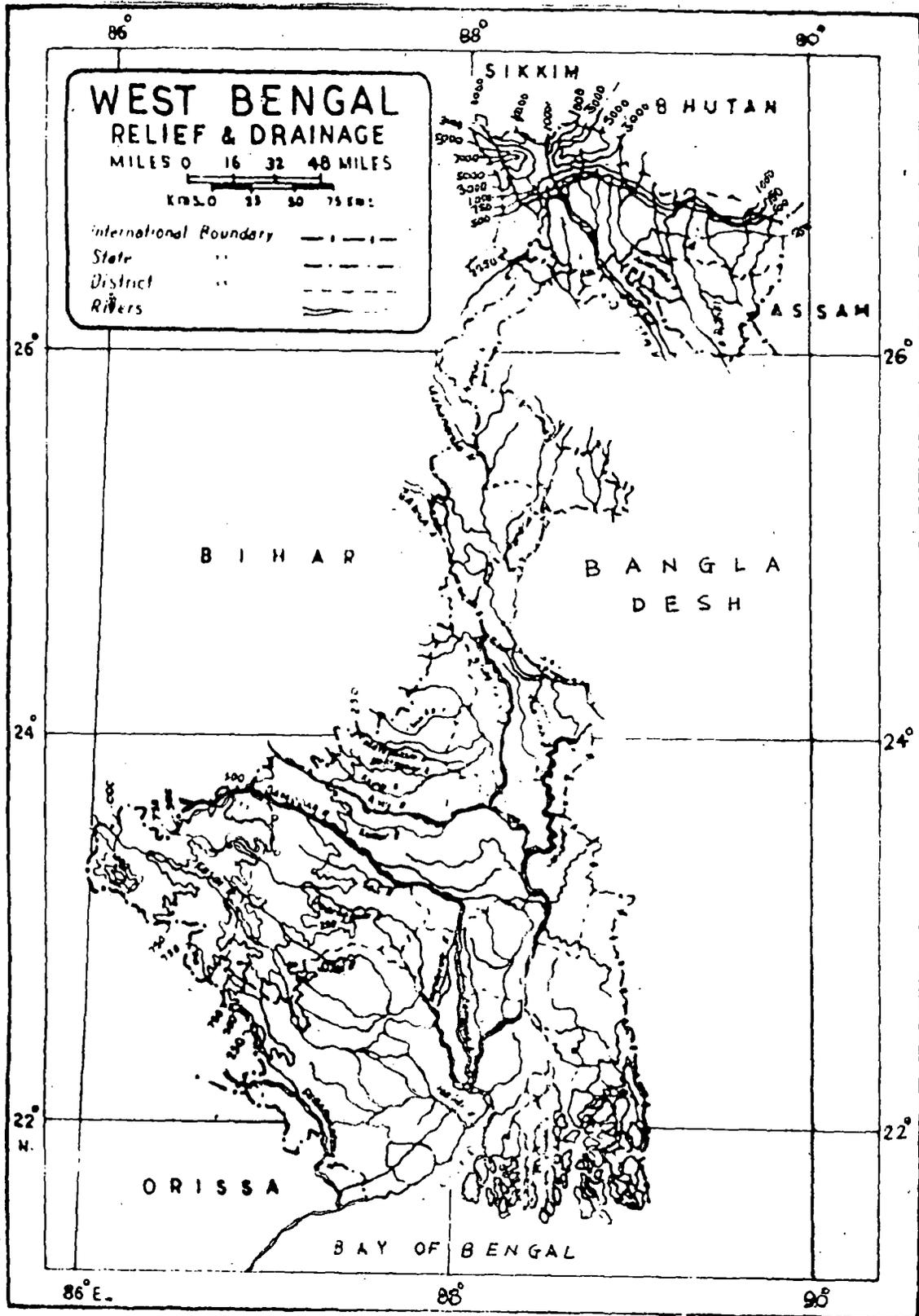
Shelf Facies	Geosynclinal Facies	
Debagram (900 m) Clays and silts showing lateral variation, shallow marine	RANAGHAT (2,530 m) below 200 m. of alluvium Estuarine to marine	Plio-pleistocene
PANDUA (700 m) Open shelf deposits of sands, silts and shales similar to Durgapur Beds	MATLA (1,200 m) Alternating marine and deltaic	Mico-pliocene
BURDWAN (160 m) Fresh to brackish weather sandstones and lignitic shales. Rich in fossils including brachyhaine forms and spores pollen. Unconformable at bottom but passup conformably into the Memari formation.	Oligocene	
KOPILI (20-25 m) Brackish water grey shales and calcareous shales. Resemble the Kopili Alternations of Assam.	Upper Eocene	
SYLHET (320 m) Marine clastics with limestone bands. Rich in formaminifera.	Mid to Upper Eocene	
JALANGI (700 m) Mainly estuarine sands and shales with lignitic matter basal portion marine in the south	L. Eocene to Upper Cretaceous	
GHATAL (120 m) Estuarine to fresh water; mainly Trap wash some white sandstone	Lower cretaceous upper Jurassic?	

Erosional Unconformity

RAJMAHAL TRAPS (Over 600 m) One borehole penetrated 287 m. of the Traps.

The present deltas of the Ganges and Brahmaputra and also the Shillong plateau appear to have been under the Sea in the Upper Cretaceous and to have formed a shelf area trending in a northeast direction. The geosynclinal part of the basin lay to the southeast, covering the southeastern part of East Bengal and Eastern and Southeastern Assam. As revealed in borings put down in this basin by the Indo-Stanvac project for petroleum, the sedimentary deposition here commences from the Lower Cretaceous and consists of the estuarine to fresh water BOLPUR FORMATION and lagoonal black shales and pink shaly limestone with calcareous sandstone intercalations of forming the GHATAL FORMATION. The Eocene comprises the JALANGI, SYLHET and KOPILI FORMATIONS. The JALANGI, about 700 m thick, consists of estuarine carbonaceous shales containing pyrites, lignite and resin, the strata become marine in the dip direction and enclose Lower Eocene foraminifera. It is possible that the lowermost beds of this formation are of late Cretaceous age. The SYLHET FORMATION overlying the Jalangi can easily be correlated with the SYLHET LIMESTONE which is exposed on the southern side of the Assam plateau. In the boreholes this formation is marine, and 320 m thick. It consists of three limestone bands separated by clastic beds, which have yielded a rich fauna including *Assilina daviesi*, *A. papillata*, *Nummulites obtusus*, *Alveolina Elliptica*, *Discocyclina javana*, etc. the age being Middle to Upper Eocene. The KOPILI FORMATION which is of Upper Eocene age, is only 20-25 m thick and consists of brackish grey shales and calcareous shales poor in fossils. They are easily correlated with the Kopili Alternations on the Assam plateau. There is an unconformity above this formation.

The area between Bhagirathi-Hooghly and the surface outcrop of the solid rocks of the Peninsula; like the eastern margins it falls into a northern and a littoral section; but here the resemblance ends. The west is a shelf of lateritic old alluvium (the Rarh), flanked by the coalesced fans of rivers draining the Peninsular plateaus - Ajai, Damodar, Rupnarayan, Kasai - which in turn fall to a dead delta zone below the higher land along the Hooghly banks. In the south lowland Midnapore is only deltaic, with a prograding coastal plain marked by lines of old beach ridges, which give rise to linear settlement patterns around Contai.



Map. 4

The lateritic areas (Khoai) are very poor, with a decidedly xerophytic aspect. The firm shelf has been from early times an avenue of settlement, between the dense jungle of the plateau and the marsh of the delta; the forest destruction has brought the usual nemesis of erosion. On the lateritic interfluves poor short grass thorny bushes, scattered wild dates and the rust red lateritic in roadside cuttings combine to present a landscape of drought and desolation, relieved only by the countersunk paddy-floored valleys. Further east the area within the great bend of the Damodar is especially liable to floods, breaching levees and embankments, and between the Damodar elbow and the Hooghly is a most typical dead delta zone. Here the small streams, some formerly spill channels of the Damodar, have lost their headwaters by silting or shifts of that river, while the Hooghly has probably been pushed to the east by the detritus of the plateau streams.

3.4 RELIEF

West Bengal, apparently a homogenous geographical entity exhibits significant variations in geographical phenomena, both physical and cultural, which render feasible the delineations of somewhat more uniform lower order units depending on different attributes. Within this region of alluvial morphology throughout its spread from the foot of the Himalaya in the north to the Sundarbans and the Kanthi Littoral in the north to the south, remarkable variations in the physical settings exist, which have their imprints on the total cultural landscape of the region. The northern districts (north of the Ganga) have the turbulent tributaries of the Ganga and the Brahmaputra, which while dissecting this tract of older alluvium have rather contributed to the development of distinct cultural patterns including human occupation units as also the patterns of transportation. Likewise, the region bordering the Chotanagpur Highlands has relatively more stable configuration with greater diversity of physical resources and consequent differentiations in the cultural landscape. In contrast, the Delta proper is characterised by the old mud, new mud and marshes, being a play ground for the dynamics of the streams leading to accordant changes in the physical as well cultural landscape (Map No. 4). Thus, the Lower Ganga Plain can be divided into three first order regions :

Relief Setting

1. Himalayan Tract

The Himalayan tract of West Bengal comprises mainly of Darjeeling district. Therefore, it is known as Darjeeling Himalaya.

The hills of Darjeeling Himalaya are divided into two parts by the deep gorge of the Tista. To the east of the gorge are the Kalimpong hills rising to a peak 3,200 metres high. Rivers radiate in all directions from it, ultimately draining into the Tista. To the west of the Tista gorge, the highest peak is the well-known Tiger Hill (2,576 m). From it also spurs radiate in many directions. The Darjeeling spur to the north, the Takadah spur to the east, the Dow Hill ridge to the south ending in the plains of Siliguri and the Ghoom ridge to the West anchoring in the Singalila range near Manebhanjang and Sukia Pokhri. South of the Ghoom ridge the Balason river fed by rain water, flows southwards into the Mahanadi, which is also of a similar nature and which rises from the Dow Hill. The two combined rivers join the Mechi and are thereafter called the Mahananda.

2. North Bengal Plain

A. Duars - which can be subdivided into three :

- i) Western
- ii) Central
- iii) Eastern

B. Barind Tract : Which can again be subdivided into the following heads.

- i) Kosi-Mahananda corridor
- ii) Mahananda Tista Interfluve
- iii) Cooch Behar Plain
- iv) Southern W. Dinajpur plain
- v) Malda Plain.

Unassorted materials and older alluvium (laterite) constitute the surface of the North Bengal plain. The swiftly flowing Himalayan streams, the Mahananda, the Tista, the Jaldhaka, the Sankosh drain the area with frequent shifts in their channels, the Tista and the Mahananda being more notorious. The sub-montane Tarai containing the foothills and the Tarai (Darjeeling, Jalpaiguri and Cooch-Bihar districts). The Duars in the north and (b) the Barind tract of the Tista Flood plain in the south become second order regions of the North Bengal Plain. The former comprising Jalpaiguri and Siliguri is the zone of coarser alluvium (Tarai type), forested tracts and confined water channels; small scale mining distinguishes the eastern section from the other parts. Thus the three third order units are (i) the Western Duar or Siliguri Duar, (ii) the Central or Jalpaiguri Duar and (iii) the Eastern of Alipur Duar. The Barind tract comprises Kishanganj, Cooch Behar, West Dinajpur and Malda and continues eastward into East Pakistan. It is conterminous with the former Rajmahal Garo alignment. Vigorous river action has imparted somewhat undulating character to this region. Intensity of hills increases southward, being maximum in Malda five order units may be distinguished in this sector (i) Kosi-Mahananda corridor or Kishanganj plain (ii) Mahananda Tista Interfluvium, (iii) Cooch Behar Plain (iv) Southern Dinajpur Plain and (v) Malda Plain.

3. Delta Regions

A. Delta Proper

- i) Murshidabad Plain
- ii) Nadia Plain

It is known as moribund Delta. This lies mainly in Nadia, Jessore, and Murshidabad Districts, the northeastern quadrilateral bounded by Bhagirathi, Padma and Madhumati, and on the south by a line roughly along the northern boundaries of 24-Parganas and Khulna. Here the off-takings of the old distributaries in the north have been silted up and the rivers themselves flow on old levees. Even in flood the country in general is not inundated; on the other hand the interfluviums are ill-drained and locally saline owing to their saucer section.

B. Mature Delta

- i) Burdwan Plain
- ii) Howrah-Hooghly Plain
- iii) Midnapur Plain

The Mature Delta is an area of choked rivers lying to the west of the Bhagirathi Hooghly. Between the moriband Delta and the Sundarban is a belt, roughly the northern half of 24 Parganas and Khulna, where the rivers are more live and some silting occurs along the larger ones. They still carry a good deal of water from the local rain, but in general they are deteriorating, and are becoming more and more brackish or saline in the dry weather. Along the western and eastern confines Hooghly and Madhumati - the land is still being built up to some extent. In the Burdwan Plain the Hooghly side industrial and urbanised belt leads to the delineation of 2 fourth order regions, Burdwan Plain East and Burdwan Plain West. (iii) The Midnapur Plain is the least developed region in the Mature Delta with moderate degree of development. In this region Midnapur-Kharagpur area is emerging as the pocket in the Lower Ganga Plain with a distinct form the dune-infested coastal tract.

C. Active Delta

- i) Northern
- ii) Southern

The Active Delta occupying the S.E. corner is the land of marshes, levees, saline water lakes and the coastal forests. Sub-regional disparity is not so high anywhere else in the Lower Ganga Plain. (i) The Upper Delta (Northern in the west; the Bidyadharya Peali tract is emerging as a unit. (ii) The Lower Delta (Southern) has the zone of tidal forests of Sundarbans in the south as also a zone of patchy cultivation by reclamation in its northern section.

4. Rarh Plain

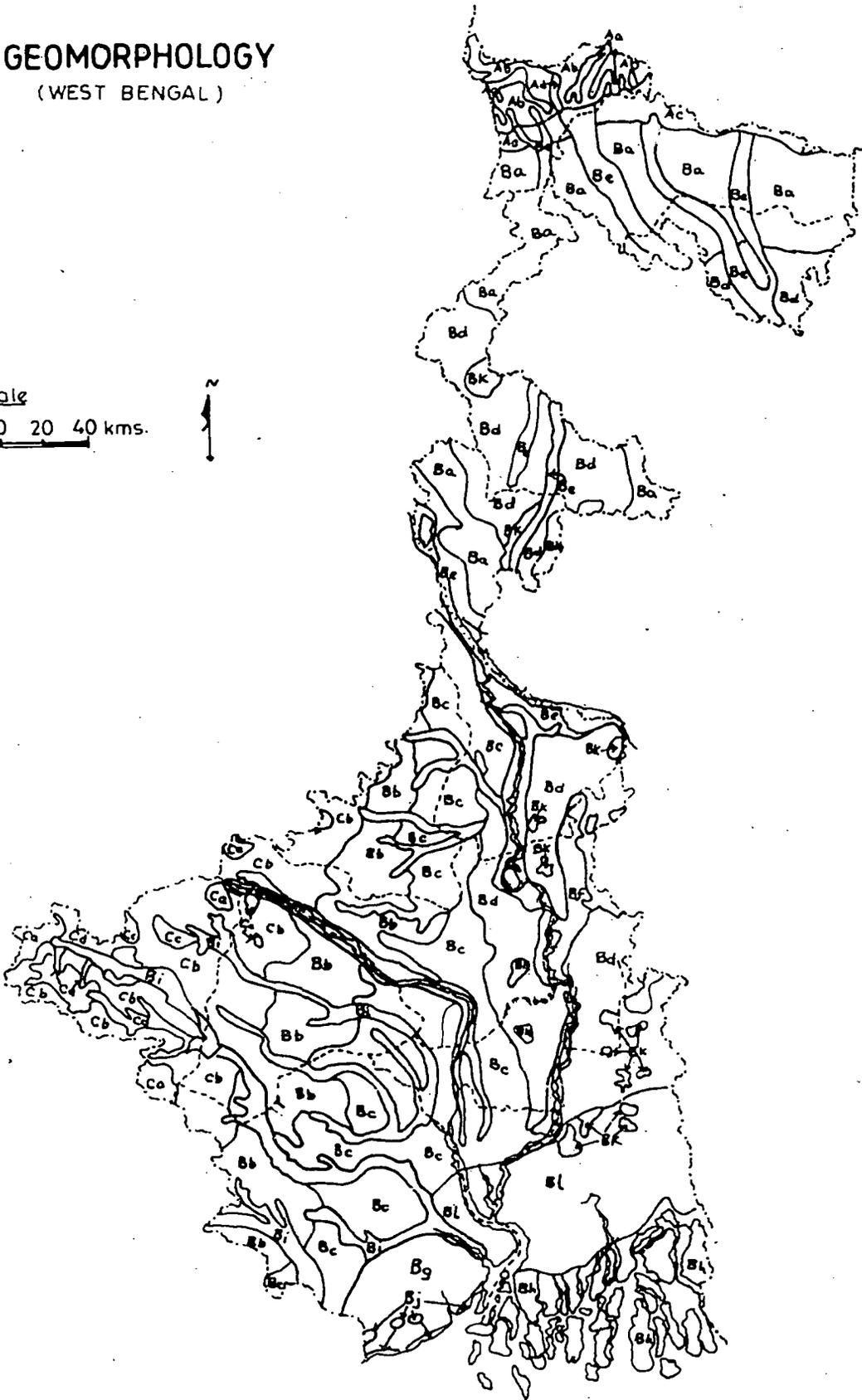
A. Birbhum - Assansol Rarh

- i) Birbhum Plain
 - ii) Ajai-Damodar Interfluve
- B. Bankura Rarh
- i) Damodar Dwarkeswar Doab.
 - ii) Dwarkeshwar Kasai Tract
- C) Midnapur Rarh
- i) Eastern
 - ii) Western

The tract to the West of the Bhagirathi was known as Rarh. The Rarh Plain consists of Birbhum, Bankura and Western part of Burdwan and Midnapur districts. This lateritic region with exposures of the Gondwanas experiences different climatic conditions from the rest of the Lower Ganga Plain. The region is characterised by semicompact and sprinkled settlements with occasional riverside lineations. Lower population density with predominant agrarian economy, except in the Ajai-Damodar interfluve is remarkable. On the basis of variations in surface configuration and the type of economy and level of economic development, three second order regions may be distinguished. The Birbhum Asansol Raha, where the northern tract (i) the Birbhum Plain predominantly rural (93% with Aman culture and moderate degree of development, stands in contrast to (ii) the Ajai Damodar interfluve which has developed as an important industrial and urban concentration towns and has high degree of development, the Bankura Rarh is distinguished by its lower urbanisation, preponderance of primary sector employment of transport arteries. Here again (i) the Damodar Dwarkeswar Doab differs from (ii) the Dwarkeswar Kasai Tract due to some mining activity. The Midnapur Rarh is divided into two third order regions (i) Eastern and (ii) Western, the former is more developed than the latter due to the influence of Kharagpur.

GEOMORPHOLOGY (WEST BENGAL)

scale
20 0 20 40 kms.



index overleaf

L E G E N D

GEOMORPHIC UNIT

SYMBOL

- A Highly dissected, folded and faulted mountainous region
- Aa Folded ridge
- Ab Highly dissected hill slopes
- Ac Piedmont fan plain
- Ad Inter montane valley
-
- B Available and deltaic plain
- Ba Old alluvial plain
- Bb Undulating upper alluvial plain
- Bc lower alluvial plain
- Bd meander flood plain
- Be Active flood plain
- Bf Natural levee
- Bg Coastal plain
- Bh Active delta (mangrove swamp)
- Bi Valley bottom
- Bj Coastal sand dune
- Bk Marshy area
- Bl Deltaic flood plain
-
- C Low dissected plateau interspersed with hills, hillocks, mounds and valleys
- Ca Residual hills, hillocks and mounds with pediments
- Cb Pediplain
- Cc Highly gullied land
- Cd Inter hill valley
- * Residual hillocks and mounds

Geomorphology of West Bengal

The State of West Bengal is highly significant geographically, historically and strategically since times immemorial. It is situated within north latitudes $21^{\circ}30'$ to $27^{\circ}13'$ and east longitudes $85^{\circ}51'$ to $89^{\circ}52'$ covering a total area of 87,85,300 hectares. The State is endowed with remarkable variations in physiographic resources from sea to snow having an elevation ranging from five metres in the south to 3,658 metres above mean sea level in the north. The histogenesis of the land form is a function of the tectonics changing river channels and sea level changes. The present land forms of West Bengal have arisen through the gradual infilling of the basin and the resultant land forms varied accordingly to the local circumstances and the geomorphic processes. (Map No. 5)

The state exhibits three broad well-marked physiographic regions on the basis of their surface forms, origin and stage of their development, viz.

- a) The Himalayan mountainous tract in the north;
- b) The alluvial and deltaic plain; and
- c) The undulating rocky plateau in the West.

a) The highly rugged mountainous terrain is intricately designed by numerous perennial and nonperennial rivers and streams and covers most of the northern part of the Darjeeling district except the Siliguri subdivision. The two ranges named Singalila and Darjeeling trending north-south are dissected into a series of escarpments and are separated by narrow longitudinal tectonic valleys called 'dun'. The rocks comprising the region consist of Siwaliks, Gondwana, Daling and Darjeeling formations. The alluvium of piedmont fan deposit is of late quaternary period. The Siwaliks consist of sandstones, conglomerates, silt stones and the sandstones with thin coal seams of Gondwana rocks which override the Siwaliks along the main boundary fault. The Slate, phyllites and quartzites of Daling formation and granite gneiss of Darjeeling formations were subjected to intensive folding, faulting and thrusting. Intensive rainfall and steep slopes have aggravated the severe erosion along with

landslides which make the rivers meander and sometimes change their courses.

The southern part of the Darjeeling district and northern part of the Jalpaiguri district comprise the submontane tract of piedmont area locally known as Duars composed mainly of hill wash consisting of gravel and coarse sand. Geomorphologically, the mountainous terrain can be subdivided into the following as per their morphological characteristics, (i) folded ridge, (ii) highly dissected hill slopes, (iii) piedmont fan plain and (iv) intermontane valley.

(b) The alluvial plain covers approximately three fifths of the area of the state concealing the older rocks under variable thicknesses of sediments. The alluvial formations are grouped into bhangar or old alluvium of pleistocene age occupying comparatively higher grounds and generally of reddish colour having calcareous and limotic concretions and 'Khadar' or newer alluvium of sub-recent to recent age consisting of alternate beds of clay, silt, sand, marl, peat bed and some forest beds and merges into deltaic flood plain. There is also a coastal plain at the south western part of Midnapur district.

The river action has imparted undulating character to the Tista flood plain comprising Cooch Behar, West Dinajpur, Malda and Part of Jalpaiguri districts. The closely spaced streams from the mountain discharge the load and make the piedmont alluvial fan made up of boulder beds, gravels, sand, silt and clays.

c) The plains lying to the west of the Bhagirathi river exhibits anatured topography covering parts of Birbhum, Burdwan, Midnapur and entire district of Hooghly and Howrah having uneven ground due to remnants of abandoned channels, bill, swamps, marshes and levees. Numerous streams have criss-crossed the area with valley fills, while the areas east of Hooghly river possess the characteristics of younger flood plains and are studied by a number of depressions, meander scars, loops, ox-bow lakes, point bars, cut-offs etc. The easterly shift of the river Ganga has rendered the area a land of almost dead and decaying rivers.

The active delta or deltaic flood plain comprises the whole of Sundarban area where the depositional activity of the streams is prominent and formations of new lands or islands over continental shelf are still active. The intricate network of tidal creeks divide the area into large number of islands with mangrove forest and other vegetation.

The tide water from sea through the rivers Matla, Ichhamati, Piali, Vidyadhari, Gosaba, Saptamukhi carry saline water and overflow inside creating some saline marshy tract.