THE DIHANG AND SOUTH SUBANSIRI BASINS, N. E. INDIA : GEOLOGY, TECTONICS AND SEISMIC POSSIBILITIES

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ABSTRACT

The paper deals with the geology, tectonics and seismic possibilities of the Dihang and the south Subansiri basins. The Dihang is the Himalayan section of the Brahmaputra from Namcha Barwa to Sadiya. The Dihang and the Subansiri are both snowfed rivers. The Brahmaputra has a large catchment area in the Tibetan section, extending from the Trans-Himalayan Range to the water-divide between the Tsang Po and the Subansiri. In the Tibetan section many of the tributaries are also snowfed. The Subansiri has also a large catchment area north of the Great Himalayan Range, and at least one of its tributaries is snowfed. Two of her main tributaries on the south flank of the Main Himalayan Range are the Ranganadi and the Khru. Next to the plain is a 20 km wide belt of Siwalik rising in hills of 700 to 1,000 m high and terminated on the north by the Main Boundary Fault. Next comes a 1,600 m narrow belt of Lower Gondwana rock greatly crushed and contorted. Over a thrust the Buxa Series is seen at places. The Daling Series of Pre-Cambrian age rides over the Buxas and Gondwanas over a thrust and exposed in a belt 77 km wide. Beyond are the tourmaline granites of the Central Himalayan Range. On the east the Miju thrust aligned NW-SE, overrides the Main Boundary Fault across the Brahmaputra valley. None of the severe earthquakes of Assam of 1897, 1930 and 1950 has had its focus located in any of the above mentioned thrusts or along the mountain chain.

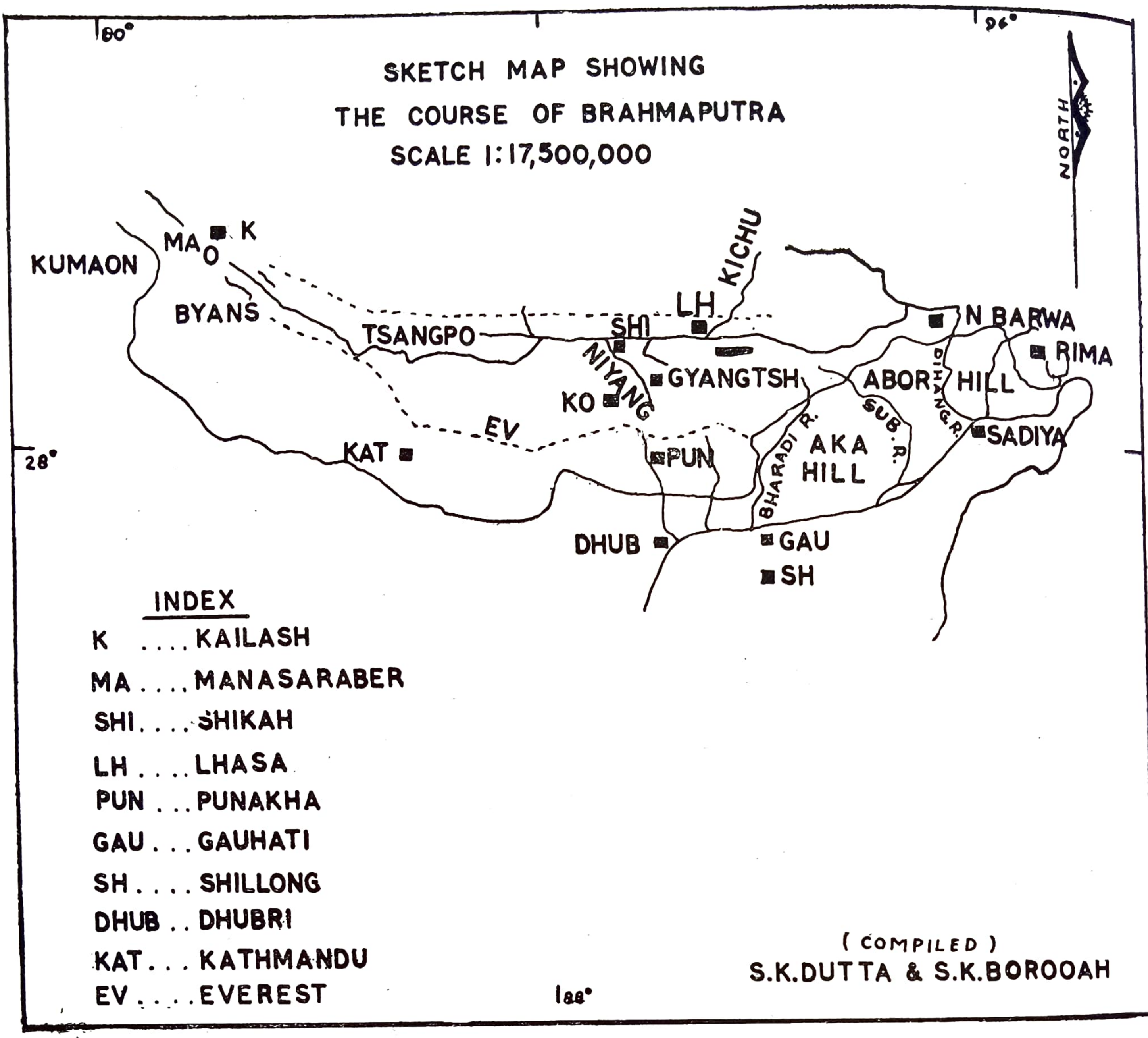
INTRODUCTION

The recurring disastrous floods in Upper Assam more than once in a year are thought to be due to the excess water brought by the Dihang and the Subansiri during the rains. Both these rivers are snowfed. The Brahmaputra actually rises in a glacier, the Chemayung Dung, between Mount Kailash and the Manasarovar lake in Tibet and after traversing a distance of 1,600 km in the Tibetan Plateau turns south rounding Namcha Barwa in the north-east of Assam (Map 1). The portion of the river from Namcha Barwa to Sadiya is known as the Dihang and it is in this portion of its course that the river crosses the Himalayan Mountains through gorges, rapids etc. During its course through the Himalayas it descends through a vertical drop of 2,285 m to the altitude of Sadiya which is only 135 m.

In the Tibetan portion, the Brahmaputra or the Tsang Po, as it is there called, has several tributaries, some rising in the Nyen-chen-Tangla Range and the Trans-Himalayan Range to the north of the Tsang Po.

The catchment area of the Brahmaputra in the Tibetan section is very large extending from the mountains to the north and the water-divide between the Tsang Po and the Subansiri to the South.

The Subansiri rises behind the main Himalayan Range at a height of 5,480 m and drains a large area north of the Central Himalayas. The south valley wall of the Tsang Po rises to a crest to form the divide between the Tsang Po and the Subansiri. Like the Brahmaputra, the Subansiri also crosses the Himalayas through a mighty gorge and



Map 1

many rapids. It has a large catchment area north of the Himalayas and some tributaries in this area rise in the northern flank of the Central Himalayan Range. On its right bank, the Subansiri has some important tributaries such as the Ranganadi and the Khru, both of which rise at a height of about 2,000 m. On the south flank of the Central Himalaya Range, the Subansiri separates the Abor country from the Miri hills and runs for a length of about 160 km in the plains before joining the Brahmaputra.

In the Assam Himalayas the snow-line is at about 4,400 m or slightly higher. There has been floods in the Brahmaputra since time immemorial but the frequency was not as great as it is today. There was certainly an annual flood during the rains but after the Rima (29° N : 97° E) Earthquake of 1950, there has been floods in the Brahmaputra more than once in a year with devastating results. It is believed that due to the earthquake, the channel of the river has been tectonically raised making it shallow and incapable of containing all the water between the banks brought down by the river. Consequently, it overflows its banks. No natural levees are seen on the Brahmaputra. The trunk river and many of its tributaries and their tributaries are snowfed and the floods are not due to precipitation alone during the monsoon but due to melting of snow at the sources of the streams and the tributaries in summer. During floods the Brahmaputra is a mighty river full to the brim, flowing swiftly with foam and fury and eroding its floodplain banks. In the dry season, the channel is heavily braided, islands and bars of sand criss-cross the whole width of the channel and the sluggish current is deflected into a tangle of converging and diverging channels.

It has to be remembered that the gradient for the valley portion is very low ranging from 8-12 cm per km. So the river has no degrading power and independently cannot repair the damage to its channel caused by the earthquake. On the other hand on building artificial levees or embankments, the river has started to aggrade its bed.

The present river-control measures endeavour to regulate the discharge of the river throughout the year by creating some storage reservoirs for the excess volume of flood water and then letting out the water at a uniform rate within the containing capacity of the channel. If this is so, then dams to create the reservoirs will have to be built at suitable places across some of the tributaries or across the trunk river itself, if at all possible. The storage capacity of the reservoirs will of course depend upon the difference between the present discharge and the safe discharge the rivers could be allowed to have throughout the year. For this purpose detail knowledge of the geology of the area is necessary.

GEOLOGY

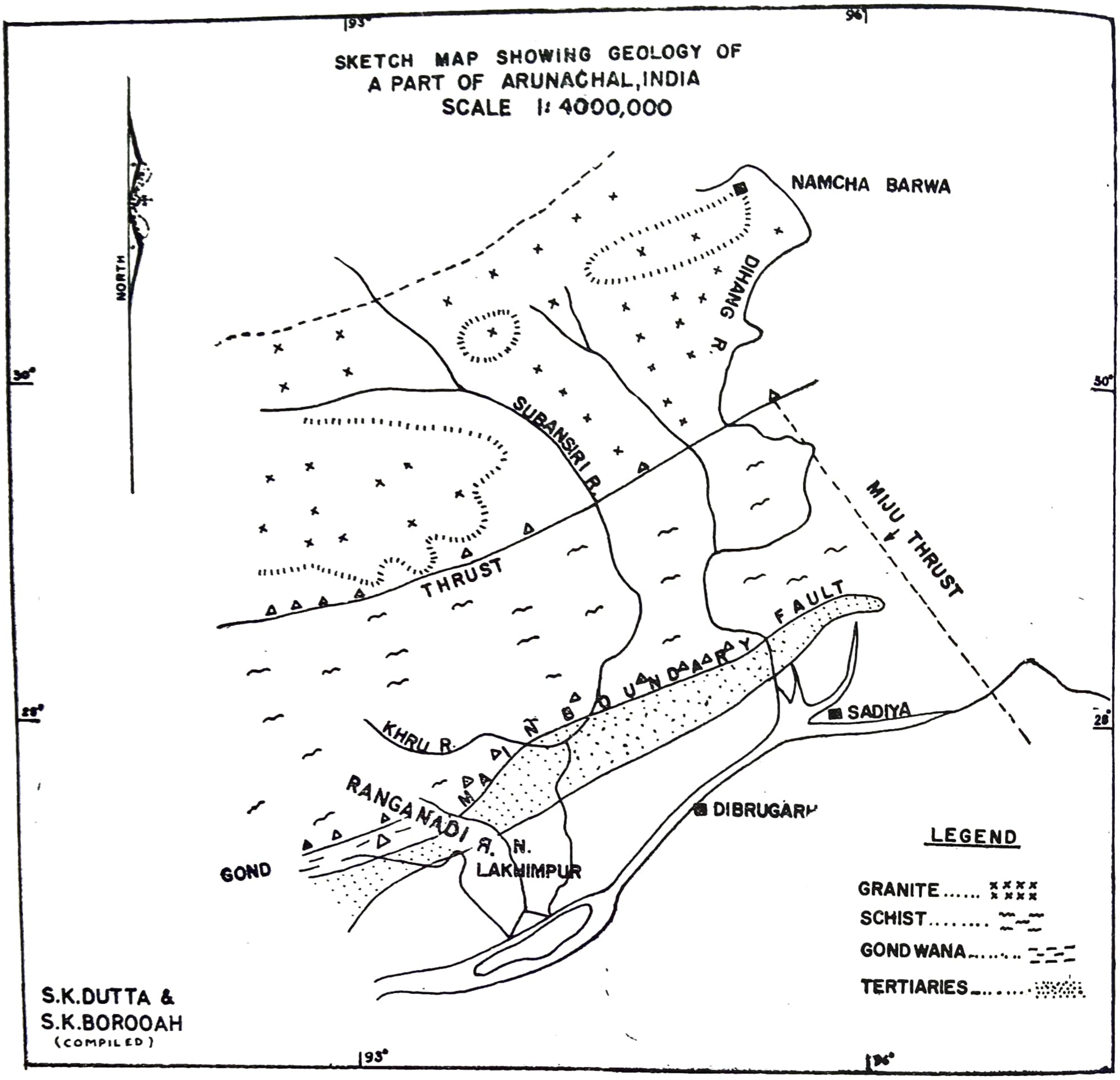
In Assam the basement is made up of a complex of sedimentary, metamorphic and igneous rocks of Pre-Cambrian age. It slopes down in a eastward direction and is lapped by Tertiary sedimentary rocks. How far north of the Brahmaputra the older Tertiary rocks extend is not known but in a deep bore hole put down at Disangmukh (*Personal communication* from O. N. G. C.; Pascoe, 1973) on the south bank of the Brahmaputra, about 1,000 m of Lower Tertiaries and 1,816 m of Upper Tertiary or Neogene rocks were encountered. Of the latter, 1,556 m including a small thickness of alluvium were Siwaliks.

In a section drawn across the Brahmaputra valley over the Naharkatiya oil field, Pascoe (1964) has shown that the older Tertiaries die out to the north of the Brahmaputra and the Neogene Tertiaries continue in great thickness right up to the foot-hill Himalayas under a mantle of recent alluvium.

North of the Assam valley, Sale and Evans (1940) say it is possible that the Surma Group of Miocene age extends from Upper Assam westward along the foot-hills of the Eastern Himalayas. It may therefore be safely concluded that the Neogene Tertiaries extend beneath the cover of recent alluvium from south to north across the Brahmaputra valley.

From the foot-hills northward, the geology is quite different both lithologically and tectonically. Here one can distinguish four almost parallel belts of rocks of varying age and width begining with the Upper Tertiaries or Siwaliks close to the plain. Next comes a narrow belt of continental Lower Gondwana rocks. Then a wide belt of metamorphosed rocks belonging to the Daling and Darjeeling Group of Pre-Cambrian age. In between the Gondwanas and the Dalings are seen at places strips of another Sub-Group of Pre-Cambrian rocks called the Buxa Sub-Group, possibly younger than the Dalings. Then comes a belt of Central Himalayan Tourmaline granite. Each of these belts is separated from the next by a thrust plane.

Let us now discuss these belts in some more detail and confine our attention mostly to the area under question. At the foot of the Aka hills (La Touche, 1885) on the Bharali river, the Siwaliks (or Upper Tertiaries) are exposed over a width of 13 km.



Map 2

They comprise light grey sandstone, fissile sandstone and shales with carbonaceous bands, dipping northeast at 55°. The beds are much crushed and contorted and rise in hills upto 400 m high.

In the Subansiri valley to the east, the Siwalik sandstones with a band of conglomerate 3 to 12 m thick rise abruptly in hills 700 to 1000 m above the plain, showing sheer cliff faces of 200 to 230 m high. The sandstone have northeasterly dips at 60 to 70°, but in the vicinity of Gaimukh some kilometer within the gorge the dip is reversed to southwest. The total width of the Siwalik may be about 20 km (Map 2).

From the Subansiri the Siwaliks extend upto the Dihang having an average width of 20 km. No further details are available. Evans (1964), however, states that near North Lakhimpur at latitude 27° 15′ N under the alluvium, the Tertiaries are about 5,000 m thick.

A word of explanation is here necessary. In the geology of Assam the word 'Siwaliks' has not often been used but in Indian geological literature it is always stated that the

Siwaliks of northwest India extend right upto the northeast of Assam. In age the Siwaliks extend from Middle Miocene to Pleistocene. The Boka Bil Stage, the Tipam Group, the Namsang beds and the Dihing Group of Assam are rocks of this period and when they occur along the foot-hills of the Himalayas they are the Siwaliks. There is, however, one great difference between the Siwaliks of northwest India and those of Assam. In the northwest, the Siwaliks are of fluviatile origin and full of vertebrate fossils. In Assam, the Tipams, the Dihings are undoubtedly fluviatile deposits but unfortunately unlike northwest India, they do not contain any vertebrate fossil.

In rock composition, the Tipam Group is distinguished by thick, coarse, ferruginous sandstone and mottled clay and sandy mottled clay. They vary in thickness from 2,000 to 4,500 m. The succeeding unconformable Namsang beds are coarse, soft sandstone of various colours including greenish blue, bluish grey and pale grey weathering to orange and brown. Intercalated with these sandstones are mottled clays. According to SALE AND EVANS (1940) the Tipam sandstone north of the Brahmaputra valley are characteristically pebbly and fragments of wood converted to lignite are common. There are local unconformities. The pebbles and conglomerates in the Namsang beds are of Barail sandstone and coal. Since the rocks are almost devoid of fossils, the texture of the rocks and mineral content help a great deal in identifying them in the field. Pebble beds which reach a thickness of 1,500 m unconformably over the Namsang or Tipam or Tipam sandstone constitute the Dihing Group. In the extreme northeast of Assam, gneiss pebbles are most common but elsewhere most pebbles are of sandstone. The matrix varies from red to mottled sand to mottled clay and soft grey clay resembling alluvial clay. The rocks are for the most part poorly consolidated and are equivalent of the Upper Siwaliks of northwest India and wholly of Pleistocene age.

Over the Siwaliks are thrust the Lower Gondwana beds of the next belt. This thrust is known as the Main Bounary Fault. This belt can be traced from Bhutan where the Main Boundary Fault is a steep-dipping thrust. The beds there form an anticlinal structure exposing reversed succession. Here the belt is from 70 to 200 m wide and is terminated on the north by a steep-dipping thrust.

Eastward in the Aka hills, the belt as exposed on the Maj Bharali is much wider—about 1,600 m. The beds consist of hard grey quartzitic sandstone, interstratified with carbonaceous shale and seams of coal. The whole set of beds is much crushed and contorted. Elsewhere in the Aka hills are exposed two belts of volcanic rocks, which are equivalent to the Panjal volcanic traps of northwest India of early Permian age (KRISHNAN, 1968).

Damudas have been reported from the Se La Agency, which are thrust over the Tipams and overridden by the Daling schist.

Further east, the Damudas are encountered in the Ranganadi basin about 32 km south-west of the Subansiri gorge, whence in 1904 MACLAREN collected limestone boulders with Permo-Carboniferous fossils. Here the Damudas are associated with Permo-Carboniferous marine limestone beds with characteristic cold fauna. The Damudas occur just north of the Tertiary or Siwalik belt and are terminated by the thrust plane.

In the Abor hills the northern belt of the volcanics exposed in the Aka hills is recognized in a wide belt of 20 km containing intercalations of reddish quartzite.

In Bhutan, the Damudas are overriden by the Buxa Series. The Buxa Series has not been identified east of Bhutan except in the Ranganadi basin and the Abor hills and that only in small strips. In the Ranganadi basin, the upper two stages of the Buxa Series namely the Jaintia Quartzite Stage and the Buxa Dolomite Stage are represented. Here the Jaintia Quartzite Stage is known as the Miri Quartzite. Representatives of the Buxa Series are also seen in the Abor hills north of the volcanic zone. The Buxa Series is not continuously exposed from Bhutan to the Abor hills, only strips are seen over the Gondwanas. It is not kown whether the Buxa Series has been completely overridden or covered by the Dalings thrust.

In Bhutan, the Dalings are slates, phyllites and micaschist with subordinte quartzite, which are gradually invaded by bands and veins of augen gneiss and migmatites and separated from the Buxa Series by a thrust plane.

In the Aka hills in the Upper Bharali, the belt north of the Gondwanas consists of micaceous slaty schist and silvery greenish mica schist belonging to the Dalings. The beds strike eastwest and dip vertically and they have been traced for a width of 13 km. The hills made of these rocks rise to 2,000 m above sea level. The Dalings are extremely sheared and over-thrust rocks.

In the Abor hills, the Daling belt of slightly metamorphosed slates and thick argillaceous beds succeed the volcanic zone, mentioned earlier but the metamorphism increases northwards and the rocks have gneissic intercalations.

There is not much information relating to the area between the Aka hills and the Abor hills, but there appears to be no doubt that the Dalings extend eastwards from the Aka hills in a broad belt of 77 km.

STRUCTURE AND TECTONICS

Mention has already been made that the basement of Pre-Cambrian rocks slopes away from the Mikir hills to the east. As the Mikir hills itself was upwarped due to some secular movement in a hog-back-fashion, the basement slopes to east, north and south and the eastern boundary of Pre-Cambrian rock is a curved line convex to the east. On the analogy of the longitudinal faults occurring in the Naharkatiya oil field, EVANS (1964) has postulated a few such faults north of the Brahmaputra. Only geophysical work can confirm this supposition.

On the northeast side of the valley is the Miju thrust. The thrust runs WNW-ESE near the Dihing river, then runs NW across the Brahmaputra valley to meet the Main Boundary Fault, which it overrides.

In the Himalayan region there are four thrusts, the southernmost being the Main Boundary Fault. The second one limits the Gondwana belt on the north, the third limits the Daling on the north. In between the last two there may possibly be a low-dipping thrust which brought the Buxas over the Gondwanas and itself being overridden by the next thrust which nearly covers the Buxas all along except in the Ranganadi basin and in the Abor hills.

SEISMOCITY

Assam is known for her frequent earthquakes, the most important of which are the Assam Earthquake of June 1897, the Dhubri Earthquake of 1930 and the Rima Earthquake of 1950.

Of these the last which occurred on the 15th of August, 1950, with its epicentre located at Rima (97°E and 29°N) in the (Lohit) Zayal valley on the Assam-China border, appears to have been studied in more technical details. From year to year the total energy released by the world's earthquakes fluctuates. For nearly the last half century from 1904 to 1952, the year 1906 showed 6 times the average record during the period. 1950 was also a very significant year, second only to 1906. The Rima Earthquake belongs to this year. This earthquake had a magnitude of 8.6 on the Richter scale, the larggest magnitude observed during the first half of the present century. The only other earthquake of equal magnitude was the one that occurred in Columbia on June 31, 1906. The earthquake, however, had a shallow focus, i.e. its focus was within 64 km of the surface.

The Assam Earthquake of June 1897 was not recorded on the Richter scale as it was not available at that time but judging by the effects produced in comparison with those of the Rima Earthquake, it would appear that it was of higher magnitude, possibly of the order of 8.7 to 9. Since the maximum energy released by earthquakes becomes progressively less as depths of the focus increases, the Assam Earthquake, like the Rima Earthquake, had only a shallow focus which was located on the Chedrung Tributary of the Krishnai river in Garo hills.

The Dhubri Earthquake epicentre zone was also located along a fault plane on the western margin of the Garo hills and like the other two had only a shallow focus but of lesser magnitude.

It is estimated that about fifteen per cent of the energy released by all earthquakes is let out in a zone that extends from Burma through the Himalayan Range into Beluchistan and across Iran to western Europe through the Alpine structure of the Mediterranean zone. Earthquakes in this zone are of shallow (up to 64 km) and intermediate (up to 320 km) depths with foci aligned along the mountain chain.

Although the Eastern Himalayas have many thrust planes, surprisingly enough none of the severe earthquakes of Assam have had its focus located in any of the thrust planes or along the mountain chain. Except for the Rima Earthquake which occurred in a region where the geological formations show sharp changes in strike due to the presence of peninsular wedges beneath, the others like the Assam Earthquake of 1897 and the Dhubri Earthquake of 1930 occurred in and along the margin of the Assam Plateau which is known to be a horst uplifted during the Miocene Period.

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