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NOTES TO ACCOMPANY A GEOLOGICAL MAP OF A PORTION OF THE KHASI HILLS NEAR LONGITUDE 91° *E.*;—*by Captain* H. H. GODWIN-AUSTEN, *F.R.G.S.*

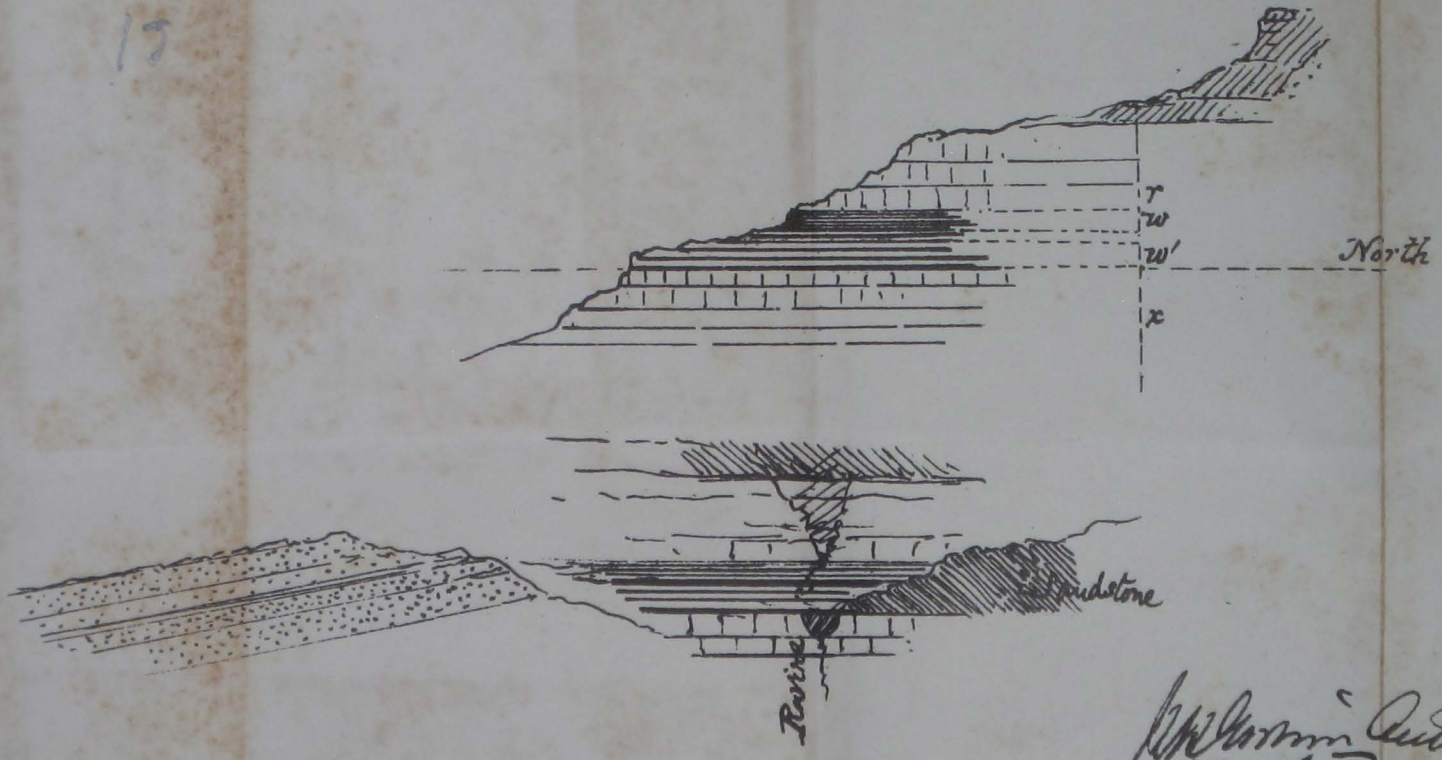
[Received 28th January, 1868.]

In contributing this paper to the Journal of the Asiatic Society, it will be first necessary, as an introduction to those unacquainted with these hills, to commence with a brief account of the geology already published; this must form the base of all further inquiry extended into portions hitherto unvisited. I cannot, therefore, do better than briefly quote from the works of Thomas Oldham, Esq, Superintendent of the Geological Survey, and H. B. Medlicott, Esq., Deputy Superintendent in the same Department. These able surveyors, by their researches in the neighbourhood of Cherra Poonjee, have determined the superposition of the principal formations as displayed there, and though many minor sub-divisions have, no doubt, yet to be discovered and worked out, the main divisions on this longitude will most probably remain as the above geologists have laid them down. Mr. Medlicott in his report on the Coal of Assam, &c.* commencing at page 34, after mentioning the trap and metamorphic rocks north of Cherra, gives in detail an ascending series of the stratified rocks. These he divides *into three great Sections*, as follows:—

* Mem. Geol. Surv. of India, vol. IV. p. 387 etc.


25°30′
25°20′
25°10′
90°50′
91°
91°10′
91°20′
NONGSTEIN
Umiam R.
NONBINORIANG H.S.
Nongrompa
Nongmopon
Nongshingriang
Umiam
Um Kanchiang
Nongtieushiling
Nongkashba
Wyyow
LANDEKAR
Nonglauba
Maomarin
Umlangyem
Nongrendong
Nonglaly
Nongsherkon
Nongpunskoy
Dekurh
Um Blay
Tenung R.
Kunchiong R.
Borpen
Nongtrai
KOKHLAM H.S.
KATILAO
Ashek
Um Maoptit
WANRAI Pt.
TIQASIN
PUNDENGROO
Sú Hileng
Nongkerasi
Nongkadang
NONGKULANG
Nongkulang
YINOKU Pt.
KUTABRAM
Shibak
Parjonkha
RONOSI TILA
Magisora
MARANOTHANG
Chandadinga
Pansgao
H A B I A N
N
G
R
O
S
PART OF THE WEST KHASI HILLS.
SURVEYED AND DRAWN BY
H.H. Godwin Austen Capt.
Nov. 1867.

Photozinco. at the Surveyor General's Office, Calcutta,
February 1868.

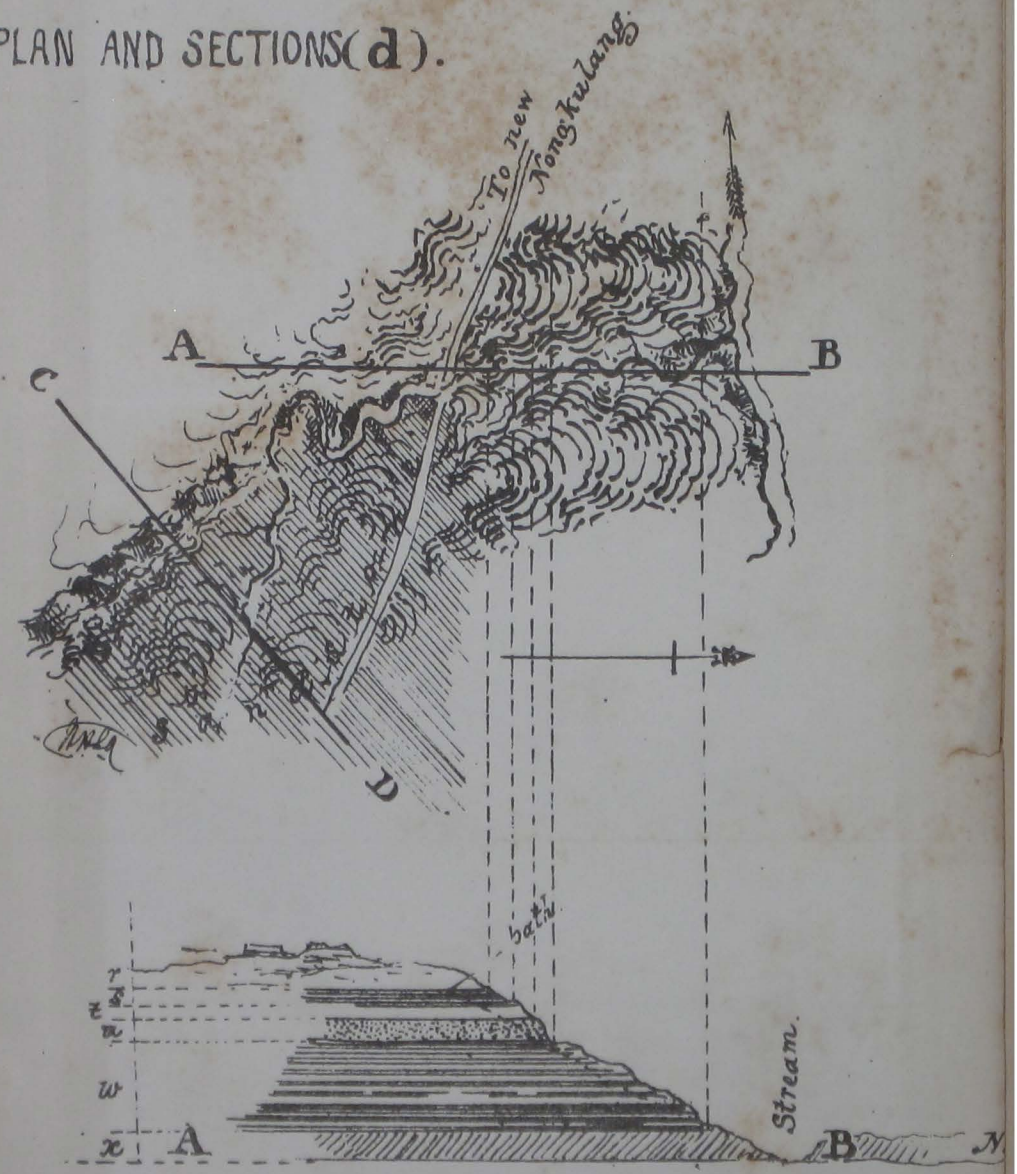


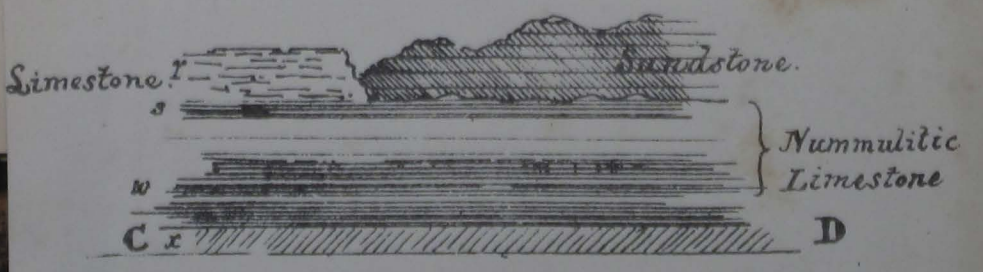
Photozinco. at the Surveyor General's Office, Calcutta,
March 1868.

Photozinco. at the Surveyor General's Office, Calcutta,
March 1868.

Journal As. Soc. Bengal, Vol. XXXVIII. Pt. II Plate VI.

PLAN AND SECTIONS(d).





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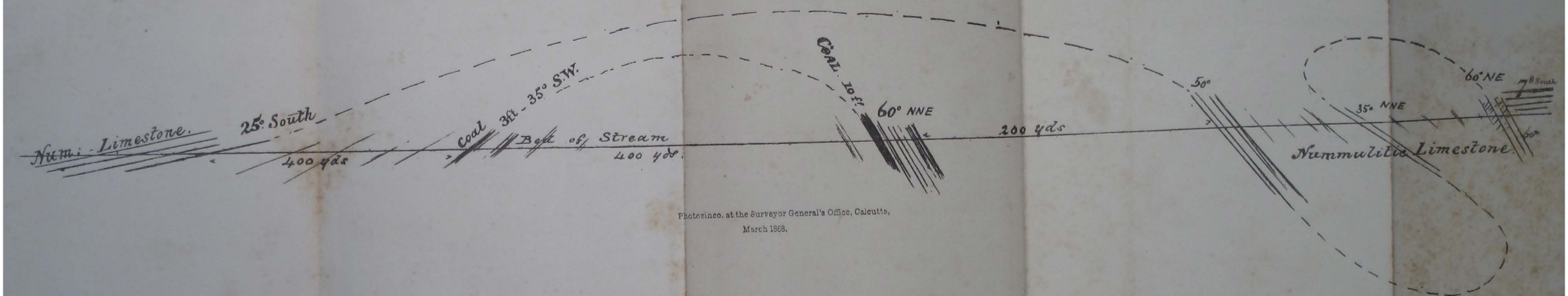
WEST KHASI HILLS.

SECTION IN THE UM-DURLIANG RIVER. (C).



Photozinco. at the Surveyor General's Office, Calcutta,
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Surveyor

1111

1112

1112

Landekar. H.S.

Katilao

Kokhlam. H.S.

Photozinco. at the Surveyor General's Office, Calcutta,
February 1868.

Journal As. Soc. Bengal, Vol. XXXVIII. Pt. II.

Marang Chang

Yindkie Hill

Pundengrù

Wanrhy Peak.

Tigasin

View from Nongkulang. Hill Station.
looking West, towards the Garo Hills.

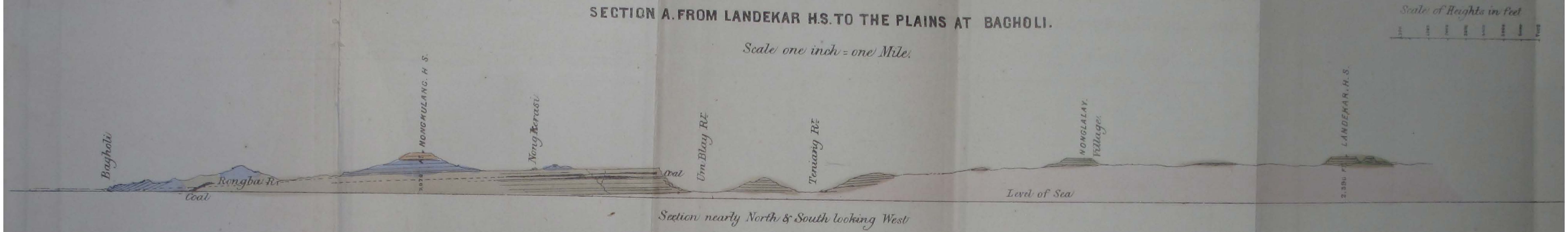
Photozinco. at the Surveyor General's Office, Calcutta,
February 1868.

1113

WEST KHASI HILLS

SECTION A. FROM LANDEKAR H.S. TO THE PLAINS AT BACHOLI.

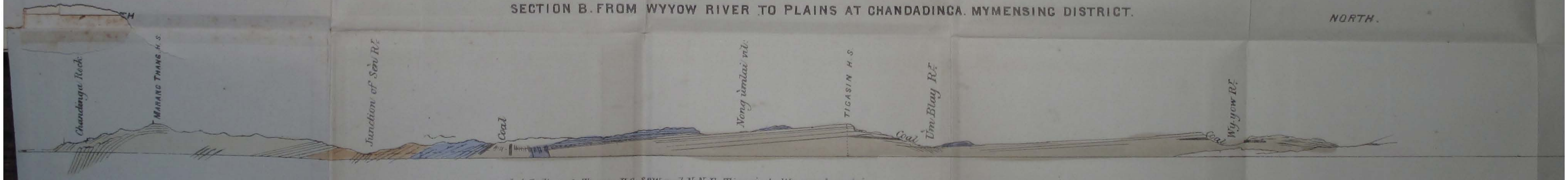
Scale one inch = one Mile.



Section nearly North & South looking West

- Granitoid Rocks.
- Infra Nummulitic.
- Nummulitic Limestone.
- Supra Nummulitic.
- Tertiary.

SECTION B. FROM WYYOW RIVER TO PLAINS AT CHANDADINCA. MYMENSING DISTRICT.



From Chandadinga to Tigasin H.S. SSW and N.N.E Tigasin to Wyyow, N. and

H.H. Godwin Austen – Capt.
Surveyor

SECTION (b.) in scarp under NONGKERASI

On the highest point of the hill the rock was a light fine grained sandstone.

60 ft.

Another bed of coaly stuff must occur about this point: following up the ravine on the hard surface of the sandstone traces of pieces of coal were seen; but the jungle became so thick I could not penetrate further; the pieces were very inferior in quality.

Coarse Sandstone

* These shales were light dove coloured very thin bedded, speckled and dotted throughout with dark spots of vegetable matter; the remains so altered as to show no structure under a low power.

5 ft. Dip 12° Southerly

Carbonaceous shales same as those at Landekar [?] in appearance may be of same age.
Very hard compact sandstone like that of Cherra & holding precisely the same Topographical position on the surface of the country.
The hill running back nearly level from this point.

25 ft.

Red and purplish coarse sandstones.

3 ft 4 in. — 3 ft. — Black Earthy Shale 1 ft. } Coal Bed No. 4

50 ft.

Sandstones fine white & coarse gritty.

3 ft 0 — 3 ft. — Coal Bed No. 3 upper 3 inches a band distinctly stratified being hard heavy and compact.

20 ft.

Upper part fine light coloured sands and soft shales with small black particles of vegetable matter.
above the coal was 4 inches of white and pinkish shale then ¼ in. band of dark carbonaceous matter.

8 ft. Dip 16° Southerly

8 ft 0 — Coal Bed No. 2 the portions on surface are lighter in weight evidently due to exposure: bedding very regular under and upper surfaces true planes.

15 ft.

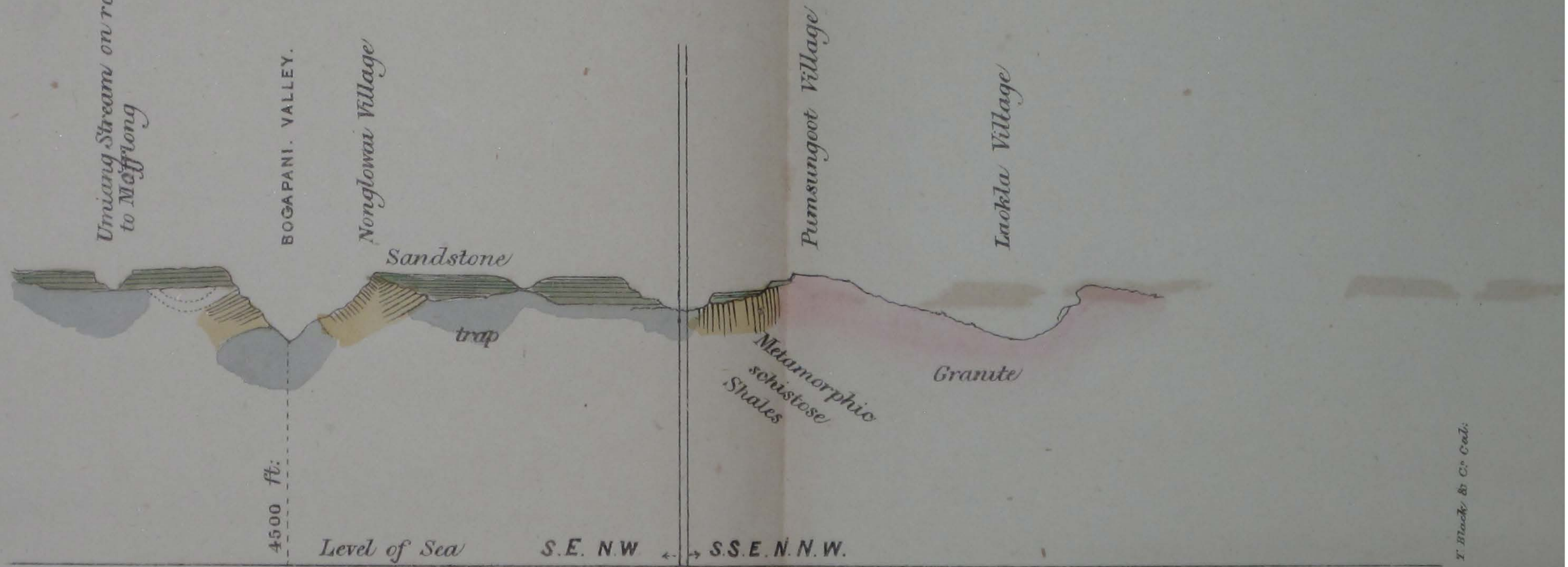
Coarse white gritty sandstone (quartz) with a few small discolorations here and there.

6 ft 0 — 6 ft. — } Coal Bed No. 1

Total of Coal 20 ft 4 in.

Sandstones red ferrogenous tinted coarse sand.

SECTION a. NEAR BOCAPANI TO-WARDS LAOKLA.



T. Black & Co Cal.

First and lowest; the coarse sands and conglomerates, resting on the trap and metamorphic rocks.

Second; the rough tabular sandstone of the Cherra plateau, with all the beds between it and No. 1;—*Cretaceous.*

Third; the limestone, sand and shale with coal, that rise on the west of Cherra, forming what is locally known as the coal-mine hills;—*Nummulitic.*

Of the oldest rocks the trap, as one proceeds northwards, is the most conspicuous, and as shown in Mr. Oldham's geology of the Khasi Hills is in great force in the bed of the Kalapani, and Bog Pani rivers. It is seen for the last time beyond Mofflang on the road to Mairang, and in the bed of the stream from Mofflang near Langiong, on the road to Nongspoong. A rough section as observed on a march from the Boga Pani, in this latter direction, appears as given in section a, pl. I. The unaltered position of the sedimentary sandstones, and grits resting on the trap, and the great difference of level and exposed surface of the last, with the high dip of associated metamorphic shales and older sandstones, show a very decided unconformity and lapse of time between the two formations, as well as the prior contortion of the metamorphic shales on the first upheaval or depression with the trap.

The sudden and final termination of the nearly horizontal stratified rocks, is nowhere better seen, than on the road between Lookla and Langiong; this would strike the most unobservant traveller, more particularly if he were coming from the northward. From the great northern scarp to the Lookla valley all is metamorphic rock, gneiss or granitic formation; giving the usual peculiar features to the country of humrocky rounded hills, steep falls encumbered with enormous weather-worn masses of granitoid rocks, and many a grassy hill capped with a dark grey, single or double boss of the same. To the geologist the only sections exposed shew an interminable succession of coloured soft-bedded gneiss, always dipping at a very high angle, and of a regular strike which has given a like parallelism to the natural features of the country, its ridges and drainage lines.

On marching from north to south, and arriving at the village of Púmsúngút situated on the ridge, that bounds the valley of the Um Lookla, the change is most sudden; one walks off the dark grey granite on to a perfect shingle beach, and topping the ridge at the

same time, the eye looks over a new land of high flat plateaus, showing at once their regular superposition, and notwithstanding the great elevation, their undisturbed state; even if the lines of bedding that show in the steep cliffs of the ravines were absent, to strengthen the impression. To the south-west rises the steep scarped hill of Maosinghi, an outlier of another long high plateau to the south; this is to a certain extent evidence of still newer deposits, mostly swept off by the all-powerful forces of denudation. The boundary of the beds first seen at Púmsúngút follows this ridge eastward towards Mofflang, these beds being at first very thin, from lying and abutting on the denuded southerly slope of the older rocks. The road towards the Bogapani, descends into the valley running towards Langiong, and the whole series is here well displayed, the most striking feature being its exceeding coarseness. Thick, irregularly bedded conglomerates of metamorphic rocks, are very equally associated with the very coarsest grits of quartzitic material. These are seen (Section A, pl. III. resting, first, on the granitoid rocks, and then on thin-bedded soft micaceous and pink-tinted schists, and in the bed of the stream below, on the dark green, or blue coloured trap, the extreme northern limit of a rock of which Mr. Medlicott in his report says:—"I have never seen, not even in Central India, such extensive phenomena of trappean intrusion."

From the great preponderance of shingle and water-worn stones in the beds around the valley of the Karamjoimai, the cliffs that were formerly cut away and bounded its sides, are now covered up for many yards in extent by a shingly gravelly talus; the old scarp only showing here and there at intervals. The quartzitic nature of the materials, as before mentioned, gives these slopes a very light colour, and to the country a very peculiar and uncommon appearance, the ground being so stony that hardly any grass grows on it.

The level of the opposite plateau, bounding the right bank of the Bogapani, is very nearly the same as that on the south of the deep gorge of that river. It is very noticeable, as one proceeds south, that the sandstones become finer, the bedding more regular, and thicker, until at last, the conglomerates are replaced by coarse grits, and the mass of the beds by hard and rather fine sands, some very white; even beds of a clayey nature are occasionally seen. North of the Boga Pani, I noticed no trace of any carbonaceous shales, which I had

at first expected to see, the series appearing so continuous with the sandstones of Maobelurkur, where coal is found, and even worked, but I think now there is enough evidence to show that a line can be drawn between the lower and coarser beds, and the upper finer ones with coal. The manner in which the general denudation has acted, indirectly proves this; the lower, older and therefore harder beds remain, withstanding this force, while the higher and softer have disappeared fast and over a larger area. Extending through the whole mass of the beds, there is a very perceptible tendency to thin away at a very low angle towards the base of the main ranges, *i. e.* southward, and at the same time to thicken, I believe, quite as much in the lower series as in the upper. This, with irregular bedding, renders it very difficult, without the closest scrutiny, to be certain of the exact portions, as the conglomerates resting on the granite incline to the beds with coal at Maobelurkur. The coal itself is very local in its distribution. We see at Cherra how soon it fines out and almost dies away on the road towards Surarim.

The conglomerates in the valley near Langiong, bear in their composition a close resemblance to the great thickness of like rocks seen below the cretaceous beds above Nongphriam, in the deep valley, east of Cherra Poonjee; and I think they are, in both these positions, the lowest in the series. Should this view be correct, the greatly denuded patch of sandstones that form a higher plateau west of Púmsúngút, together with Mao Shinghi Hill, &c. are the representatives of the higher beds, forming a part of the nummultic series, the coarse grit and conglomerate being the very lowest of the cretaceous rocks; the well developed later beds containing fossils only come in with their increased thickness further south, but on this latitude they are absent.

I have not had the leisure or opportunity of examining any of the country adjacent to Cherra Poonjee itself. It has been examined by far abler and professional geologists; I will therefore, make no further remarks in connection with this area into which I had begun to wander. In the section through the Bogapani, a series of schistose, yet sandy rocks is seen in close contiguity to the trap, and it occurs successively in two valleys. No like formation is to be found among the series of the sedimentary rocks, that have retained their almost normal position; they are quite distinct, and seem to form the oldest trace of a much earlier

stratified formation, indurated, altered, and much disturbed by the trap. I think their extension east, and their counterpart is to be found in the quartzite sandstones of Mofflang and Shillong, associated with gneiss, and to all appearance merging into this rock, which is in all respects similar to that seen towards Nunklow, Kollong, &c.

Having endeavoured to give the reader an insight into the class of rocks and general characters of the country to the edge of the great granitoid centre of the Khasi Hills, I will, in proceeding to the portion in which my map (see pl. IX.) and sections were made, sketch the general topographical features adjacent to the route.

On this side of the Khasi Hills, the highest and most conspicuous feature is the Maotherichan ridge, the highest point of which, the trigonometrical station, is 6,297 feet above the sea. It is in fact the backbone of the range, throwing off its streams into the Brahmaputra on the north, and the vast jheels of Mymensing on the south. From the extreme northern point in section A (pl. III.), proceeding towards this central mass, the country is open and bleak, covered with grass, only some of the northern faces of the hill being sided and sheltered ravines, with a shrubby jungle. The Khasi Pine must have been once abundant, but has been so indiscriminately felled, that its southern limit is much contracted; it is fast disappearing along this line, and calls for Government interference and protection. The jungles are of sufficient extent near Nowgspoong, to supply the large quantity of charcoal, used by the iron smelters there. The whole process of extraction of the ore, found in the state of small grains of titaniferous iron, is fully described in Oldham's geology of the Khasi Hills; it gives employment to a large number of the inhabitants. The rivers Um Laokla and Um Nongspoong, are large broad streams, and shew that they are heavily swollen during the rainy months. Before reaching the southern foot of the Maotherichan ridge, a much larger river, the Um Kainchi is crossed, flowing through a broad flat valley, generally well cultivated with rice. These broad flat valleys are a very characteristic feature of the drainage lines in this portion of the hills, and some especially that of Mokasa, give the idea of a former lake system, before the sluggish rivers that flow through them, cut the present deeper channels. Under the ridge of Maotherichan, in the last named valley, the very regular strike and high

dip of the gneiss is very marked, in a white coloured soft band that crops out at the very base of the hill, and is continued E. S. E. past the village of Laoburtun.

From all I could see of this formation here, the Mokasa valley, lies on a very sharp anticlinal bend of those gneisose rocks, the granite appearing to curve over the Maotherichan ridge.

Ideal Section looking West, near Mokasa.

The rock near the summit of Maotherichan is very porphyritic, containing large oblong crystals of felspar. In the valley it disappears, and coloured gneiss, soft and friable, comes in, to which is very probably due the present configuration of the valley. To the south near Mahaton, the porphyritic granite is again seen, with a corresponding rise in the hills. The above kind of granite is very common about here, forming as a rule the lines of the higher ground and elevated masses; it is of a very hard nature, often pink, and is generally used by the people for the monoliths set up beside the ashes of their dead.

On and about the summits of the low hills, south of Maotherichan, that rise some 150 feet above the present level of the rice cultivation, or what was originally the bed of a lake, I was surprised to find, scattered over the surface, a few well water-worn pebbles, mostly of a hard quartzitic rock. No beds exist anywhere near from which such well-rounded pebbles could have been washed, and I was quite unable to account for their appearance. They were not numerous, but sufficiently so to preclude the possibility of having been carried there by human agency, the nearest spot whence they could have been brought was the bed of the valley below. No well marked traces of any

thing like glacial action are apparent. Equally puzzling in such valleys are two or three low mounds, all of transported material, that are to be seen at the eastern and upper limits of the Mokasa valley. I may ask, can even these hills have been affected by the glacial period in the Himalayas? On this supposition, long and deep snow beds extending down the flanks of this ridge, would be quite sufficient to account for the above appearance, without the intervention of true ice streams, but cold sufficient, to cover them deeply in snow, during the winter is by no means an improbable state for them to have passed through; and we have no reason to suppose, that their mean attitude has altered since the time when Himalayan glaciers extended down to 5,000 feet below their present limits. Such a physical change in a mountain range so close on the north, must have wrought a perceptible one on the highest parts of an outlier like the Khasi Hills.

Fifteen miles to the west of Maotherichan the higher general level of the hills, some 4,000 feet, comes to a rather sudden termination; and the central main water shed takes a bend to the N. W. Rising again, there in another higher portion called Laobersat 5,400, and Nongkana 3,726; overlooking the northern slopes that thence fall very rapidly towards the Assam valley. The watershed is thus brought very close to the northern face of the hills, almost the whole drainage being thrown to the south. The great depression west of Nongkana in the main axis of the range extends quite across them, the highest part the ridge near Nongkulang rises only 2,000 feet on the south, forming there a kind of natural wall, between the main drainage and the plains of India, the Um-Blay cutting through it near Púna Tith. The cause of this sudden fall in the levels of the country, I would suggest, is neither due to subsidence of the metamorphic rocks, or to their denudation, but that this portion has remained in a more tranquil state, and been less affected by the changes of level, on the west and east, particularly in the latter side, where the intrusion of the trap rocks alone has played so important a part in the present elevation of the whole series. As we shall see, this trap rock entirely disappears on this more western longitude, and in the sections (see pl. III.), I propose to explain, the stratified rocks are seen but little disturbed; whereas with the proportionate rise in the

hills, on either side is to be seen an equal bending and displacement of the strata at their base.

Nongstoin, the residence of the Seem, or native chief of that name, is situated near the edge of the general fall, towards the west and south. A road leads out into the western part of the Nongstoin state, viâ Nongsingriang. Crossing the Kerkonshiongba river, 400 feet immediately below, its bed is seen cut through the metamorphic rocks; thence ascending to the plateau on the other side, the village of Nongrompoi is reached. This part loses fast the open bare features of the Khasi Hills, large timber trees come in, with densely wooded ravines, principally bamboo, until with the descent to the Umiam river and the village of the same name, this jungle growth becomes so dense, that nothing can be seen of the country on either side of the path. The scenery in the above valley is very lovely near the river, fine trees on every side overhang the still winding reaches of the Umiam. To the traveller it is both striking and novel scenery. It was only in the beds of streams that the rock *in situ* could be seen; this still continued to be of azoic age. Turning S. W. up, over and down low ridges covered with the same monotonous jungle of bamboo, grasses, and shrubs, Maomarin was reached, and a short distance to the west is Nongkúba built on a clearing at the south side of a hill, called Lamdekar in the map (properly Lúmdellor, Khasi) conspicuous even at Nongshingring from its sharply cut, though low scarp. On this hill is the site of one of the principal trigonometrical stations of the Khasi Hills Survey, and this led to my obtaining an insight into the formation. Nongkúba stands on a hard hornblendic gneiss, slightly pink in places, with a certain amount of bedding, the dip being very high to the north; it was of very compact grain and different to the same class of rocks hitherto seen in the East.

On leaving the base of Lamdekar Hill, at the very commencement of the ascent, is met a dark blue grey, and coarsish grit, having scattered water-worn pebbles of quartzitic rock in it. At the next portion of the ascent and the main one to the summit, these pebbles are not seen, but the same coloured grit, very conspicuous from its extreme neutral grey colour, occurs as a thick bed of quite 14 feet. This is succeeded by beds of a lighter colour, but still coarse texture. Higher again it changes to a bed of

extremely coarse subangular quartzitic grit, set in a white sandy matrix. The whole thickness would be up to this point about 150 feet of horizontal bedding. Here a very fine grained series of beds comes in conformably. In this occurs a dark carbonaceous shale from two to three feet thick, shewing on fracture indistinct traces of carbonized wood and vegetable matter; it was very fine and soft, with few mica grains here and there. The colour is of a dark indigo, approaching to black in places; the little carbonized bits of wood still showed the fibre. The beds above this I could not see in section, but quite 30 feet or more, cap the hill. A great deal of loose stone lies about, and also shaly white fine clays and fine sands, more or less micaceous. The sands are thin-bedded, white and pink, some beds being composed of a finer material of a light blue colour, and full of minute bits of blackened vegetable matter. On splitting several of the slabs, I disclosed some very perfect impressions of large well developed leaves. The greater number of these were evidently of grasses, as large as bamboo, and interlaced over and under each other.

The Lumdekorh hill has no great area on the top, it is perfectly isolated, and another small hill of the same formation stands to the N. W., about 400 yards off. For 40 feet it falls in a cliff, and thence in steep latus the rest of the height; but owing to the dense jungle, it is almost impossible to examine the cliff. The Garrow hills rise rather abruptly on the S.W. into long flat-topped hills, having no conspicuous eminences, and are covered with forest; they so vary in height that no particular tree can be selected anywhere on their crests, that might serve, when observed from some other station, as a point for the detail Surveyor. Deep ravines proceed towards the plains, cut through horizontally stratified rocks. On the south rise two eminences of the same type as Lumdekorh, and in one and the same true line, due N. W.—S. E. It is curious to find these isolated masses, the last remnants of a higher level of the formation, still remaining, when all else has been removed. To the east of Nongkúba village, a hard hornblendic gneiss was seen, and the same rock extends towards Maomarin. A short distance before reaching this place, the path towards the south diverges, passing the site of the deserted village of Umlangyem.

Eight minutes walk along the ridge S. W. of this brings one upon a sheet of the coarse sandstones, resting on and capping the gneiss; not more than three feet of the sandstone remains visible; it is no doubt the same as the lowest beds seen at the base of Lumdekorh. Passing over this little outlier the ridge falls, and the metamorphic rocks are again traversed all the way to Nonglalay; the path crosses one large stream, and on the descent into this valley, much milky quartz is seen, evidently in thick veins. Close to Nonglalay, rises one of the eminences noticed at Lumdekorh. The lowest beds were precisely similar to those previously noticed. In the scarp, near the top, a few very dark beds gave indication of the presence of the carbonaceous and upper beds, which I have already described. Unfortunately dense jungle and want of time, prevented my paying a visit to the summit of the hill. From Nonglalay the country is seen to fall gradually towards a deep valley on the south. To the south-east again, the second isolated mass Katelao was seen, its scarped features are the same as the one we were under. This last also threw off spurs towards the deep valley of the Um Blay. Down towards this our path wended, following a long broad spur. About two miles down, I came on a thin capping of coarse sandstone, with sub-angular quartz pebbles, the position being due west of Katelao hill. The sandstone was evidently dipping away south together with the level surface of the metamorphic rocks. We thence rather more rapidly descended into a deep valley on the right, the Teniang, backed by a high wooded scarp, the stream flowing through beds of coarse sandstones and conglomerates, being nearly horizontally bedded. The forest is here very fine, the bamboos of enormous length, the tallest certainly I have ever seen. Crossing the Teniang, the path ascends steeply to the top of the plateau, and descends again a considerable distance, suddenly opening out of the forest upon the high bank of the broad fine river, the Um Blay. Sandstone is seen all the way to this. On both of the intervening ridges, or rather plateaus, one sandstone bed of a very blue colour was conspicuous, the tint generally was precisely the same as that of the beds noticed at Lumdekorh, but here the series had become of very considerable thickness, from 800 to about 1000 feet.

The way looking up and down the Um Blay, was very pretty, as regards its wooded character. The river was nowhere under 100 yards in

breadth, flowing very sluggishly ; in its bed the sandstones had a south-easterly dip of about 5 degrees. A ford was formed about a quarter of a mile down, it was water knee-deep, but a very small fall of rain would have rendered it quite impassable. At the junction of a tributary from the south-west a short distance further down the right bank, the path leaves the Um Blay, and follows the new stream. In the bed I at once noticed rolled pieces of coal. Sandstone of the coarse purple kind was exposed in thick beds on the ravine side, dipping south with 7 degrees; and further up, the coal occurred in water-worn lumps quite 2 lbs. in weight,its fracture was bright. At half a mile the path leaves this ravine on its left bank, continuing steeply through a magnificent forest with very little undergrowth. As one ascends, the sandstones become finer and lighter, and at about 400 feet in a side ravine with water coal again was noticed in its bed, showing that it lay high in the series. Leaving the path, I struck up the steep ravine, which gave every promise of a good section being obtained, and it has well repaid the trouble of the climb, for at 50 feet of vertical height, coal was found. It rested on ferruginous coarse sands, and was overlain by a coarsish white quartz-grit, with a few little dark discolorations here and there. I am not over-estimating the thickness of this lowest bed of coal at six feet, and in places it was more; the bedding was irregular. On a like surface of the strata below it I commenced here to take in the whole of the measurements with a 10 feet pole, well knowing how very wild some estimates have been, especially with regard to coal beds; that at Cherra Poonjee, for instance, having been put down at as much as 17 feet by one officer. The results are given in section b, Plate II, shewing thus more clearly the succession of the beds and coal seams, which, good and bad, gave a total of 20 feet. The similarity of the upper fine beds was remarkable, as being very like those which were seen capping the Lúmdekorh Hill.

Leaving this section and continuing the march, we ascended along the face of the hill, the coal showing again on the path itself. On reaching the compact hard beds of sandstone (*vide* Section on Plate III.) the ascent ended, and the general level of the country dips away with the even slope of its dark brown weathered surface towards the south, and in many parts over several acres in extent is entirely bare, all earthy matter having been washed off it. A quarter of a mile further

the village of Maokerasi, inhabited by a people of the Langam tribe, is built on a low knoll, rising above the plateau on the edge of the steep scarp that marks the sudden commencement of the gorge we had just come up. No streams find their way over this northern cliff, and the slope of the strata being south, the water issues from below and must have gradually caused the cliff and gorge to eat back far from the valley of the Um Blay.

From Maokerasi towards Nongkulang, is at first seen the tabular sandstone, which dips at a low angle from the edge of the northern scarp (*see* Sec. A, Plate III,) up to the stream that flows along the base of the Nongkulang ridge. This sheet of rock is so hard, that denudation appears to have made little or no impress on it, and the streams which cross its surface have scarcely cut into it at all, in fact, in many instances they flow irregularly and widely over its surface. At half a mile further on we crossed the main stream flowing westward, full of *Melaniæ* and *Paludomi ;* the forest commenced immediately on the left bank and, I found, with it we had suddenly entered upon limestone rocks full of *Nummulites*. This was rather a surprise, as I had not expected to find them on the northern face of this ridge.*

We now began to ascend the Nongkulang hill through a very great thickness of the nummulitic limestone series, certainly 300 feet, if not more of it; this rock ended rather abruptly, and was succeeded by sandy ferruginous strata, some of the beds being very nodular, continuing to the crest of the ridge. Near the highest level of the limestone rocks occurred one very marked bed containing *Nummulites* (about five feet thick) of very large diameter and perfect form; the stratum was horizontal and curiously weathered by the action of damp and water. The upper sandstone series was found to be rich in fossils well preserved; there must be several beds of these parted by non-fossiliferous, light friable shales, and by less fossiliferous sandy beds. *Turritella*, *Neritina*, *Cyprea* and a *Trochus*, were common forms, besides a few *Echini* and numerous *Bivalves*. I made a good collection of these, a hazy day intervening when survey work was stopped; yet owing to

* I may here add, for the information of shell collectors, that this spot is a most productive one. Landshells were most plentiful, and in great variety. I added a large number to my collection in a few minutes, many of which have since turned out to be new species. It was just their favorite spot, a dense damp forest, black vegetable mould and limestone rock.

the sandstone being so friable and soft, it was very difficult to obtain perfect specimens.

From the top of the ridge, looking north and west, the view was a curious one, and showed the geological features very strikingly. This was principally due to the hard sandstone of the Maokerasi plateau which, I believe, to be exactly the same as that on which the station of Cherra Poonjee is built, and it occurs precisely on the same horizon as regards the nummulitic limestone. I give a panoramic sketch, taken from Nongkulang, which will give, I trust, an idea of this portion of the Khasi Hills, with those of the Garow hills in the extreme distance. (See Plate IV.)*

In such interminable forests, as here cover the country, it is not an easy task on first coming upon a new series of beds to make them out, and be quite certain of their relative position. I was inclined to think the fossils I had found, bore a cretaceous type, and again the perfect horizontality of the limestone did not appear conformable with the southerly inclination of the sandstone, which is about 5—7 degrees. We may account for this by the difference in their mode of deposit. The Molluscs in the upper beds point to a shallow sea with, in all probability, a sloping bottom. The limestone partakes in many places of a southerly incline, even very perceptible further west. To clear up this point, I made several excursions around this ridge, and was successful in finding several good sections. One of the best of these sections is to be seen on the path that leads from the old and deserted village of Nongkulang, to the new site of the same; it was at first a somewhat puzzling one. Leaving the trigonometrical station for some distance west, the main ridge on which it stands, is followed; it soon falls, the ferruginous sandy clays and shales continuing all the way to the first considerable ravine, and on the left bank of this, limestone comes suddenly in, but does not extend to the right bank. By following down this narrow ravine bed, the section d, represented on plate VI, with plan, in the nummulitic series was displayed. In this section *r* represents the hard white coloured limestone; *s*, where the path crossed the bed of the ravine, is a blue clay, four feet thick, resting

* There is one error I must point out, *i. e.* the peak of Wanrhy is too far to the north, its true position is immediately over Pudengrú scarp. This mistake originated by my putting in Wanrhy from another sketch, the peak at the time having been obscured by haze.

on light blue limestone and containing small *Nummulites;* its thickness is about 5 feet. This bed was succeeded in descending series, by 10 feet of sandy beds, *u*, the lowest being calcareous; then followed a massive bed of dark blue clay, *w*, quite 35 feet thick, in parts very nodular; these nodules were large and very hard, inside of a darker colour than the clay, and were not in the least calcareous. I found no fossil remains of any kind in this stratum. The lowest rock, *x*, seen at the junction with the last, and in the bed of a larger ravine with running water, shewed about 12 feet in the section. This limestone was full of large-sized *Nummulites*, and the base of the series was still many feet below. The hard blue clays were a new feature, as also the sandy beds; both were only locally developed. On the ascent to Nongkulang, I did not see them nor again do they appear further west; for proceeding towards new Nongkulang, the white hard nummulitic limestone is followed all the way from near section d, and is at last seen to rest on coarse and strong bedded sandstones, of the coal series (cretaceous ?). Approaching the village, the path ascends a low spur, and with it the limestone, contrary to expectation, is left, and sandstone is seen. In a cliff section, bordering a clearing here, a good view of these lower thick-bedded sandstones is to be got, the limestone forming another low scarp; on the south of the clearing scattered blocks of the same being still left on the intervening level ground. This marks the commencement of a great roll in the lower sandstones (coal series), its line of elevation running from east, and ascending to west, dipping low to north and south, taking the whole series some 1,000 feet in height up to the culminating cliff of Pundengroo. The amount of nummulitic limestone greatly decreases towards west; the thickest section being that under Nongkulang hill series up to and as far as section d; and I am even inclined to think that the beds were originally deposited on a very irregular surface of these underlying rocks. We cannot expect so sudden a change in their mineral composition to form a very conformable series.

To return to section A, the lower portion of which I have only alluded to. Following up the same ravine from the path, the highly fossiliferous sandstone of the Nongkulang hill series is seen on the left hand, or the east bank, and nummulitic limestone on the right or west. In the sandstone I found an *Ocula* with

Echini. Keeping to the well defined boundary of the limestone, I met with a well marked unconformity of the two series running in a line, from south-east to north-west, and at a short distance further on, from north to south. The limestone terminated in a perfect cliff, and not a single particle was to be found on the sandstone side of the depression between the two. In these depressions blocks of the sandstone were found resting on the limestone irregular surface, and the former also rose in a rounded hill considerably above the general level of the latter. I give a sketch, (Plate VII) and a section (Plate VIII) of this upper junction. The local unconformity of the rocks clearly shews, that the sandstones have been here deposited around and against an old cliff of the limestone rocks. The section exposed in the same ravine, showed it was no result of local displacement.

In some new clearings, close under the trigonometrical station of Nongkulang, and on the north side some good sections are to be seen of the relative positions of the limestone and superincumbent sand. The first and highest bed of the nummulitic limestone series, is a peculiar dark burnt, umber-coloured calcareous rock, containing scattered very small *Nummulites*. In a ravine close by the light-coloured pure limestone was seen to pass horizontally into the hill. Great hollows occurred in the surface, where the limestone had evidently fallen in, and the ravine first mentioned entered into one that was of great depth.

Proceeding from Nongkulang south along the path to Shibak, one passes over a steep scarp of some 50 feet in the upper sandstones (fossils numerous), which extend some distance to the bed of the first considerable ravine. Nummulitic limestone occurs here again, and following it up in the section represented on plate VIII, it is seen close to the path, being a hard blue clay (*w*); it contains hard nodules of the same material, its thickness varrying from eight to ten feet. This accords, in its character, with Section d, see plate VI; above *r* is a great thickness of white pure nummulitic limestone, continuing up the face of the hill. Below the blue clay, following down the ravine, is a darkish purple earthy rock (three feet), it effervesces slightly with acid; then follows a bed of a dark brown rock, having minute white *Nummulites* scattered through the mass, and being interstratified with some light-coloured beds, the

whole thickness amounting to about ten feet. The darker coloured beds are seldom more than one foot thick, and the whole rests on a hard thick bedded and light-coloured limestone (x), the thickness of which is unknown, although it must be considerable.

In this section again, the unconformity of the upper sandstone is apparent, masses of it are seen resting on all the above beds, in the position of outliers, and are the remains of the upper series, deposited against a high and irregularly scarped surface of the limestone series. The dark umber coloured bed, with small *Nummulites*, corresponds to the one mentioned, as seen on the north side of the ridge, being the highest of the limestone resting on the sand, but I am much inclined to think, that on that side (the north) much of the limestone was denuded, prior to the deposition of the fossiliferous sandstones and shales.

After leaving this section, one passes (on ascending to the crest of the ridge to the west) on to coarse sandstone of the lower group, *infra-Nummulitic*. There is no doubt of this, as on the south-west face, after crossing the crest, these same rocks dip into the valley at an angle of 10 degrees S. W. One again encounters the nummulitic limestone near Purjonkha, clearing the strata, seen in a ravine close to the field and belonging to the lower sandstones, on which the limestone rests horizontally. From the sudden appearance of these lower beds on the above ridge, close to the strata showing no sign of bending or contortion, I am inclined to think that even between these two last, a considerable unconformity exists, and that separation can be established. The surface of the lower beds must have been locally altered in level, before the nummulitic limestone commenced to be formed. Throughout the great thickness of the lower sandstone with coal, I have never found a single Mollusc or any remains, save those of indistinct vegetable matter. According to the sections, noticed by Messrs. Oldham and Medlicott, we should find, as at Cherra, the cretaceous rocks here; whether these sands with coal are their equivalents, or whether they will be eventually found below, or above them, and adjacent to the nummulitic formation, is an interesting point, yet to be discovered;—the probability is, that they are upper cretaceous.

From Nongkulang, direct to Maokerasi, a good section, displaying

the conformity of the last named rocks, with the limestone, is met with. In the bed of the small stream with water, near where the paths to Maokerasi and old Nongkulang diverge, the sandstones are seen exposed; the limestone rests horizontally on it, and from this the path leads down the easy hill side, through a descending series of the limestone to the level of the main stream, in the valley, in which it terminates. The way in which the sandstone passed under the limestone was very striking, the former being the same kind of rock one had seen higher up on the Nongkulang main ridge, where there was apparent unconformity. At one spot where the main stream here entered the limestone rocks, for a short distance, the scenery was extraordinary, from the strange and grotesque way these had been eroded. No water was to be seen, as it soon disappeared among the blocks and masses of rocks that filled the bed. All the limestone was perfectly horizontal, the effects of denudation were most extraordinary and marvellous; huge masses formed columns and natural arches, or standing on three or four thin pedestals reared themselves amidst the forest trees, 15 to 20 feet in height. Sometimes such a mass was surmounted by a tall stately tree, whose roots ramified among the holes and crevices in the rock; huge cable-like creepers hung suspended from, or wound round them, while canes and ferns formed the under-wood, and flourished in the dark vegetable mould of this damp virgin forest.

After leaving New Nongkulang less limestone is encountered, though it occasionally is seen on the left hand side of the road, but is nowhere thick, and partakes more of the character of outliers that have stood out the forces of denudation. In all the numerous ravines that are crossed, up to the steep descent into the Riangwylam, the lower sandstone in thick beds is seen with a dip of from 10 to 12 degrees west, bending to south-west, in the direction of the main ridge. The descent into the Riangwylam valley was quite 300 feet; on reaching the river and looking up the gorge, a fine cascade is seen falling over a steer cliff of horizontal strata, the limestone at the top; the whole scene being most lovely and grand. In the bed of this stream, lay masses of limestone fallen from the cliff above, and a few pieces of coal soon led to my finding a thin seam of bad quality, and evidently the highest in the series. It was about one foot thick associated with coarse

sandstone of light colour. A bed of carbonaceous shale above this contained a good deal of shining iron pyrites, and was very heavy. A steep ascent here commences, up a spur, bounded on the north by a lateral valley of the Riangwylam, we had just crossed. Beds now were seen, with the rise to have an easterly incline, or the commencement of another great roll in the sandstones. Near the top a trace of coal was found, but nowhere in the forest could I find a satisfactory section. The thick debris covered the ground too deeply, the associated beds being very fine sparkling, lilac coloured sandstones. At the top of the final ascent, where an open glade in the forest was entered, the surface sandstones were of a very gritty coarse description, with thin beds of water-worn quartz pebbles, and had more the look of the coarse beds seen near Maobelurkur, &c. After crossing a ravine where the dip is south, these beds are seen capped by the lowest strata of the nummulitic rocks, but it is a mere outlier and only some 20 feet thick. Several other isolated masses are contiguous. The sandstone, beyond this a short distance towards the village of Nongumlai, dip with the surface level of the ground, and is evidently of the same hard durable kind, that occurs near Nongkerasi, but here it is thrown up several hundred feet higher, falling towards the south-west to rise again in a higher roll, in the culminating scarp of Pundengroo.

The village of Nongumlai is a very good central point, whence the geology of this neighbourhood can be studied. It stands on an open bare slope of the hard sandstone that terminate a few hundred yards below, in the main stream, a source of the Um Durliang flowing to the south. Immediately beyond this stream a densely forest-clad hill rises rather abruptly, all of nummulitic limestone, the surface of the slope being as usual, most fantastically eaten away. Thence to the south a very large area covered with forest is also of this rock, in which all trace of drainage lines ceases, water finding its way down the innumerable crevices and holes, or rather wells in the rocks, for the word hole hardly expresses the deeply honey-combed state, it presents. Land shells literally strewed the ground, principally large *Cyclophoridæ*. The limestone here presents a thickness of some 250 to 300 feet, and is very similar in stucture, colour and hardness throughout, none of the blue and clayey bands being seen. Both in the stream and near the top of the ridges, transported small lumps of the fossiliferous

upper beds were found, but nowhere did I see it *in situ*. The large quantity in the ravine points to its existence higher up the valley, but I had no time to penetrate in that direction.

To give some slight idea of the majesty of these forests, I may here give the dimensions of a tree on the top of this hill on which a *maichan* was erected by one of my assistants, ascended by a rough ladder lashed on with cane. After sketching the surrounding country on the plane table from it, on descending, I measured it down 92 feet. The upper branches before they were cut away to open out the view were probably 20 feet higher. The tree was without a branch for 50 feet from the ground, a clean straight trunk, but at that height forked into two contiguous stems, and continued thus for 30 feet higher. Its girth was small for size, being only some 14 feet near the ground. This tree was a very good average, few were shorter, and many exceeded it. With such associates, those who have never seen such tropical scenery, can hardly realize its features, and the feeling instilled by the antiquity of such vast growths of vegetable life, when passing through them for hours of the day. In such a country all its topographical features are lost, and to see them and sketch them in, the only plan for the surveyor is to erect platforms on trees, selected for the purpose, that they overtop and command the sea of waving foliage that stretches for miles around. Reaching the level of such a platform and emerging from the gloom and shade of the 80 feet below one into bright sun, with the far horizon of blue hill and mountain, and nearer valleys, is like entering another world. The highest level of these forests form a densely populated zone of insect life, among which the *Lepidoptera* seem to rule, and many a coveted form have I seen from these sites, flitting safe beyond the reach of net, much less of foot.

One of the most conspicuous hills in the neighbourhood of Nongumlai is Yindku, and as on its flanks some of the best sections are to be obtained forming a passage into still newer strata, I will describe them as they come in in turn along the ridge. This has a direction almost due south, to which the road keeps. The sandstone on which the nummulitic rocks in their outliers are seen, extend for some distance, the dip about 15° east; 1½ miles from where this path leaves that from Nongkulang to Nongumlai, at the foot of a rather steep ascent the

limestone occurs in great thickness, the total being perhaps 250 feet. On this ascent I came on detached pieces of the fossiliferous iron-coloured clays. Next in order came the nodular ferruginous sandstones, noticed also below Nongkulang on the northern side, and then again some 40 feet of limestone. The topmost bed of this rock was of a brown umber colour, the *Nummulites* were small and much reduced in number, with here and there a faint trace of a shell; shales, and sandstones with precisely the same fossils as I had found on Nongkulang ridge, then succeeded. The base of Yindku was quite 1½ miles further along the ridge; where an ascending series of the beds is first noticed, they at once become much lighter in colour, and coarser in texture. With this change the fossils become scarce, at last only an occasional bivalve is to be found, and these soon disappear altogether, thin shalely beds intervene, and at the top of Yindku itself, the rock was soft, sandy, and friable. The thickness of these newer deposits is quite 200 feet, the dip now being very low to N.W. Yindku from its isolated position, and greater height than any of the hills around, formed an excellent point for observation, but being covered to the very top with large timber trees, would be of little use without a *maichan*. From the one built there, the view was most commanding, extending to the very foot of the hills in the Mymensing district.

On the spur thrown off from it, to the east, a like section to that first described, occurs again, and the best spot whence to visit it is Shibak, situated on the direct road from Nongumlai to Bagoli in the plains. After leaving the main ridge of Tigasin near Nongumlai, a quarter of a mile of descent brings one to the Laokla stream flowing north. Leaving this a ridge of the fossilferous beds is another stream, the Umpernon, is crossed where they dip S. W. at a low angle; on the descent, the unconformity was again noticeable, although the beds still retained their normal horizontality. After descending over a considerable thickness of the nummulitic limestone, it suddenly is replaced by the ochre-coloured sandstones, at the foot of an ascent extending to a height, considerably above the lowest limestone just left. At half a mile, limestones again dip north 5°, and at the bottom of the valley all was of this formation; near a huge overhanging mass of it, used as a temporary shelter, it was seen to rest on a light coloured fine sandstone (the cretaceous?), the same sequence in every respect as is seen near

New-Nongkulang. The Shibak stream was now quite close, flowing over the slightly sloping surface of the lower sands, and striking the edges and the termination of the limestone, which also marked that of the forest. This valley of the Shibak was for a long time a very great puzzle. In no direction could I see any likely depression in the forest-clad heights about, where the united streams of Shibak (the Wakit from under and north of Yindku, and the Umpernon and others) might find their way to the plains.

The conspicuous cliff of Kúta Bram, was the only open point in the neighbourhood, and it was by visiting this, I determined the existence of a very anomalous physical feature, on a really grand scale and one which, though familiar with the like topographical feature on a small scale, as seen near Cherra Poonjee, fairly surprised me. The cause is simple enough, the united streams all meet in the nummulitic limestone, that here extends quite across the main valley; the streams drain away under it, over the surface of the harder sandstone on which it rests. This water must percolate under the Kúta Bram ridge into the Rugsir, but the greater quantity evidently finds its way into the Gabir, at Bagholi, there a large stream without an equivalent drainage area. The ascent to Kúta Bram cliff is through a forest of enormous trees in the bottom of the valley, passing into bamboo near the crest of the ridge, that rises quite 350 feet on the south. The fossiliferous sands succeeded limestone as usual, and continued to a short distance within a few feet of the cliff; this consisted of fine thin-bedded sands, micaceous, of light ochre and gray colours; they dip about 10° south, but no fossils could I find in any of the debris at its foot, although about 100 feet of the beds were here exposed. This newer series covers all the spurs south of Yindkú, and is exposed again on a direct path leading from that peak into the Rugsir and on to Gillagora, a village of Habi-ang Garos. Some of the beds at this point were of a blue, crumbly clay, and all thin-bedded; the presence of springs causing land-slips, have formed this bare open spot, whence a fine view is obtained.

Passing on down this ridge, nummulitic limestone again makes its appearance on the right hand or the west, rising in a very steep cliff, the path is over the red sandy clay (fossils being numerous of Nongkulang forms) at its base. Descended at last rapidly into the bed of Rungsir, here hard massive fine sandstones passed under the limestone, which

dipped far higher than yet seen in this area, being evidently on the south side of an anticlinal fold. The beds where first observed, dipped 12° south by west, then 15° to the south, increasing to 20° and 25° south. Although a deep gorge existed through the mass of the limestone (here very thickly bedded) no water is seen; at about 400 yards through the gorge, it terminated suddenly with its highest dip, succeeded immediately by highly fossiliferous beds, well developed under Rongsitilah, (the summit of which is of the higher series, of coarser sand and thin shales). In the first open clearing on the right bank I found my best specimens of fossils in a bed *in situ*, most of the Nongkulang forms turning up. These rich deposits of shells are immediately succeeded, as one travels down the bed of the Rugsir, by thin-bedded bluish clays, the sandstone shales becoming more sandy and compact, the dip increasing with every few 100 yards, until below the village at the debouchement of the stream into the plains, at the very last spur and section exposed, they are complete sandstones of very lower tertiary Siwalik type; their colour is brown, and their dip about 50 degrees to the south.

Emerging into the rice fields of the plains, and looking both to the east and west, it is very evident that the last and far newer beds, extend on both sides along the base of the hills. The dip of the beds is seen on the ridges of the spurs most markedly,—more marked is this on the west, at the base of the true Garo hills, and these, bending more to the south of the latitude, we are now standing on, bring in beds of again a later period. Save for the marshy plains, flat as an ocean and the greater exuberance of the forest on the hill slopes, one might be looking at an expanse of the Siwaliks of the Deyrah Dhoon, the same characteristic long slopes towards the plain terminating in a short steep fall on the north, whence rises another long slope of rather a less incline to the horizon.

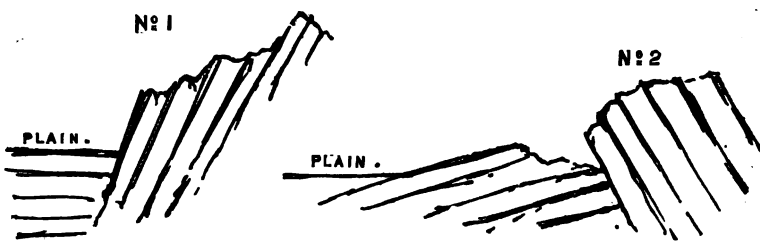
I followed the foot of the hills, in both directions; 1st, on the east side to Bogali, where two streams the Gabir and Ronga unite, and form a large and navigable stream. Nothing new is observable thus far, the different "soras" or streams take their rise in the tertiary sandstones; in their beds, the same succession is seen, as in the Rugsir at Gilla Gora, and the usual fossils are also found as one gets deeper into the series. Crossing the Gabir into the village of Bagoli,

the whole eastern side with the hill slopes, are of nummulitic limestone, which here abuts on the plains; the Ronga flows out through the mass of it, which dips 25° south, in hard thick beds, and is the first point on this side, where it is worked for the Calcutta lime trade. A limestone quarry, with a shallow canal approach for canoes, occurs about 1½ miles to the east of Bagoli, worked I believe by the Manager, C. K. Hudson, Esq. of the Inglis estates. The Ronga river takes its rise immediately under, and to the south of the Nongkúlang hill series, and has one point of interest, but I was unable, from want of leisure, to follow up and examine it. Much coal is to be seen in the bed of the stream brought down from above, and can be no other than an outcrop of that in the infra nummulitic beds seen and described at Nongkerasi; what its extent may be here in the Ronga, it is impossible to say, but it deserves examination. A subsequent attack of fever prevented my penetrating further to the east of this line, in the most interesting and promising part of this geological district, where the useful mineral beds approach so near the plains with the magnificent water carriage which the Um Blay must offer at this very point. I do not think it likely that the coal will be found again near the base of the hills, west of the Moishkulla or Rungsiang river, for a very considerable distance. The general strike has assumed too strong W. N. W. direction, towards the culminating point Wanrai, and the tertiary sandstones appear very persistent, and with greater breadth, west of Chanda Dinga, owing to the slight extension of the hills southward. Returning to Gilla Gora, I carried my survey along the base of the hills westward, crossing the Rongsiang, near longitude 91°, and on to Chanda Dinga, in order to ascend and observe angles at the fine elevated hill of Marang Thang.

All belongs to the older tertiary series here; the principal and most noticeable feature of the rock being, the great increase of dip in this direction, coming in with the newer beds of the series (this is shown in Section B, Plate III), until at Chanda Dinga, the beds are almost perpendicular into the plain, forming here a bare flat rock on the hill side, marked in the old revenue map, as Chanda Dinga stone. The beds here had assumed that coarse texture, with light brown, or gray tint, lithologically so exactly similar to rocks of the Siwaliks,—even to the scattered strings of water-worn small pebbles, met with in the

great mass of the lower series, known better as the Nahun group or Lower Siwalik formation,—that I think they can be well placed on that horizon. Whether this will be proved still further west, by the presence of the later Mammaliferous sands and gravels of the higher, and again unconformable series of the Siwalik group, is to be seen, and it is a most interesting point; or may not these last beds still exist under the present plain of Sylhet and Mymensing, undisturbed, abutting like the present land surface against the lower series? The change is so sudden here, from dry sandy steep slopes to swamps, that within a few paces of the hill side, the ground is covered with the dead shells of *Paludina* and *Ampullaria;* the sections seen in the beds of the streams show an alternation of sands with dark clay, containing the same shells. I could point out a bed, under and to the south of Nahun, so precisely similar, with the above shells (particularly the more lasting *opercula* of the latter species) that no one who had wandered over both areas, examining them attentively, could fail to be struck with the great similarity of their deposition. The only difference rests in the present unconformity of the one, due to elevation; and in the still normal position of the other, slowly accumulating bed over bed, and perhaps in some future geological age, to pass through the same mighty changes. Medlicott's explanatory ideal section in the Markunda under Nahun, (where also lies the beds I have just referred to) is nowhere brought so forcibly to the imagination, as at the foot of these Hahiang Garo Hills.

The beds are actually at Chanda Dinga so near the perpendicular, that a transition from No. 1 to No. 2 (*vide* Ideal Sections below) is easily wrought, and this is what is actually seen at the junction near Nahun, if anything greatly exaggerated in nature, from the lateral force that has been introduced.



After visiting Marang Thang, whence the deep gorges with precipitous sides of a large river, draining from south-west of Pundengroo scarp, was seen, and presenting a complete section of the whole series I have been detailing, I retraced my steps into the interior of the hills once more, *viâ* Júgni, situated about four miles up the Rongsiang river. I give the reader some idea of this mountain stream, its features being so unlike what is generally seen, and nothing like it is met with at the base of the Himalayas. I proceeded the whole way, without much obstruction, in a canoe to Júgni, the water being so little deep in parts that save to a native who easily disencumbers himself of superfluous clothing, it would have been a most disagreeable route. It became still more difficult to navigate beyond the above village, shallows and rapids commencing; yet very deep long reaches still continued right up to the junction with the Sen river, where is a pool famous for the immense number of fish killed periodically by poisoning the water. With a stream navigable so far into the hills, one would expect the valley on either side to be broad and somewhat open, the contrary is however the case. For the whole distance the spurs approach, and end in high sheer cliffs, washed by the excessively deep water of the pools at their base; opposite Júgni itself these cliffs are at least 200 feet high.*

The whole valley is extremely malarious, close, and shut in from air, and we all suffered a few days after from passing up it; not a man with me or self escaped fever, the season was advancing, rain had begun to fall (March 1867), which may account in a measure for the suddenness of the attack. A short distance above the last deep pool, the river is seen gushing out, with a considerable body of water, from a small cavern in the limestone rocks. The valley still continues over these dipping at about 20° to 25° S. S. W., their strike being in the general direction of the valley. At about two miles further up the limestone comes to an end, and the lower sandstones become visible; they dip at 30 degrees. Pieces of coal had been common for some distance below, and here it was seen *in situ*, with an increasing

* They present excellent sections of the sandstone rocks: these gradually lower in dip, becoming very low and rise again towards the junction with the Sen river. There is nothing remarkable in their appearance, being thick-bedded, sometimes very soft light coloured and micaceous; their dip is always a southerly one.

dip in the coarse sandstones. About 400 yards on was another bed, of greater thickness and better quality, the remnants of which we had seen scattered all the way down the stream bed; it passed quite across it, from bank to bank. For a better idea of this most interesting section see that marked C; it will be there seen, that the coal is brought to the surface by the anticlinal in the whole set of these beds, which extend to the nummulitic limestone, being evidently much disturbed here, and seen to change suddenly from a dip of 60 degrees N. E. to perfect horizontality, and continuing thus with the slightest dip, about equal to the fall of the valley, all the way up to Nongumlai. This line of dislocation, it will be seen from a glance at the map, is curiously situated, in a direct line, with another evident great bending of the same strata in the Rugsir, where the limestone crosses that stream, and would extend to Bagoli, where the limestone is again seen bending over with an increased dip of 25 degrees to the south. Continued to the N. W. as a due straight line, it passes through a culminating point of the Garo hills, Wanrai Prak, which seen from a distance is doubtless of the newer stratified rocks, having there attained considerable elevation.

Not far above the last mentioned section the Sú Hileng tributary comes down to the N. West; and from under the eastern scarp of Pundengroo, much coal is washed down; but I had no opportunity of visiting the site.* To the north of Tigasin hill-station the coal is seen, with a dip north of about 8 degrees and a thickness of some 8 to 10 feet, in the infra nummulitic beds; this northerly dip brings in the limestone at the bottom of the valley, whence the beds rise again with a S. S. West incline, and a very low angle. At a distance of some six miles, the path descends into the Asbik river, close to which, the same coal is met with again, here almost in a horizontal position. It is again seen on the ascent of the left bank, but a good deal of it is covered up with debris. On descending to the Wy-yow river on the other side of the ridge, gneiss comes in, and I did not again observe any stratified rocks all the way to Nongtien Shiling, and thence *viâ* Nongkushba, until Landekar is again reached. The Um Blay at this part of its course, flowed through the mass of metamorphic rocks.

* Native information indicates that the coal here is in large quantity; even should this be found the case, it is too far into hills to be worked profitably.

From the preceding notes and sections, it will be observed, that on this longitude we have no infra-nummulitic coal as at Cherra, that the seams here occur always below the last named formation, at a very regular depth below it, and that unlike the coal of Cherra, it is very persistent over a large area, and often to be found in a series of deposits one above the other. It is to be traced along the high long line of bluff that bounds the Um Blay on the south, in its south-east course to its debouchement near Puna Tith bazar. If this coal ever be utilized, it must be somewhere in this neighbourhood, or between longitude 91° 10′ and 91° 20′, and south of latitude 25° 26′. This small area would well deserve a close inspection, and the results would be extremely interesting, if continued to the east, the rocks be followed out into the Cherra sections. Until this be done, it would be premature to theorise, or draw comparisons, between different beds, one of which, the limestone, is identical, while the beds both immediately below and above differ very much. I have already stated my opinion that for a long distance, west of Chaudadinga, and the Rongsiang rivers, but little coal can be expected to be found, from the presence of tertiary sandstones on that side.

This paper has now reached a size I little contemplated, yet with its errors, with which no doubt it may abound, in bringing it to a close, I trust it may prove useful to those, who may at some future date visit, and plot out the same sections.

Camp, Cherra Poonjee, October, 1867.