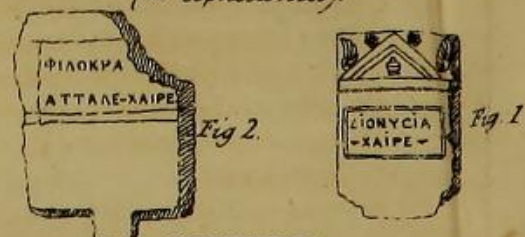
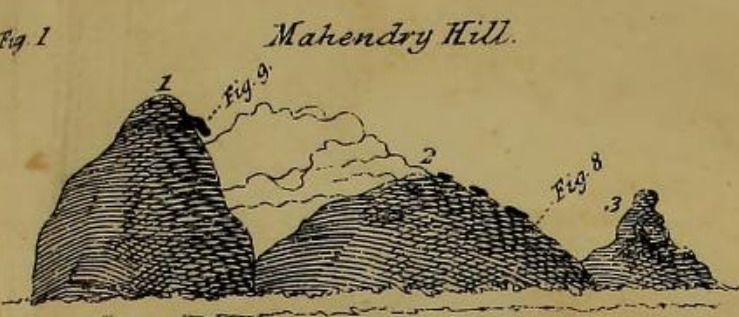
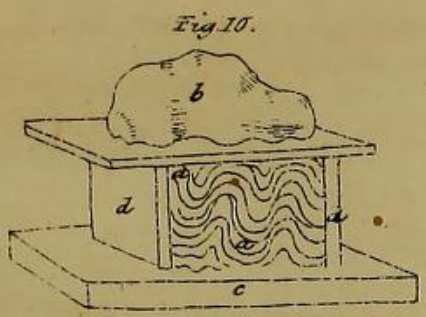




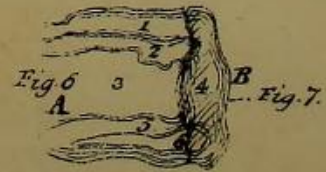
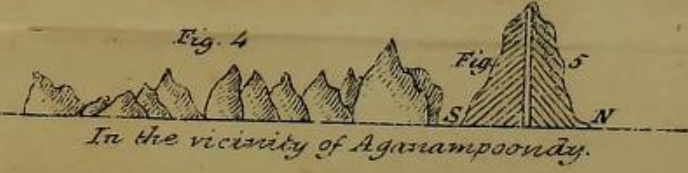
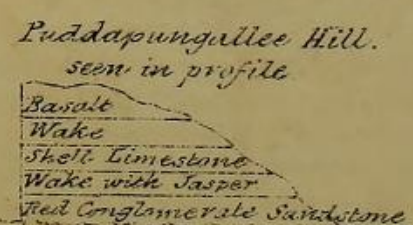
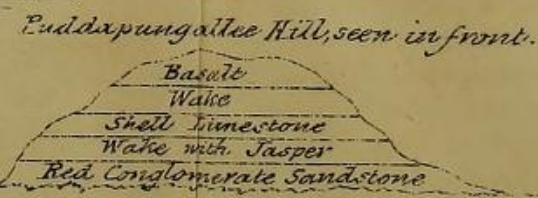
Tomb Stones at Samos. (at Cephalonia).



Tomb Stone found at Corfu.



Chittoconda Rocks (1, 2, 3, Porphyry).



MAP
of
Dr. Benja's Route
through the
Northern Circars.

Scale of 32 Miles to an Inch.

- 1 Hornblende Slate.
- 2 Greenstone Dyke.
- 3 Hornblende Slate.
- 4 Fracture.
- 5 Greenstone Dyke.
- 6 Nest of Felspar.

to the introduction of the herbaceous forms only, but may, by applying the same principles to the arboreous vegetation of temperate climates, extend it to the tropics, thereby supplying ourselves, not only with the products of the farm and kitchen garden, but of the forest and orchard. On these grounds I cannot refrain from soliciting—urgently entreating—all those enjoying opportunities of making experiments, both in India and Europe, to unite in their endeavours to confirm by repeated trials the truth or fallacy of the principles I have deduced from the facts and analogies above stated.

IX.—*Notes, chiefly Geological, of a Journey through the Northern Circars in the year 1835.*—By P. M. BENZA, Esq. M. D.

Sono, prima d' ogni altro, da compararsi i varii, e slegati fenomeni già posti, e raccolti dalla osservazione, e dall' esperienza, così ad uno ad uno, come tutti insieme; per vedere in che si convengano, o peravventura si differiscano.—*Seinà. Introd: alla Fisica Sperimentale.*

MASULIPATAM, Jan. 16, 1835.—We disembarked at this place from Calcutta, and proceeded to the camp, pitched about a mile from the place of debarkation. I felt distinctly that we were passing through an unhealthy, marshy situation, the atmosphere having the characteristic odour of such pestiferous places, arising from the putrefaction of the lacustripe plants the *salicorniæ* principally.

As we traversed the plain, we could not but wonder at the many human skulls scattered over it, having been, as we were told, dug up by jackals, and other animals from their untimely graves. They were those of the unfortunate people, who fell victims to the mortiferous epidemic, which, two years before, carried off a great many European soldiers, and multitudes of the natives.

Although the Right Honourable the Governor's camp was pitched some distance from the unhealthiest part of the plain, yet, the miasmatic effluvia, particularly at night, was powerfully felt. I never recollect the odour so strong, except in the swampy plains of the Acherusian lake (*hodie* Fanari), where, during the heat of the summer months, the exhalations from that vast swamp corrupt the air to such a degree, as to prove exceedingly baneful to the imprudent who ventures to sleep, even one single night, within the influence of these pestiferous exhalations. At Masulipatam, the two nights we slept there, the odour was very strongly developed.

The plain, round Masulipatam, is sandy, having a substratum of clay. In this sand are found many pieces of a concretionary calcareous sandstone, generally speaking mammillary, such as we see in alluvial depo-

sits* of many places in Europe. This is the only locality, where I did not meet with the substance, so widely spread in the plains of India—the nodular kankar.

In the middle of the Pettah, at the spot where the two principal streets cross each other, are placed erect and arranged in a circular form, thirty-three large slabs of a compact limestone, covered with numerous figures in *basso* and *alto relievo*, of the most exquisite execution; excelling any in the few places I have visited in India, containing such relics of the remotest antiquity, the Seven Pagodas not excepted. The sculptures at Masulipatam, being cut in compact limestone, of a very fine texture, are susceptible of receiving a delicacy, a kind of mellowness in the execution of figures and friezes, which it is impossible to impart to the coarse grained pegmatitic rock of the Seven Pagodas. There is such anatomical correctness in the figures, and so much nature and freedom in their positions and attitudes, that Gaggino† himself would have been proud of acknowledging them as his work.

These sculptured slabs were brought from the ruins of a pagoda, seven miles from Masulipatam; and, by what I remarked in one of them, they must have belonged to a more ancient building, than the pagoda whence they were brought to Masulipatam. One of the largest slabs (more than four feet high) had one of the two surfaces, convex, the other, plane. On the convex one, were multitudes of figures, which covered its whole space, representing processions, sacrifices of animals, and other religious ceremonies, said to be those of the Jain tribe. On the back surface was sculptured a reversed column, the pedestal turned upwards, and the capital downwards; showing that the two faces of the stone had been sculptured and used at two different periods, and for two different buildings.‡

* Doctor MacCulloch describes calcareous concretions found in banks of sand in Perthshire, which “present a great variety of stalactitic forms generally more or less complicated, and often exceedingly intricate and strange, and which appear analogous to those of King George’s Sound, and Sewers island.” *Quarterly Journal*, (Royal Institution) Oct. 1833, vol. xiv. page 79--83.

† The celebrated Sicilian sculptor in *basso* and *alto relievo*,

‡ It is common to find sculptures on both sides of a slab, either as a frieze, architrave, inscription, or other ornaments, in Greece. I discovered in the ruins of ancient Samos in Cephalonia (one of the provinces tributary once to Ulysses), opposite to Ithaca, two sepulchres; the one having on the external surface of the cover the following inscription in ancient Greek: DIONISIA VALE, (Plate 17. fig. 1); and, descending into the sarcophagus, I saw, on the under surface of the same slab, some very old Greek letters, the remains of an inscription, which I could not decypher.

On the cover of the second tomb, externally, there was no sculpture, nor inscription of any kind; but, on turning it was seen, in very rude, and apparently very ancient, Greek characters, the following inscription: PHILOSTRATE ATTATE VALE, (Plate 17, fig. 2). In the island of Corfu (Phœacia, *olim*), at the summit of Capo Bianco (*olim* Lencimne) I found a tomb-stone with the following inscription: FULCENNIA FAUSTA, ANNORUM XX. VALE, (Plate 17, fig. 3). On the reverse of this slab there were arabesques, lines, &c, indicating that that side had been probably employed as an ornament in a more ancient building, before it was used as a tomb-stone.

Among the sculptures at Masulipatam there was a piece, apparently part of the entablature of an architrave, which was really in a very refined style; there were figures of lions, tigers, rhinoceroses, buffaloes and men, executed with so much taste, and so exquisitely correct, as to call forth the admiration of all who saw it.

This, and many others of the sculptures attracted the Right Honourable the Governor's attention, who on the spot gave orders for their transmission to a safer, cleaner and more conspicuous place.*

The limestone of these slabs is stratified, and has great similarity to that used for lithographic purposes (No. 1)—colour, yellowish gray—fracture, splintery and dull, occasionally glimmering—semi-transparent at the edges; in short, it resembles magnesian, or some species of the alpine, limestone. I was told that it is quarried on the banks of the Kistna river, near Chindapilly.

GOODOOR, *January 19.*—The substratum to the alluvial sand, in the plain between Masulipatam and this place, is blackish clay (No. 2), containing some fresh water shells, such as *ampullaria*, *planorbis*, &c. (No. 3). Just before reaching Poomroo the sandy alluvium is succeeded by the black cotton soil, in which I found also *ampullariæ* and *planorbis*.

WEEYOOR, *Jan. 21.*—Cultivation of all sorts of grains appears to prosper in the environs of Whehoor, and the black soil prevails, in which are found, even at one or two feet depth, under the surface, fresh water shells, of species now existing in tanks.

BEZOARA, *Jan. 22.*—All the plain between Whehoor and this place has the usual uninteresting, monotonous appearance of the plains of India; but close to the village of Pattamotta, not three miles from Bezoara, we were relieved from this dispiriting sameness, by the sight of elevated land and hills. The knoll, at the foot of which the village stands, is hardly 40 feet above the plain; and another near it has somewhat less elevation. Both are formed of a variety of gneiss, which contains garnets instead of mica; although, in some blocks we see this last mineral not only added to the other three, but sometimes predominating over them (No. 4). We shall see, hereafter, that, in the whole province, this is the predominant rock; the quartz of which has a gray colour, the felspar white, with the appearance and nature of albite; the garnets, generally amorphous, but occasionally crystalline, and of the common colour.

* They have not yet reached their destination, the Museum of the Literary Society.

The different colours of the minerals give to the rock a fine appearance. The direction of the strata in these hillocks is N. and S. dipping east, and, as far as could be judged at that distance (3 miles), the hills west of these last are formed of the same rock, the direction and the dip of the strata being the same as of the eminences near Pottamotta. This species of gneiss seems to decompose easily, the albite being the mineral to decay first. Many blocks, both loose and fixed in the soil, are seen between Pottamotta and Bezoara. This last town is situated close to the left bank of the Kistna, at the eastern side of the hill, whose western base, is washed by the river during the freshes. Two ranges of hills, having the same direction, viz., N and S., confine the river in a kind of gorge; the one to the north, the other to the south, and therefore running in a direction at right angles with the course of the river. The height of both these ridges seems to be the same, about 600 feet above the river.

The water in the Kistna at this season is hardly one-third of the breadth of the river during the monsoon; but during the freshes the waters expand, filling the whole breadth of the bed, reaching the foot of both ranges of hills; and then the stream must be at least a mile and a half broad. It appeared to me that, both above this gap of the hills, through which the river runs, and below it, the country is flat, and nearly on the same level; therefore, what I have read in some publication, of the waters of the river having cut through this chain of hills, does not appear very probable.

In the alluvium, many strata of which are seen on both banks in an horizontal position, are composed of a coarse sand, alternating with those of a greyish clay (No. 5). The rock forming the hill, at the eastern foot of which Bezoara stands, is the gneiss I have just described, the strata being very much distorted and inclined, dipping south. It is not rare to see entire strata formed exclusively either of quartz, or felspar, or hornblende rock, which last lies, dyke-like, among the gneiss.

The direction of the strata is N. E. and S. W. nearly perpendicular to the course of the river, which at this place runs N. W. and S. E. Gneiss is the lowest visible rock about Bezoara, the contortions of the strata of which are well displayed in the sections of the new road at the base of the hill to the left.

GUNNAWARUM, Jan. 23.—Early in the morning we passed over a ridge, the continuation of the Bezoara hill, running eastwardly; it was still dark, so I could not distinguish the nature of the stone composing it; but some specimens I picked up in the road, proved to be garnetic gneiss, analogous to that of Bezoara. The plain near this place displays hardly any blocks of stone, either loose or implanted in the soil, except near

a deep nullah, where are many masses of quartz-rock, which must have been brought from the distant high hills to the north, and accumulated there for the purpose of building a bridge; the few projecting rocks are the usual garnetic gneiss, often decomposing, the garnets assuming a canceled structure (No. 6).

This gneiss, like all primitive Indian rocks, whether stratified, or massive, contains immense beds, or veins, of quartz. When the other minerals decompose and are removed, the quartz must protrude, and, deprived of support, split into fissures, the pieces being scattered in the plain; or, if the rock be in the declivity of a hill, it is hurled down into the ravines and valleys. In one place, to the right of the road, there is a little elevation of sandstone, with a few blocks projecting at the summit (No. 7) which sometimes assume the conglomerate structure, resembling clay prophyry (No. 8), or conglomerate sandstone (No. 9); over the whole plain, pebbles of quartz and of sandstone are very abundant.

APPOORAPET, Jan. 24.—The Right Honourable the Governor having resolved to stay here for the remainder of this, and all the following day, I did not miss the opportunity of examining the diamond mines, which the Honourable Mr. Russell informed me were only six miles north of this place.

Having made my arrangements for the journey, a tent accompanying me, I started at 5 o'clock next morning in a palanquin. After about three miles having traversed a plain of some extent, near the village of Shingoonoosondum, the guide, who had assured me, with an oath, that he knew the place, began to talk with every person he met, *sotto voce*; which led me to suspect he was ignorant of the place we were going to. Fortunately, meeting a man who understood Hindostanee, and having the memorandum, with which Mr. Russell kindly provided me, of the name of the village close to the mines, I asked for Mullavelly, and immediately the man pointed out a tuft of lofty trees, in the middle of which were seen the huts of the village, I was in search of. He took me, at my request, to the headman of the village who conducted me to the pits, answering, with a captivating affability, all the questions I put to him in our way to the excavations.

The road from Appoorapet to Mullavelly, lies along a sandy plain, which, I am told, is swampy during the heavy rains. Approaching the last mentioned village the plain is bestrewed with blocks and fragments of a very hard conglomerate sandstone, some pieces being of a purplish colour (No. 13). There are also some large blocks of garnetic gneiss, in a state of decomposition (No. 14). But the red sandstone abounds most, although rolled pieces of quartz, with a covering of a ferruginous clay, or carbonate of iron, together with the conglomerate sandstone, are scattered over the plain.

The hollow flat, where the diamond pits are excavated, was a low swampy plain, at the season I visited them, the lower part only containing some water. Being surrounded by a bank, or rising of the soil in a circular manner, it has the appearance of having been once a lake. The banks are formed of the red ferruginous sandy soil, prevailing all round this place; through this plain no river or rivulet flows, and the pools in its lower part dry up about the month of March; and it is then the time when the excavations may be commenced, and not before.

The few hills I could see near this place were those to the north, not above two or three hundred feet above the plain, and covered with underwood, interspersed with large trees. Some miles beyond these hillocks runs another range of hills, loftier than the nearest ones, having, however, the same direction.

The diamond pits are in general excavated at the north end of the bank that surrounds the hollow. Judging from some which were dry, the deepest could not be more than 12 feet; and I observed that, whatever their depth was, they never came to a hard mass of rock. The strata which they penetrate during the search are—first, a grey, clayey, vegetable mould, about a foot or two thick; below this an alluvium, composed of the following pebbles, (not including the diamonds) which have evidently undergone attrition, their angles having been worn off: sandstone similar, to the one already described—quartz—siliceous iron—hornstone—carbonate of iron—felspar—conglomerate sandstone, and a prodigious quantity of kankar, or concretionary limestone (No. 15). Of this last mentioned rock, we must say a little more than of the others; the reason is obvious—namely, that the gem is the base of the acid in the calcarious stone.

Besides the numerous pieces of this concretionary rock, scattered on the surface of the soil, and also intermixed in large quantities in the diamond alluvium, it forms regular strata, or veins we might call them, in a horizontal position, both in the vegetable earth, and in the diamond alluvium, precisely like flints in chalk. Many of the pebbles of quartz, and hornstone are not only varnished, as it were, with a ferruginous *enduit*, but it penetrates into their substance. This kankar contains not a trace of quartz or any other mineral; and that in strata, in the vegetable soil and in the diamond alluvium, is more friable than that exposed on the surface of the ground.

It is in this alluvial detritus that the diamonds are found; my specimens were taken from a heap, on the brim of the last excavation, made five years ago. From this refuse, the headman told me, were obtained, as many small pieces of the gem, as might fill, the hollow of the palm of the hand; no other excavation has taken place since.

All the pits are of an irregular form; generally, oblong; the head-

man told me they were not more than ten feet deep; this I could not ascertain, on account of the water, with which they were partly filled.

The headman, who appeared an intelligent, obliging person, gave me the following information, in reply to my interrogatories; he always presides over the excavations, whether the pits are farmed, or are worked on account of the Nizam. The diamond is never found imbedded, or, in any way, attached to any of the pebbles, with which they are invariably associated in this locality. They are always found loose, mixed with the other little stones. On my particularly pointing out the kankar, he said the gem was never attached to that substance. On enquiring, which were the pebbles most constantly associated with, and forming infallible indications of the existence of, the diamond; he picked up from the heaps of detritus, the following pebbles—iron ore, hornstone and the kankar.

Notwithstanding the prodigious quantity of carbonate of lime in this locality, the water did not appear to contain any traces of it; and the inhabitants used even that collected in the pits.

The detritus, forming the diamond stratum, must have proceeded from the hills north, the only ones near this place; being probably the continuation of the sandstone range, which extends eastwardly from Banganapilly, Condapilly and Mullavelly, in all of which localities the matrix of the diamond is a conglomerate sandstone.

ELLORE, *Jan. 26.*—This place is more celebrated for handsome women, and fine, muscular, well proportioned men, than any other in the peninsula. And indeed, among the numerous persons both young and old, who crowded along the road to see the Governor pass, I did not perceive one who could be called ugly, or who was sickly in appearance, filthy, or in ragged attire.

The Native regiment in the garrison (of course recruited from different parts of India) had suffered severely this year (1835) from pernicious intermittent and remittent fevers, the inhabitants having had likewise their share of the mortiferous scourge. Dr. Davison, a very able, well informed, zealous professional man, told me that the proximate cause of this epidemy, was, both in the last and present year, the profuse rains, which, whenever exorbitant, never failed to impart to the exhalations from the rice fields a deleterious influence, that proves very baneful to the human system. The same happens in the south of Italy, where, if on account of profuse rains, or ill-managed irrigation, the rice fields be overflowed, a burning sun succeeding to them, the air in their vicinity becomes pestiferous, and very dangerous, to the cultivators particularly. We were informed, that out of five hundred men of the regiment, one hundred were in hospital; and although the disease had then abated in severity, yet many of the con-

valescents had engorgement of the spleen, or other abdominal viscera, which eventually terminate in dropsy, beriberri, or other *sequelæ*, most of which prove incurable, and at last end fatally. The condition in which the Governor found the hospital, although unavoidably crowded, gave great satisfaction, and did credit to Dr. Davison's zeal and exertions.

NULLACHERLA, *Jan. 28.*—The plain, which surrounds Nullacherla for some miles, is covered with a sandy soil, overspread with numerous pieces and blocks of sandstone. The grains of quartz, in this last mentioned stone, are cemented by a ferruginous paste, which gives to the rock a deep red, or purple, colour; the loose pieces apparently have undergone long attrition, being rounded, or at least their angles very much blunted. In many places there are blocks of the same rock jutting many feet above the soil, and evidently impacted deeply in it.

In these last mentioned rocks the stratification is quite evident (No. 16), and in many pieces the iron is in such a quantity that they might be called siliceous iron ore, rather than sandstone (No. 17). About half a mile before we come to this sandstone, in the middle of the road, are seen some projecting blocks, of a black colour and cavernous structure, so as to simulate lava, for which I took it at first, when at some distance; but, on a closer examination, it proved to be the lateritic stone of this part of India, differing from that of the Red Hills, and other localities of the Carnatic, in containing more quartz, being more cavernous, with more sinuosities, which are empty, not being lined by, or filled with, felspar (No. 18). It is evidently a conglomerate rock, some of the composing pebbles being carbonate of iron, of a dark brown colour. As these lateritic rocks are, as it were, impacted in others of purple-coloured sandstone, and protruding in a similar way to those of the latter rock, we may infer that the cavernous iron ore forms a bed in sandstone.

PUDDAPANGALLEE, *Jan. 30.*—About five miles before reaching this place, and between it and Yernagorium, is seen a small hillock, to the right hand side, near the road. I was riding in company with my friend Colonel Cullen, conversing on the geology of the district we were travelling through. He told me that just before us there was a very interesting phenomenon; nothing less than shell-limestone underlying, and alternating with, basalt. Before reaching the place I saw in the dry beds of the torrents, and in the ditches on both sides of the road, a very compact, conglomerate sandstone, which I will hereafter describe.

As may be supposed I was extremely anxious to arrive at the locality indicated by Colonel Cullen, which we did, in less than half an hour.

Having reached a nullah, which ran down from the north declivity of the hillock, we dismounted, directing our horses to be taken a mile or two further on.

In the bed of the dry nullahs, as well as along the road, were seen blocks of limestone, some of them loose, and others implanted in the soil of the declivity of the hillock. This rock has a white colour, and a fracture semi-conchoidal and glimmering, on account of the numerous crystals of carbonate of lime, into which all the fossil shells are converted. The height of the hillock may be three or four hundred feet above the plain, and the slope of the northern side is gentle and gradual. Its form is oblong; the ridge having a north and south direction.

The north declivity is covered with blocks and large pieces of basalt, scattered and intermixed with those of the limestone. Some of the masses of the last mentioned rock were entirely composed of shells, converted into brilliant and sparry crystals of carbonate of lime. It seems, that they must have undergone violent compression, since they are fractured, and many of them crushed into comminuted fragments. This limestone is very compact, and differs from that a few yards higher, in not containing sparry particles (No. 19). Ascending still, the basaltic masses became more numerous, both loose and fixed; many of them decomposing in concentric layers, and passing into wacke (No. 20). Although this trap appears tough and of a firm compact texture, yet when looked at through a lens, it is observed full of microscopic cavities, some of them lined with a yellow powder (No. 21).

The top of this hill, which forms a kind of table-land, is capped with basalt, apparently extending a few miles eastwardly, and decomposing in concentric layers, which are clearly seen in the dry beds of brooks, having their line of separation well defined. This wacke contains no shells of any sort (No. 22). Many of the masses of basalt, on the summit of the hill, are vesicular, sometimes approaching amygdaloid, not only on the surface, but also in the substance of the stone. Not rarely, large isolated nests of this amygdaloid occur in the compact basalt, the cavities being, in both cases, lined or filled with calcspar (No. 23).

Descending a little way to the right (N. E.) we came to a thick bed of limestone projecting in a little ridge, a foot or two raised above the side of the declivity, running some hundred yards east and west, and cutting the hill in a direction parallel to its base; it appeared to be vertically situated. The outgoings of this bed are tufaceous, as well as the surface of the implanted blocks all around it, and in which the fossil shells were clearly distinguishable, such as oysters, limas, small melaniæ, &c. (No. 24). Notwithstanding the tufaceous structure of the outgoings of this bed, the limestone, when fractured deep, exhibits a texture similar to that of the loose blocks on the declivity of the hill,

full of small cavities lined with calcespar, and exhibiting only the impressions of the shells, their substance having been absorbed.

The colour of this compact kind of limestone is whitish, verging to yellow, and its geological position appears to be that of a bed in the wacke, into which last the trap has decomposed; so that the calcareous rock is imbedded in, and alternates with, the decomposed basalt. Descending a little lower down, the wacke is again seen, with jasper, of a very compact structure, in the form of thick veins, or thin ramifications, or in beds (No. 25), in which, however, no fossil shells are contained, as we know to be the case in other localities in India, where the basalt overlays shell-limestone, and a similar kind of sandstone to that mentioned in these pages. The wacke being removed by atmospheric influences, these pieces of jasper are scattered over the ground.

The outlines of the hills to the eastward, appeared to indicate their being of the same formation as the one we had examined; and Colonel Cullen, who had, some years before, examined the whole of these hills, confirmed my surmise; with the addition, that the other hills being loftier than the one we stood upon, and presenting deeper nullahs, vertical escarpments and precipices, better opportunities were afforded of seeing the position of the rocks.

This place is about ten miles from the right bank of the Godavery, in a line with Rajahmundry. Along the road to the last mentioned place, at the foot of this group of hills, immense blocks of conglomerate red sandstone are seen, apparently underlying the limestone. Many rounded pebbles, resulting from the disintegration of this conglomerate, bestrewed the road, and lay in many of the nullahs (No. 26).

Having travelled a couple of miles towards the Godavery, I saw, in the middle of the road and in a nullah near, the outgoings of a thick bed of limestone, which in texture, compactness and composition, differed from that we examined in the hill. It was crystalline, contained no shells, was of a grey colour, with the aspect of dolomite (No. 27). This bed is evidently flanked by the wacke and basalt, which are seen, the one in concentric laminæ in the beds of brooks, the other implanted in the vicinity.*

To conclude my short account of this interesting locality, judging by what a cursory examination can warrant our saying, regarding the geological position of these rocks, it seems—1st. That the lowest visible rock is the conglomerate red sandstone, so common throughout this district†—2d. That shell-limestone is a subordinate rock to it—3d.

* Is this crystalline limestone, without shells, of the same age as the compact kind containing them? And, if we suppose that the igneous rock converted it into dolomite, why did it not produce the same change in the other?

† Putting aside the consideration that basalt appears to be the *lowest rock*, not only in this locality, but perhaps in all the crust of our Planet.

That jasper must have had its origin in sandstone, acted on by the igneous rock, which, bursting through both the sandstone and the limestone, altered their nature.

Colonel Cullen informed me that, in the hills further east, the beds of shell limestone are seen alternating with the corresponding beds of trap, in more than one locality, and that tufaceous limestone contains the shells of large *ampullaria*, living now in many of the tanks in India.

RAJAHMUNDRY, Jan. 31.—During the freshes, the Godavery must carry an immense volume of water, judging by the breadth of the whole bed, which cannot be less than three miles. Puddapangallee, being ten miles from Rajahmundry, when we entered the dry bed of the river we had gone only seven miles; therefore we had yet to go three miles to the latter place, which space is all occupied by the water of the river during the rains. At this time of the year the stream is hardly half a mile broad; of the remaining breadth, there are two miles of very fine and deep sand, from the right bank to the margin of the present stream, and half a mile of the same sand on the left bank. The tide does not reach Rajahmundry, which is about 30 miles from the sea.

The sand carried down by the Godavery, is the detritus, resulting from the disintegration of the granitic rocks of the hills about twenty miles north. Were we to judge by the alluvium, daily deposited on the banks, and by the more ancient one some miles inland, the water, during the freshes, must flow with extreme velocity, after having run along a level ground, to be able to propel large rounded pieces of rocks, many the size of an orange, while the ordinary impetus of the stream carries along only coarse sand. This difference in size of the transported pebbles, according to the velocity and the volume of the water, produces in the silt deposited, and still depositing, strata of various composition. We see, therefore, both in the ancient alluvium in the plain round Rajahmundry, and in that close to the banks of the river, strata of large rounded stones alternating conformably with those composed of very fine materials (No. 28). This indurated silt is seen clearly in the left bank of the river, and better still on the sides of the Fort ditch. This conglomerate decomposes easily, however, covering the soil about Rajahmundry with pebbly shingle. Mount Delight (hardly ten feet above the plain!) is the only elevation about Rajahmundry, and is formed of this indurated, easily disintegrated, silt.

In the sandy bed of the Godavery, are found the beautiful *pietre dure*, so much esteemed; such as jaspers, agates, sardonyx, onyx, cachalong, cornelians, &c. (No. 29), mixed with black, scabrous pieces of kankar (No. 30). These stones, collected so low down the river, are not large; but, I am told that, about twenty-five miles above this place, they are commonly found of great size. They are undoubtedly

derived from the decomposition of the amygdaloidal trap, which, with granite, forms the hills to the north of Rajahmundry. In the indurated conglomerate silt composed of large pebbles, are some pieces of porcelain earth (No. 31), which the natives employ in the manufacture of a fine kind of pottery, very much esteemed all over India. The decomposition of the felspar into porcelain earth, must have taken place after deposition of the fragment, while still hard and compact, so as to be able to withstand in its descent the consequences of attrition; supposing the contrary to be the case, we cannot possibly explain how so friable a body as the porcelain earth, could have been driven to such a distance in water, without crumbling into clay and dissolving.

Kankar is very abundant about Rajahmundry, and it is burnt as lime.

SAMULCOTTAH, *Feb. 3.*—About half past five this morning our road lay between two high hills; the composition of which I could not discover, on account of the darkness.

At day break we approached the village of Puddagarum: before reaching it, I went to examine some hillocks near the road. The summit of the first I came up to, was formed of sandstone of a deep red or purple colour, the grains of quartz being cemented by a ferruginous clay (No. 32). The surface of the blocks at the top is extremely scabrous and beset with sharp points.

In this hill, the sandstone overlays lithomarge, tinged of different colours (No. 33); but in others the lithomarge is overlaid by a lateritic rock. Close to this first hillock, there are two others of greater dimensions, in which the abovementioned geological position of the rocks is seen in a more defined and distinct manner.

A hill to the eastward of the first, has a kind of talus (not formed of any detritus, but by the strata of the sandstone elevated a few feet towards the hill), which extends one or two hundred yards round its foot. This rock being evidently stratified, slabs of any dimensions and forms may be easily detached, for architectural purposes, for which it seems to be extensively employed, judging by the numerous quarries worked in the talus and in the plain round it, where the sandstone is the surface-rock.

The small ridge forming the summit of this second hill is, as it were, capped with modified hæmatitic iron ore, which last rock, in this locality, is evidently stratified (No. 34). In more than one place of this hill, a bed of lithomarge intervenes between sandstone and the iron ore; this is the case at the western extremity of the ridge, where a deep well is excavated to procure the lithomarge, with which the natives mark their foreheads.

Now, it is curious to observe close to this pit, that the masses just above it are the lateritic iron ore, compact in the lower part, cavernous in the upper; but, attention is attracted by the stalactitical projections of iron ore, some one or two inches in diameter, shooting downwards, penetrating and being imbedded in the subjacent lithomarge. Some of these stalactites imitate the drippings from a candle.

The third hill, a continuation of the second, but higher than any in this plain, (being two hundred feet high, or little less,) is capped by the already mentioned lateritic stone. It is very cavernous, mixed with a good deal of sand—a conglomerate in composition—the sinuosities lined, or filled, with a whitish or yellowish clayey substance.

But, what we must not lose sight of is, that this lateritic mass is traversed by thick veins of the compact, glimmering hæmatitic ore: and the passage of the one into the other is hardly perceptible. This is one of the localities in the plains of India, which, together with those on the Neilgherry mountains examined by me, might invalidate the opinion that the laterite is a formation *per se* associated with trap.

The fort of Puddagarum is built on the summit of a hill of this sandstone; and the soil covering the plain is a red ferruginous sand containing many pebbles of sandstone and the lateritic rock just described. Next day I re-examined this locality, and clearly noted the insensible passage between the hæmatitic iron ore and the lateritic stone; in some places, this last overlaying the former, and in others *vice versa*.

PAYKAROW and TOONEE, *Feb. 7*.—These two villages are divided by a torrent, being situated at the foot of a group of hills, which rise in a ridgy form with an east and west direction. Some hills of this group attain a height of about one thousand feet above the plain, and are thickly covered with shrubs and underwood. They are formed of garnetic gneiss with occasional strata of quartz, their direction being that of the ridge itself, viz. east and west, and nearly all of them are vertical; at least those of the summit are clearly so.

The populous village on the left bank of the torrent, is called Paykarow, the other on the opposite bank Toonee. The skeleton of the famous bandit Paykarow is seen hanging on a gibbet here, outside his own village. This marauder gave the Government much trouble many years, and defied the few troops sent against him and his associates; the gang burning, destroying and plundering the houses and property of the Zemindars, and of all who were known to be partial to their enemies. They cut off the ears and noses of those whom they thought befriended the British Government and sent them to our Commissioner, the Honorable Mr. Russell. The energetic and decisive measures of Sir Frederick Adam, carried into

execution, in a prompt and determined manner, by Mr. Russell, caused the dispersion of the whole gang; many of whom were caught and hanged on gibbets.

ANUKAPILLY, *Feb. 9.*—The country, between Toonee and this place, is interspersed with numerous hills and knolls, all of them of a conical shape, covered with thick shrubby vegetation. They are formed of the garnetic gneiss; the only difference between this rock and that of other localities, is that the felspar has the composition of that variety called albite or cleavelandite.

Close to our encampment was a hill, about four hundred feet above the plain, near whose summit is a kind of grotto, over which hang two enormous masses of gneiss, which has been converted into a tiny pagoda, dedicated to the goddess Coocoresha, whose devotees must have patience to ascend 295 steps cut in the rock, besides paying their propitiatory offerings. The view enjoyed from the pagoda is magnificent. The whole hill is gneiss, and, in the large masses on the sides and above the pagoda, the stratification is well marked, the strata dipping eastwardly.

YELLAMUNGALLEE, *Feb. 10.*—The approach to this place is very picturesque, the village being surrounded by numerous hills rising abruptly to various heights, and assuming the most romantic shapes. The rock is garnetic gneiss, most of the garnets being amorphous, and decomposed into a cancelliform structure, to be explained at a subsequent portion of this journal (No. 35). The quartz strata sometimes resemble quartz-rock, and at others they are divided into many smaller strata conformable to those of the rock. The colour of the quartz is white, except in some few blocks, when it becomes of a rose colour (No. 36).

Some strata of this as well as of the other kinds of gneiss, are exclusively formed either of garnets or felspar, which last mineral, when decomposed, forms a coarse kind of porcelain earth (No. 37). The strata near our camp had a vertical position, their direction, and that of the other neighbouring hills, being about N. E. and S. W. dipping west. These strata are easily separable, and the pagoda, in ruins at its summit, is built of this gneiss, which is exceedingly well adapted for such purposes, on account of the great facility of its cleavage into slabs of any dimensions and form. The felspar has often a laminar structure, and assumes a beautiful scarlet red colour (No. 38).

CASSIMCOTTA, *February 11.*—Approaching this place, the hills are composed of the gneiss previously described; and the garnets are so

numerous as to form strata exclusively. The direction of this range is the same as the preceding, the strata being nearly vertical.

The sides of some of the hills presented a chalky colour, owing to the number of decomposed felspathic strata. I must here particularize an observation which occurs in more than one place of my note book, regarding the durability of this gneiss, namely, that quartz seems to give a greater compactness to the rock, than when the other two minerals are the only ones composing it.

Besides the seams of the strata, this gneiss is intersected at all angles by many fissures, which divide the strata into rhombs, cubes and other angular forms; which is clearly seen in the two hills close to Cassimcotta to the north. The usual nodular kankar is frequently seen over the soil. This concretionary rock, met every where in the plains of India, and particularly along water-courses, seems of recent origin, and, indeed, to be daily forming.

AGANAMPOODY, *Feb.* 12.—Anukapilly being only three miles on our way to this place, instead of remaining at Cassimcotta the whole night, some of our party went to visit the residence of Sooria Pracasa Row, who has laid out his gardens, and fitted up his houses after the European fashion. Sooria is one of the Zemindars who contributed so materially to the destruction of Paykarow and his gang. He is one of the *rare aves* among the higher class of people of India. He is very partial to European manners and adopts them (not for affectation sake). He speaks and writes the English language uncommonly well, and his pronunciation evinces hardly any foreign accent. He disregards the show and glitter, the suite of attendants, the umbrella-carriers, and other indispensable appendages of his countrymen, of rank corresponding to his own; and wears none of their ornaments. He came to visit the Governor on a superb Arabian horse, and was introduced without a single attendant. We accompanied him on his return to Anukapilly, and he conducted us to his garden, which was laid out in a most beautiful style, rich with indigenous and exotic plants and trees, before Paykarow laid his destructive hands on it, as well as on his other houses. Yet, being in some degree repaired, the garden and bungalow were in a very neat and comfortable condition, all in true European style. Some of us slept at Anukapilly, and had scarcely eight miles journey to Aganampoody, and did not leave the former village till past seven in the morning.

All the hills on the way had the usual conical shape, and were formed of gneiss. Those to the north of our camp, were quite of a different outline and form from most seen during this excursion, being of a ridgy shape, with spiry summits and naked precipitous sides (Pl. 17 fig. 4). Close to the camp was an isolated hill about

one thousand feet above the plain, of peculiar conformation, being of a conical shape with a vertical, ridgy projection, some feet thick, down its eastern side from apex to base, dividing the hill into two halves, a northern and southern portion. The strata forming both sides have an opposite dip; those to the north dip northward, and those to the south, southward; thus diverging from the projecting ridge, as if from an anticlinal line (Pl. 17 fig. 5). If this vertical ridge had had a black, instead of a whitish grey, colour, as it appeared at a mile distance, I should have taken it for a basaltic dyke, bursting through the gneiss, and at the same time elevating the margin of the fractured strata. I then recollected that, at the western foot of this mountain, there was a dry deep nullah, in the bed of which were implanted large masses of common granite, projecting many feet above it (No. 39). From this I conclude that the lowest rock is common granite, which elevated, and intruded into, the stratified rock.

The appearance of the spiry, sharp-peaked mountains to the north, seems to countenance the above mentioned surmise; nor can we suppose the enormous blocks in the bed of the nullah to be erratic boulders; because many had their extensive, convex surface a few inches only above the bed of the torrent. The other rocks in this plain, are loose pieces of lateritic iron ore, and below the soil a thick stratum of kankar. Carbonate of soda incrusts the indurated sandy soil in some places (No. 40).

WALTAIR, *Feb.* 13.—From the last encampment to this place the hilly appearance of the district continues; the rock is gneiss, the strata highly inclined, and, in some hills, nearly vertical, and traversed by fissures, which, cutting the seams at an angle, the naked sides of the hills are thereby marked with lozenge shapes. The plain before reaching Vizagapatam, is covered with a white efflorescence, like hoarfrost, produced by the small crystals of muriate of soda, deposited after the evaporation of the sea water, with which this soil appears to be impregnated. Numerous pits are dug in the soil, close to the hill of gneiss in the road to Waltair, to obtain the shells many feet below, which are burnt for lime; generally they are salt-water shells. If my memory does not fail me, a portion of this plain has been lately drained, by which the air, before proverbially unhealthy, has been rendered pure, and many thousand acres of land have been reclaimed from the sea.

The hills about Waltair are gneiss; some of the strata are exclusively formed of garnets, sometimes containing more mica than in other localities, occasionally in nests (No. 41). The way from Vizagapatam to Waltair lays through rocky knolls, hillocks and masses heaped one over the other, and before reaching Waltair there is an undulating sandy plain (perhaps not a quarter of a mile broad) of a red colour, the result of the disintegration of the gneiss abounding with garnets.

BIMLIPATAM, *Feb. 14.*—It seems that the range, or at least a branch, of the mountains composed of gneiss terminates in abrupt cliffs and precipices in the sea, a few miles north of Waltair. The tide ebbing after midnight, we availed ourselves of that time to start from Waltair, the road which traverses the shore and passes over the large masses of rock which jut out into the sea, being at that time passable. This spur of the gneiss forms rough tabular masses, which, in a vertical position, extend some way into the sea; and, although the moon shone bright, I could only discriminate the position of the strata. The specimens, which I broke off as I passed, proved to be the gneiss, which prevails in the road we followed.

The hill at the foot of which Bimlipatam stands is also composed of this rock, the strata being in no way contorted, although very much inclined. This is the case, likewise, with this rock, in other localities of the Northern Circars; differing from other species of gneiss common to the table-land of Mysore, and extending as far as Erroad, which are tortuous and twisted in all directions. The summit of this hill is capped with an enormous tabular mass of a lateritic stone, placed horizontally over the bassets of the vertical strata of the gneiss (No. 43). This cavernous, ferruginous clay-stone imbeds very large pieces of the subjacent rock, not only near its surface but also deep in its substance. The nearly vertical position of the strata is seen better than in any other situation of this hill, in the sides of the tank close to the ruined house, which is cut in the hard rock. It must be remarked, that, at the points of contact between the gneiss and the lateritic rock, the former is very much infiltrated with iron.

VIZIANAGRUM, *Feb. 16.*—The plain, for many miles round Vizianagram, is sandy, mixed with some pieces of quartz; below the soil, in one or two nullahs, are strata of nodular kankar, occasionally imbedding pebbles of hæmatitic iron; the stalactitic kind of this ore being also common (No. 44).

Behind the barracks and the bazar of the Native Regiment quartered here are some hillocks quite different, in aspect and form, from the gneiss rocks we have described. It is common granite, having the mica both disseminated and in nests, and contains a good deal of quartz. Enormous masses of this granite are heaped up in great confusion, some of them placed, tor-like, one above the other; many rest on the convex surface of others, which are deeply fixed in the ground. On the surface this granite has a brownish black tinge, but it is whitish grey in the fracture. When the mica is wanting and the felspar scanty, the rock resembles quartz-rock. Close to these hillocks some blocks of lateritic rock are seen, which have the same position as the granite, that is, implanted in the soil.

The black soil in this locality, as in other places, has a substratum of nodular kankar, besides the tufaceous kind scattered on the soil. In the dry bed of a brook, I saw enormous blocks of this last mentioned rock jutting forth.

COTTEPOLLUM, *Feb. 18.*—We left Canada this morning at half-past four. I employed about an hour in examining a hill to the north of the road, not more than two miles from this place. It is rather steep, about four hundred feet from the ground, formed of gneiss abounding in garnets. At the summit I looked for lateritic ferruginous clay-stone, but I did not see a trace of it, nor in the declivities, except a few erratic pieces in the talus. It is in this locality, that I first saw some blocks of garnetic gneiss, with strata very much distorted, their parallelism being not affected. Those on the summit were vertical; at least the bassets of vertical strata were seen running in a direction N. and S., while those on the eastern and western sides appeared to diverge (having the same direction as those of the summit) anticlinally, the western dipping west, the eastern to the east. This hill, and another near, were surrounded with a talus at their base, an unusual occurrence in India. The kankar is abundant.

CHICACOLE, *Feb. 19.*—As it was hardly day-light when we left Cottapollum, I could not distinguish the character of the rocks, projecting here and there close to the road, which appeared of a black colour, and probably were greenstone, or basalt. On arriving at the camp I saw many masses similar in appearance to those passed early in the morning. These were hornblende slate, and those previously seen were probably the same rock, both being in immense tabular masses laid one over the other horizontally, or placed in an erect position, the raised extremities leaning against each other, or heaped together, without any regularity or order; when the quartz was scanty, the rock became characteristic hornblende slate (No. 45).

The highest hill, about five hundred feet above the plain of Chicacole, is composed of garnetic gneiss in a state of decomposition, the strata nearly vertical. From the north side of this hill, is seen projecting along the plain, in the manner of a dyke, many blocks of hornblende rock; and at the foot, facing north, is an enormous vein, or rather bed, of quartz rock, many yards thick, whose outgoings form a kind of shelly projection at the base of the hill; the direction of this bed being east and west. Most of this latter rock consists of the intimate agglutination of angular pieces of transparent quartz, without any apparent cement (No. 46); although in some parts they are united by a clayey ferruginous paste, producing a kind of silicious puddingstone (No. 47), or claystone porphyry.

SITTUMPETTA, *Feb. 23.*—In the middle of the new Palconda pass. This road, which has lately been constructed, is cut through a group of hills, covered to the summit with thick impervious forests of gigantic trees, the road lying along the tortuous valleys, and intricate paths at their base. On account of the thick arboreous vegetation, the prevailing rocks are seen now and then only, jutting through an occasional avenue, or in the openings between the trees, or, more perfectly, along the space which has been cleared for the road. They are all of hornblende slate, the strata of which are well defined; the same rock, found near Chicacole, is probably a diramation of this centre group, which appears to give off branches in different directions.

This schistous diorite has a bluish colour, on account of the large quantity of hornblende entering into its composition—its fracture is splintery and glimmering (No. 48); and when the felspar predominates, the colour changes into whitish. In most of the places we have been journeying through, all the hills, knolls and elevations, and projecting rocks of any altitude, have been of the class of primitive stratified rocks, but, the reader must have remarked, that, wherever opportunities of observation occurred in deep nullahs at their base or in the valleys, common granite formed the lowest visible rock. This is the case in the Palconda Pass; the beds of the torrents, which occupy the narrow and deep valleys among these closely crowded hills, show blocks of granitic rocks, deep in the ground, composed of quartz, felspar and a few garnets (No. 49), and exfoliating in concentric laminæ, as other granites do.

Below the soil of the valleys through which we passed, the kankar formed, as usual, a substratum. Some of the hills, near the eastern end of the pass, present denuded, vertical, precipitous façades, which permit of no vegetation, and the stratification of the rock is displayed in the most striking manner. This place recalled to my mind the awful escarpment of the northern side of the Holykooldroog, facing the Koonoor Pass (Neilgherries) the summit of which presents to view the immense strata of hornblende, which rock forms in most places, the extreme vertical precipices of the Neilgherries.

NEEMGAUM, *Feb. 25.*—The Governor and party, left Cootoor at 4 o'clock P. M. to visit the western end of the pass, the strong hold of a gang of desperate marauders, who, during many years, issued thence to commit highway robbery and murder, maiming those whom they thought friendly to Government; the wild imperviousness of the place, rendering it almost unassailable by regular forces.

Close to Neemgaum is a hill about 1000 feet above the plain, covered on all sides to the summit with thick jungle, and almost inaccessible. Only a few masses of rock, are seen on the sides and at the top. At

the base, however, and some way up, many blocks are seen apparently of the same nature as those on the sides. Many of these are *in situ*; but some have evidently been hurled down from the summit or sides of the hill. They are all hornblende slate, probably a diramation of the Sittumpetta group, being composed of felspar, hornblende in large proportion, and a few garnets—the fracture glimmering and texture extremely tough (No. 50). Although, generally speaking, this rock is stratified, yet there are some blocks that put on the appearance of a granitic, unstratified rock. There is a huge block, just above a hamlet, at the southern base of the hill, which seems to have been precipitated from near the summit of the hill, where many similar are perched, nodding to their fall. This mass, of an oblong shape, is traversed in different directions by regular dykes, either of hornblende, or of greenstone. The diagram (Pl. 17 fig. 6), is meant to represent this block: A is the longitudinal face of its north side, and B the fracture perpendicular to it. Along the lower margin of the northern side, runs horizontally a very thick dyke, the line of demarcation, between the intruding and intruded rocks, being well marked. The dyke having reached the middle of the mass, bifurcates to inclose an oblong mass of felspar, which follows all the wavings of the dyke which thus imbeds it. Looking at the fracture B, we see that the dyke of greenstone did not penetrate so far into the substance of the hornblende slate, as to burst through the other side of the mass; but, having intruded some inches, ended in the substance of the rock (Pl. 17 fig. 7). The texture of this hornblende slate appears to have suffered no change, by the contact and proximity of the dyke. This dioretic rock is of a composition common in India, entire strata being formed of hornblende with a few garnets, and others of felspar alone. The greatest number of loose blocks along the road, from Neemgaum to Kimidy, are gneiss, composed of quartz, felspar and garnets (No. 51). Some masses have occasionally a small stratum, a few lines, of gold coloured mica in the seams.

KIMIDY, Feb. 23.—At day-break I saw a hillock near the road, formed of immense unstratified masses, which proved to be common granite, with the addition of a few garnets. Although this rock is unstratified in the large, it is laminar in the small, on account of the mica being placed in parallel laminae. The felspar is in large well-formed crystals in some masses. Close to the town of Kimidy are many erratic blocks of hornblende rock.

March 1.—I rose early this morning, with the intention of ascending to the summit of the high hill which rises behind Kimidy, and had mounted nearly half way up, along a fatiguing path, when a thick fog

descended from the top of the hill, and in a few minutes enveloped it in obscurity. I waited patiently for some time, but, seeing no prospect of the weather clearing, I pushed on towards the summit, and proceeded about twenty minutes, groping my way all the time, both on account of the darkness from the fog, and the slippery nature of the path, which was full of loose stones, rendering my advance difficult and laborious. At last, seeing that there was no hope of the speedy clearing up of the weather, and the time for departure approaching, I descended; breaking some specimens from the blocks on my way. They were of gneiss, the garnets decomposed, assuming the cancelliform structure. The direction of the strata was E. and W.

GARABUNDA, March 2.—Four miles before reaching this place, I remarked, just in front of us, a very black looking hill, apparently formed of a single enormous block, of an oval form; one third of the broadest part of which was buried under ground. At a distance of two or three miles I took it for basalt; but, on nearing it, I saw no fissures, no columnar structure, no step-like sides, but, an uniform, convex surface. It was about 400 feet high, and when we came abreast of it, another hill, not so lofty, was perceived behind, very convex, and lying against the eastern side of the former one (Pl. 17 fig. 8). These enormous monolithic masses were unstratified, with no trace of split or fissure; the natives call these rocks Chittabunda. Being hardly half a mile from the road and one from our camp, I went to examine it leisurely. On a nearer approach it was evident that they were formed of porphyry, composed of very large, well defined crystals of pearly felspar, imbedded in a paste of hornblende (No. 52). On the convexity of the lower rock to the east, were scattered many tabular masses of the same porphyry, of different angular forms, such as rhombs, cubes, parallelepipeds, &c., all evidently portions of the thick concentric laminæ, into which this porphyry exfoliates. The most striking of these tabular masses is seen in the eastern side of the highest of the two hills, where it hangs from the precipitous face of the rock by a very precarious hold (Pl. 17 fig. 9).

The crystals in this porphyry are very large, many of them being two or three inches long, and many lines thick. It is worth remarking, that nearly all of them are placed in the rock in the same direction, and parallel to each other; at least that is their position on the surface, and I could not see any of them crossing each other, or having different directions. The hills on the opposite side of the road, about a mile from these porphyritic masses, differ in aspect from them, being covered with impenetrable jungle, so as to conceal all rocks, that might project on their slopes and summits. Notwithstanding which, judging by the few blocks, fixed and loose, near the road at their base, they are of

sienitic granite, composed of felspar, quartz, and hornblende (No. 53); the presence of the last mineral accounts for the difference in the outline, and in their being covered with luxurious shrubby and arboreous vegetation; in opposition to the barrenness of the porphyritic ones.

The felspar of this sienitic granite is of a pale yellow, which gives to the rock a different colour to that of the same species in other localities. The hills to the north, very near to our encampment, were formed of porphyry similar to that of Chittabunda. Their black, barren appearance bespoke, even at a distance, the nature of the rocks forming them. That which we are now describing, however, differed in having some clefts and fissures, in which many shrubs take root. In this locality, many of the masses abound with hornblende, with a few garnets, the rock then resembling hornblende porphyry (No. 54), somewhat similar to that rock at Mantoo on the Neilgherries. Here I observed, what I did not see at Chittabunda, large nests, or veins, of a fine grained granite, or of pure hornblende, intruding in the usual irregular manner, and imbedded in the substance of the porphyry.

In general the crystals of felspar are white, but, not rarely, of a reddish colour. On the last described hills were seen rhomboidal and cubic masses like those at Chittabunda, either suspended from the nearly vertical façade, or laid on their convex surfaces. To the south of our camp, facing and hardly two miles from the porphyritic ones, are some hills, the continuation of those of the same nature opposite to Chittabunda, of similar outline, and covered by the same thick vegetation.

CASSIMBOGA, *March 3.*—This village is fourteen miles from the last stage. The pass of Cassimboga is the eastern end of the Sittumpettas; the strong hold of the famous Paykarow, Garolle, and their associates. The narrowest part of the pass commenced about three miles from our last camp, but its whole extent from Cassimboga is eight miles. The Governor wished to survey the place where had been perpetrated hundreds of murders and robberies, the victims being sometimes mutilated to annoy the Government, which was taking every measure to suppress this gang of assassins, which kept the whole province in the greatest confusion and alarm. We did not leave Garabunda until half past six; the road lies between two ranges of hills, along the narrow valleys at their base, which, until two years ago, were covered with thick jungle, almost impervious, except along foot paths known only to those who frequented them. The horizontal branches of the gigantic trees, crossing each other and descending very low, rendered the path difficult and laborious, giving full scope for the attacks of robbers, and, in case of their being assailed, enabling them to resist any force sent against them.

Some of the spurs of both mountains extend more than others into the little flat, the pass contracting in those places. In these narrow spots the gang awaited their victims; and, in such inaccessible positions, a few persons could defy all troops opposed to them. Besides their natural strength these places were guarded by parapets of mud, with a ditch behind them, extending from one to the other, leaving only a very narrow space for passengers. Even this precaution did not appear to them sufficient security. They piled up entire trunks of trees and brambles on the summit of this imbankment, rendering it nearly impregnable. Two or three of these trenches extended from one extremity of the pass to the other. After having resisted several years, the present government put a stop to the iniquities committed by this gang.

The officers sent against them, got information of an intricate by-path, full of dangers, on account of the numerous wild animals and the probability of being lost in the jungle. But, English bravery is not easily daunted by difficulties, and in the night the guides succeeded in conducting safely the attacking party to the rear of the enemy. The success was complete; the military entered the marauders' villages, set fire to them, and the conflagration of their homes was the first intimation they had of their being surrounded. Of course, they had recourse to the *sauve qui peut*, and scrambled up the hills. Some were taken, others killed; it ended in the total destruction of this abominable nest of villains. This pass, after the extinction of the gang, was cleared, and a spacious road formed, flanked by several hundred yards of clear ground.

We have said, that the hills of this pass are porphyritic to the north, granitic, to the south. A mile or two from the eastern end, a dyke of basaltic hornblende is seen (No. 55), flanked to the west by projecting masses of porphyry; it is of moderate thickness, and many hundred yards long; some of the exposed blocks have a cavernous or amygdaloidal structure. Further on, at a little distance from the road (S.), I saw another dyke of the same trap, capped by a stratified rock, seemingly gneiss.

After passing these dykes, all the hills and knolls to the left were of the already described porphyry, and those to the right, granitic. Only one hill, about four miles before reaching this place, is of a different composition. Its lower part was porphyritic granite, the crystals of felspar being neither so large, nor so well defined, as in the porphyry of the pass, but yet the rock was unstratified, in immense masses, exfoliating concentrically. This granite is overlaid by gneiss, resembling that of Kimidy, with a profusion of amorphous garnets.

In the brief manner these cursory notes permit, we may draw the following conclusions, with regard to the geological features of this noted pass. The hills, which confine it to the north, are porphyritic

almost exclusively; those to the south are, in general, gneiss with garnets, with one or two hills of granite. The porphyritic formation seems to extend as far as the Mahandry mountain (N.), the highest in this district, which does not appear to have the conformation, outline, and black aspect, of those formed of porphyry. The soil all along the level of the pass, is sand and clay of a reddish colour; the nodular kankar forms the stratum under the vegetable soil, and is also scattered on its surface. A few pieces of loose lateritic stone were met with, but none implanted in the ground; the gravelly detritus of this ferruginous claystone on the soil was not scarce.

POONDY, *March 5.*—The sand, over the whole plain before reaching this place, is very fine grained, whitish and extremely loose. Having ferried over the river near Poondy, we proceeded to our camp, pitched on a sandy eminence, not two hundred yards from the sea. In the swamp, between the river and Poondy, are numerous blocks produced by the oysters, which are very abundant at this place, the masses projecting some feet above the mud. They are composed of nothing else but oyster shells, with little cement agglutinating them. These are the only rocks at Poondy; cut into square pieces they are used for constructing the walls of huts; with them, also, they line the interior of wells, to prevent the sand, through which they are dug, from falling in. The water of these wells, although a few yards only from the sea, is perfectly fresh and drinkable.

About two miles north of our camp, near the beach, a village is situated at the foot of a granitic hill, the rock of which is composed of a great quantity of garnets and hornblende, with felspar. At the surface of some blocks the rock appears stratified, but the huge masses at the summit are all unstratified. In the more compact pieces the felspar changes into albite (No. 56); and some, composed of a prodigious number of large amorphous garnets, are knobby on the surface, owing to the two other minerals having decomposed, and left the decomposing garnets, like small filberts, protruding (No. 57). Not rarely some masses are entirely formed of garnets, to the exclusion of the other minerals. All the black looking masses along the beach and protruding from the sea, opposite to this hillock, are the continuation of this rock.

POONDY, *March 9.*—The whole plain west of this place, and along the shore for some miles, is covered with a very thick deposit of whitish, extremely fine, loose sand, which, extending for a quarter of a mile inland, is undulated with numerous swells and small elevations of this highly comminuted sand, on which nothing but a species of

convolvulus grows. In this thick stratum of sand no shells are to be found, except those thrown by the sea on its surface. Under it, however, a clayey stratum, the thickness of which it is difficult to ascertain, contains a great many shells, both salt and fresh water. This is clearly seen in the sides of wells; in digging which they always come to this clayey substratum, before water is obtained.

Many of these shells are identical with those of mollusca now living in the river and on the shore, besides the pelagic ones. The stratum of clay with shells, extends three or four miles inland, where pits are dug to procure them for lime; and these fossils may be seen, even, in the soil thrown up by the large crabs which burrow in the ground.

In the plain of Poondy we thus see phenomena similar to those witnessed at Vizagapatam, and the same inferences may be drawn at both places. There are frequent signs, along the eastern shore of the peninsula, of estuaries, or shallow bays, having formerly existed, into which rivers discharged their waters: thus the clayey stratum, containing sea and fresh-water shells, must have been deposited. When the catastrophe happened which heaved up to its present altitude this part of India, the clayey bottom of these estuaries containing shells, was raised into the atmosphere, and, at the same time, the hills around. The subsequent decomposition, and gradual decay, of these mountains, has covered this stratum of clay with one of sand.

POONDY, *March 11.*—About a quarter of a mile north of the village of Guirzinghee, two miles from Poondy, there is a ridgy hillock, two miles from the shore, not more than 200 feet high, its direction east and west, sloping gently on both northern and southern declivities; with the village of Carverà at its northern foot. It is composed of the usual garnetic gneiss, stratified. The felspar, one of its ingredients, is of the species called albite or silicious felspar, in a granular state, and also in slender needle-shaped crystals (No. 58). The cleavage of this gneiss is in the line of the seams, which renders it extremely useful for architectural purposes, as it splits easily in the usual way of masses with parallel surfaces.

This rock, to the touch has a harsh, rough feel, probably on account of the great number of the crystals of silicious felspar. The albite sometimes is in slender prisms, one or two inches long, particularly when on the surface, dispersed through the rock without regularity or any common direction; many crossing each other forming a net work. No mica enters into the composition of this gneiss, except a few plates dispersed through the rock; a few garnets, which are imbedded in the albite or cleavelandite, are not always in regular crystals, sometimes being finely granular, which gives the rock a remarkable glim-

mering (No. 59). Between the seams of the strata, the albite sometimes forms a thin stratum of the pure mineral, in needle-shaped crystals. Judging by the outline of the hills six or seven miles west of Poondy, it would seem that they are formed of the same gneiss as that near Carverà, the ravines, down their sides having the same reddish appearance in the places divested of vegetation.

Leaving this hill, and going north about two miles, in the middle of the road are some enormous masses of porphyry, their surface nearly level with the ground and convex, perfectly similar in composition to the rock of the Garabunda pass, the crystals as large, and as well defined. About fifty yards beyond these masses, was a heap of immense blocks of the same rock, many implanted in the soil, while others were placed, tor-like, over the surface of the former. In these rocks the crystals of felspar were better defined and larger than those of Garabunda.

Not more than five yards to the west of these rocks, is a small double eminence, composed of albitic gneiss, similar to that of Carverà, on the little ridge of which were placed many granitic blocks, analogous to those of Guirzinghee. Looking at the direction of the masses of this porphyry, which is precisely the same as that of the pass, it is more than probable that they are the prolongation, under ground, of the same formation. The hillocks and small eminences in other parts of this plain, are either the common garnetic gneiss, or that in which the laminar felspar passes into albite; through which the porphyry at this place seems to have forced its way.

In conclusion, we may be permitted to make a few general remarks on the phenomena observed during the journey. The first is the singular fact, observed and mentioned by writers on Indian geology, Dr. Heyne among others, of the total absence of organic exuviæ in both species of kankar, which, notwithstanding the different periods of their deposition, are alike deficient in this respect.

The same remark has been made with regard to the laterite, in which no shells or other fossils have been found, either in the Indian peninsula, or on the opposite continent and adjoining islands. Such absence is more remarkable, because it is observed of two rocks, the one concretionary, the other conglomerate, which appears to indicate an origin not very ancient; and the kankar, in particular, which invests, not only the detritus and small pieces of the unstratified and stratified primitive rocks, such as granite, gneiss, hornblende, chlorite slate, actynolite schist, quartz, &c.; but also the modern ones, I mean the fossiliferous, such as mountain limestone, sandstone, basalt, &c.

The lateritic rock at Puddagarum, is the modified hæmatitic iron ore,

and the conglomerate rock results from its detritus. At Nullacherla, the blocks were little above the soil, and situated in the same position as those of conglomerate sandstone, evidently forming a bed in the last mentioned rock. The third kind of laterite, that at the summit of the hill of Bimlipatam, overlaying, and imbedding fragments of, gneiss, both at the surface and near the points of contact with the subjacent rock, contains many veins of hæmatitic iron of different thickness, into which it passes in its lower part. Those blocks called laterite at Pudagarum are, evidently, in appearance, and in the circumstance of association with the hæmatitic iron ore, analogous to that of the Neilgherries; of the other two, we must be satisfied of their similitude, by induction only.

Adverting to the rarity of contorted strata in the rock prevailing in this part of India, namely, garnetic gneiss, with occasional intermixture of albite; and to their frequency in the other variety of the analogous rock, containing mica, in many other localities, we must feel anxious to inquire, what is the real cause of the difference in the forms assumed by the strata, when in a semi-consolidated state.

Along the route which we have travelled, the only two places, where I met with gneiss whose strata were contorted and undulating, were the hill of Bezoara, and that about two miles west of Cottipollium. We must not omit mentioning, that, in both places, the disturbance did not extend far; at Bezoara it occupied only one side of the hill; and in that near Cottipollium, the contortions were seen only in loose, erratic blocks, perched on the south declivity of the hill. It is necessary here to remark that, through the Bezoara strata, were seen large dykes, or beds, of greenstone, which, evidently, must have contributed greatly to the distortion of the strata.

The other variety of gneiss, containing mica, such as that in the table-land of Mysore, and elsewhere, is traversed by numerous basaltic or porphyritic dykes, the existence of which suggests a plausible reason for the disturbed strata of gneiss in that district.

Thus, suppose two enormous dykes of basalt, at a certain distance from each other, bursting through the semi-consolidated, horizontal strata of a rock, say gneiss, enclosing between them a certain extent of these strata, which, we suppose, to be under a moderate pressure from above: what will be the consequence of a force, such as that of the intruding basalt, applied on the extremities of the strata, in opposite directions?

The luminous experiment of Sir James Hall, answers satisfactorily this question. He put on a table different coloured square pieces of cloth, horizontally, one over the other, having put a board with a moderate weight on them (Pl. 17. fig. 10): *aa*, are the pieces of cloth, which, in the beginning of the experiment, were horizontal; *b* the

weight; *c* the table; *d* the two pieces of board, which are made to slide on towards each other. It was found that the superincumbent weight was raised some few inches, and the horizontal pieces of cloth became distorted, like the strata of many rocks.

We must take into consideration the numerous fissures, through which the immense quantity of trap in India must have been erupted at some remote period, and of which, at present, nothing remains, except the outgoings of these gigantic dykes, on mountains, and in plains, sometimes invisible, because covered with the soil.

The mass of gneiss, which we have supposed to be enclosed, and compressed between two opposite forces, having been lifted into the atmosphere; owing to the comparatively speedier decomposition and disintegration of the basalt, which, after a time, falls away, the contorted stratified rock is left, either as a solitary block, or as an implanted mass in the detritus of the imbedding rock accumulated round it.

This must have been the case, with many of the masses of gneiss near Bangalore, Golcondapatnam, &c.; whose strata, although exceedingly disordered, yet have very little trap in their vicinity, which, however, is seen at some distance from them. After what we have stated, we may safely affirm that the frequency of intruding rocks in a formation of stratified ones, produces the contortions in these last; and that when rare, or totally absent, no disturbance in the strata is observed.

To conclude these cursory notes, we will give a brief catalogue of the principal rocks, examined during the journey, ranged according to their degree of prevalence.

1. Garnetic gneiss, the felspar sometimes changing into albite or
2. Porphyry. [adularia.
3. Hornblende slate and rock.
4. Sandstone.
5. Kankar, ancient and modern.
6. Shell limestone.
7. Common granite.
8. Basalt.
9. Lateritic iron ore.
10. Sienitic granite.
11. Black soil.
12. Alluvium.