
77°
78°
79°
80°
13°
12°
11°
Madras
Perumpaucum
Chaultry
Poonamallee
Tirrivapoor
Allampaucum
Arcot
Vellore
Pallicondu
Amboor
Vaniambaddy
Pallar R.
Gorcattum
Soulgur
Eastern Ghauts
Baitmunglum
Golcondapalnam
Shamarpilly
Colar
Bangalore
Chinnapatam
Mundium
Seringapatam
Mysore
Nunjengode
Cavery R.
Tripatoor
Trimolcor
Darampoory
Adamcotta
Poncar R.
Goondlapet
Gocalvor
Neelgherries
Mollipolium
Avanashy
Errod
Chengapilly
Palliapolliam
Sankly-droog
Choultry
Woomaloor
Salem
Coleroon R.
Cavery R.
1. Granite
2. Sienitic Granite
3. Pegmatite
4. Protogine
5. Hornblende Rock
6. Gneiss
7. Hornblende Slate
8. Silicious Slate
9. Actynolite Slate
10 Eurite
11 Porphyry
12 Sienite
13 Basalt
14 Kaolin
15 Conglomerate Laterite
16 Lateritic Detritus
17 Quartzy Detritus
18 Magnesite
19 Ancient Kankar
20 Tufaceous and Nodular Modern Kankar
21 Magnetic Iron ore
22 Stalactitic Iron ore
23 Chlorite Slate

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1.—*Notes on the Geology of the Country, between Madras and the Neilgherry Hills, viâ Bangalore and viâ Salem.—By* P. M. Benza, Esq. M. D. *of the Madras Medical Establishment.*

" What benefits has not Geology reaped from the activity of industrious individuals, who setting aside all theoretical views, have been content to exercise the useful and entertaining occupation of collecting specimens from the countries which they visit."* J. F. W. Herschel.

Before entering into the detailed remarks on the geology of the places I passed through, I think that a concise statement of the geological features of the plain near Madras, would be of some utility to the generality of readers, inasmuch as it would make them acquainted with the names and nature of the rocks, which they must have seen often, and to which reference is frequently made in these Notes.

Granite seems the lowest rock in almost all localities of this plain, and it is composed, in general, of the three usual minerals, quartz, felspar and mica, their relative proportion varying occasionally (No. 1). †

In almost all the borings for the water, and excavations for tanks and wells, which I have had an opportunity of visiting, granite has been always the lowest rock.

This rock is observed also at the surface of the soil, forming clustered masses of rock, or small eminences, in many parts of this plain;

* A Preliminary Discourse on the study of Natural Philosophy, page 133. Lardner's Cabinet Cyclopedia, 1831.

† The figures refer to specimens, intended for deposit in the Museum of the Society.—*Editor.*

such as to the right of the road from Madras to the Mount, just after passing Marmalong-bridge—also a mile farther up, close to the right bank of the river—near the little Mount—to the west of, and few yards from, the Race-Course—in which places the clusters of granite are intermixed with those of pegmatite (No. 2)—at the foot of Palaveram Hill, in one of which the granite contains garnets, in addition to the other minerals (No. 3)—and probably in many other places, which have not come under my observation.

In more than one locality, this granite loses the mica and becomes pegmatite, one of the granitic rocks most apt to decompose, forming white clay, or kaolin (No. 4); as may be seen at the western extremity of the Mount—along the right bank of the Adyar river, below Marmalong-bridge—between the native village, at the foot of the Mount, and the Race-Course; and in many other places.

Considering this superficial position of granite over the whole plain of Madras, it would seem more than probable that boring for water cannot be attended with success in any part of it.

Porphyritic boulders are not a rare occurrence in this plain, of which I have seen some between Guindy and Trimatoor, and at the foot of Palaveram. This porphyry is formed of well defined and separate crystals of white felspar, imbedded in a paste of the same mineral in the compact state (No. 5). Not a tract of hornblende, and very few plates of mica, are found in this porphyry.

In the little eminences of this plain, hornblende slate, occasionally passing into hornblende rock, overlays the fundamental rock; such is the case at the Mount, at Palaveram, etc. (No. 6).

The stratification of this rock is clearly seen in every place where it exists; many of the contorted strata being composed of coarse materials; others although having the same minerals, are in a more comminuted state, forming a finer grained stratum. In this rock the variety of proportions of the minerals composing it is endless; in some blocks we see strata of hornblende only; in others, of felspar and quartz, and, in others, of simple quartz; which last mineral occasionally intersects the strata at all angles, and in different directions, in very thick veins.

The huge masses of hornblende rock on the summits, or on the sides, of these hills, contain very little felspar, and having the appearance of being unstratified, the hornblende being foliated, shining and nearly black; in short it is the primitive greenstone, which is found all over India (No. 7). Its fracture is splintery, and the texture, like that of all green-stones, very tough and compact.

We must not omit mentioning in this place a rock which extends nearly over the whole plain (at least the eastern part of it), overlaying in many places the granite. I mean the conglomerate laterite, which

is observed in two different conditions, that of undisintegrated and that of a detritus.

The conglomerate laterite is seen, in its entire state, on the banks of the Adyar (where the blocks for the Break-water are quarried), overlaying the pegmatite—close to the Race-Course, going to the native village under the Mount, on a granitic block; and perhaps in other places (No. 8).

The detritus from this rock has two geological positions; the one as loose rounded pebbles, scattered all over the surface of the plain; the other as a substratum to the soil. This last has sometimes many feet thickness, imbedding occasionally undecomposed pieces of the compact conglomerate laterite, which proves that the detritus is derived from the present conglomerate (No. 9).

In more than one locality of this plain a stratum of nodular kankar is found between the lateritic detritus and the granite (No. 10). In some of these places (Guindy-garden near the Tank, south of the House) it is like earthy, friable, calcareous tufa, having pieces of granite imbedded in it (No. 11).

Trap is not unfrequently met with, either in loose blocks, or in dykes apparently of considerable dimensions. These last are to be seen between Palaveram and Trimatoor, where they are nearly level with the soil, or forming small swellings on the ground. Both the boulders and the dykes are composed chiefly of basaltic hornblende (No. 12). These dykes, as I have mentioned in another publication, are of a very frequent occurrence in India (*a*).

The surface of a portion of this plain, particularly near the sea, is sandy in some places, having minute grains of disintegrated garnets, which are derived from that mineral contained in the granite, and in the hornblende slate of the Hills about (No. 13).

Before finishing the geology of the plain of Madras, I must mention that in the clayey stratum, which, in some places inland, underlays the sand, marine organic exuviæ have been found, according to information I have received.

The investigation of the existence of these fossils is of the highest possible geological interest, and it would be doing the greatest service to science, if zealous individuals, resident in the Carnatic and along the Coromandel Coast, would collect specimens and facts on this subject, which is one of the *desiderata* in Indian geology.

Hitherto we have but few observations on the subject. Dr. Voysey was, I think, one of the first who mentioned the existence of marine and fresh water shells, in a fossil state, in the south of India (*b*). Colonel Cullen of the Madras Presidency deposited, as far back as 1822, in the

(*a*) Journal of the Asiatic Society of Bengal, August 1835, page 432.
(*b*) Journal of the Asiatic Society of Bengal, 1833.

Museum of the College of Madras, shell-limestone found by him at Paddapangallee in the Northern Circars, a few miles west of Rajamundry, and nearly forty miles from the sea shore, underlaying basalt. I was fortunate enough, in the year 1835, to visit one of those interesting hills in his company; some oyster shells are well preserved in this limestone. Lately, Mr. Malcolmson of this Presidency, has given a more detailed account of the geological position of the fossil shells, found under the trap between Hyderabad and Nagpoor.

These geological appearances seem to countenance what is said in the Puranas, "that it has been handed down by tradition, that the "greatest part of the Coromandel Coast was suddenly elevated out of "the sea." (*a*)

Having given the foregoing cursory sketch of the geology of the environs of Madras, we may proceed to the description of the geological appearances of the places examined during the two Journies.

Allampaucum.—The monotonous plain, between Poonamalee and this place, offers nothing of any interest to the geologist, except the existence of a few straggling pieces of a chloritic slate, probably derived from some of the hills which are seen at some distance.

Near the Bungalow of Allampaucum the protruding rocks are composed of foliated felspar of a pale flesh colour, in some places decomposing, but not to such a degree as to form clay (No. 14). This felspathic rock occasionally imbeds angular pieces of white transparent quartz, and, *vice versa*, the quartz imbeds the felspar (No. 15).

The surface of the soil is bestrewed with a prodigious number of quartz pebbles, the angles of which are often worn down (No. 16). These pebbles originate in the disintegration of the huge veins of quartz, seen protruding through the soil, the imbedding felspathic rock having decayed.

These quartz veins are seen intersecting this rock close to the outlet of the large tank near the Bungalow, where is also observed the two minerals imbedding each other reciprocally. Not a few of these pebbles have their surface of a red color, which extends for some lines into their substance. It is the effect of the infiltration of oxide of iron *after* the disintegration of the vein, since the colour of the quartz in the rock is perfectly white and transparent (*b*).

Goriattum.—Approaching Goriattum the country loses the flat, tiresome appearance it hitherto had, and becomes hilly and pleasantly variegated with inequalities of the ground, and majestic arboreous vegetation in the ravines, and on the declivities of the hills.

(*a*) Heyne's Tracts, &c. But, curious enough, afterwards he adds, "but the appearances of the low lands renders it evident that the tradition cannot be correct!" page 1.

(*b*) I think it is what Buchanan call quartz impregnated with iron.—Vol. 1. page 31.

The greatest number of the projecting rocks, and of the rolled masses in the river close to the Bungalow, are granitic, both the common and the sienitic (No. 18).

As I was anxious to pass the eastern Ghauts by day-light (the party intending to pass in at night) I left Goriattum before them, and, as I thought, early enough to reach the Ghauts before sun-set.

Proceeding west, the country puts on a pleasing aspect, being interspersed with hills and vallies, which relieve both the mind and the eye from the wearisome sameness encountered before, and delights the inquiring traveller, offering objects of scientific interest.

Many hills and clustered masses of rock are seen in all directions; and on the convex sides of many of the former are placed saddle-shaped, immense cubic masses of rock, the remainder, and more depending portion, of the laminæ to which they belonged, having been hurled down into the plain. Others have these blocks, tor-like, on their summits.

Judging from the many rocks I examined near the road, all these hills are granitic, the rock being traversed by thick veins of quartz. Here and there in the plain I saw numerous pieces of quartzy magnetic iron ore, so common in the south of India; and in one place I saw an immense bed of it projecting above the soil.

Approaching Sautgur, numerous beds of a chloritic rock are seen, sometimes porphyritic; and in other masses, the minerals being distributed either in strata, or uniformly through the substance of the rock, it becomes a protogine (No. 19).

The clustered masses of rock in the plain, below the hills of Sautgur, are of sienitic granite (No. 20), intersected, as usual, by thick veins of quartz. When these veins happen to be found down the precipitous, naked face of a hill, and in a direction perpendicular to the horizon, the rock intervening between them decaying, these project above the vertical surface of the rock, which appears as if furrowed, or fluted. One of the hills of Sautgur has this appearance.

This sienitic granite, besides the hornblende intermixed with the other minerals, has nests of it formed of the pure foliated mineral, or in a granular state, with some pieces of compact felspar, so as to resemble hornblende porphyry (No. 21).

All the plain below these hills is bestrewed with numerous pieces of quartz and of foliated felspar, this last mineral being regularly crystalized, and its surface shining when seen at an angle with the light (No. 22).

On both sides of the road are seen, nearly level with the soil, the convex surfaces of large masses of a porphyritic rock, composed of regular crystals of red felspar, hornblende and a lively pistachio coloured substance—(chlorite ?) (No. 23).

The approach to Laulpet is exceedingly picturesque, on account of the many hills surrounding it, and the beautiful valley, so well cultivated with gardens, and fruit trees. The magnificent Mosque, close to the road, heightens the beauty of the scene, which receives no trifling additional ornament from the majestic Tamarind trees near the river.

The country, on both sides of the river, is alluvial and sandy, and after two or three miles it is interspersed with hills and knolls. On their summits, or sides, are seen rounded blocks, like logging stones; and it is remarkable that this conformation obtains oftener on the hills to the right, than on those to the left, of the road. Does this appearance indicate a difference in the rocks of both sides?

Having miscalculated my time, or lost more of it than I was aware of on the road, it was nearly sun-set when I reached the first little ridge which forms the beginning of the pass. This ridge is hardly two hundred feet above the level of the plain, and, in the section for the road, I could clearly see that the rock of which it is formed is sienitic granite (No. 24).

A torrent divides this little ridge from the high hill, up the steep acclivity of which the pass is cut. It was dark, and I was obliged in consequence to make use of torches, when I began the ascent, therefore I could see but little of the nature of the rocks forming this second hill. Yet on examining, afterwards, the specimens I had detached from the huge masses which had been blasted both on the floor and on the sides of the road, I found that this second hill, like the first, is formed of sienitic granite, with this slight difference, that, in some of the specimens from this last hill, there were a few plates of mica in addition to the other three minerals (No. 25).

Among them I found one which seems interesting, and the composition of which resembles an analogous rock found at Chinnapatam, to be described hereafter.

It resembles red porphyry, but it has nothing porphyritic in its structure, being composed of red foliated felspar—fracture rather shining—honey-combed with numerous small cavities, which are filled with a yellow substance, some of them having a micaceous, brilliant, metallic powder, strongly magnetic. In this specimen I saw no quartz which, however, is found in the rock of Chinnapatam, (No. 26).

Baitmungalum.—At this place we all were agreeably surprised and delighted, at being treated at breakfast with grapes, peaches and apples, of an exquisite flavour, the produce of the country about*—the climate being so mild, and the appearance of these European dainties on the table, carried us irresistibly, in imagination, to Europe, and me, in particular, to dear Italy.

* From Bangalore or Palamanair?

After passing the eastern Ghauts, the rocks met with on the road to Baitmungalum are gneiss, the contorted strata of which are seen almost in every one of the blocks (No. 27).

This gneiss is similar to the same rock found in many other places in India, and, like it, has some of its strata almost exclusively formed of mica, with a few grains of quartz; and, in this last case, a hand specimen of it might be taken for mica slate (No. 28).

This last mineral (like hornblende in the sienitic granite) is occasionally contained in nests in this gneiss; and, mica being easily decomposed, it falls off, leaving small cavities on the surface of the rock, which are seen in many of the masses about Baitmungalum.

Going a mile or two west, and before coming to Golcondapatnam, the granitic blocks are scattered about all over the plain, particularly near the last mentioned village; they look like erratic blocks, and are easily recognized as granite by their appearance, different from those of gneiss, which have hardly any elevation above the soil, with a rounded convex surface; while the granitic clusters are more elevated and affect either a prismatic form, or are piled up one on the other like logging stones. Those close to Golcondapatnam, at the foot of which some batteries have been erected, have this last appearance.

In the dry bed of a river, before arriving at the last mentioned village, I saw a thick basaltic dyke, which stretched across the whole breadth of the river, its outgoings being split into rhombs, or parallelopipeds. This dyke appeared to have burst through the granite (No. 29).

Looking attentively to the numerous blocks of granite scattered about this plain, particularly those about a mile or two north of Golcondapatnam, the idea presents itself, almost involuntarily, to the mind, whether these masses are not erratic boulders, similar to those found in the plains of Sweden, Russia and northern Germany, and which, it is now ascertained, were derived from the Scandinavian mountains, very likely at the time of their elevation.

Brongniart (*a*) is of opinion that the boulders near Hyderabad are of the erratic kind, quoting the authority of De Luc (nephew); and, really, seeing on a level and perfectly horizontal plain (no hills of any magnitude being within many miles of them) these sometimes solitary, unconnected boulders, scattered in the most irregular manner, and, at others, heaped together confusedly in clusters and groups, the opinion of some geologists, regarding the erratic nature of these boulders in India, does not seem improbable.

This granite exfoliates in concentric laminæ of different thickness; nor are the causes producing this exfoliation confined to the mere sur-

(*a*) Tableau des Terrains, &c. page 83.

face, but they extend their action many inches into the substance of the rock, producing in consequence three, four or more laminæ, which, although having decided lines of demarcation, still adhere to the parent rock.

In this sienitic granite nests of green-stone porphyry are imbedded, as is the case almost in all localities in India, where this rock is found (No. 30). Their decomposition, and consequent falling off, accounts for the cavities we see occasionally on the surface of this rock, at the bottom of which it is not rare to find the remains of the old tenant (the nest of hornblende porphyry) still adhering undecomposed.

Proceeding west, towards Shamarpilly (just after leaving Golcondapatnam) ; to the left of, and close to, the road, is a little oblong knoll, or rather undulation of the ground, having at the top many blocks, different in colour and appearance from the granitic boulders just described. These are of a blackish colour, and covered with large patches of the all-pervading lichens (No. 30).

They are hornblende rock containing very little felspar—structure semi-foliated, and fracture glimmering. Numerous quartz veins intersect it irregularly and in all directions, some of them being nearly a foot thick. They are discernible from a distance on account of the contrast between their white colour and the black of the rock. In those masses in which the hornblende decays, they are seen projecting above the soil like beds of quartz rock.

The direction of this dyke-like bed of hornblende rock is N. and S. and its decomposition imparts to the soil in its vicinity a red ferruginous colour, different to that about Golcondapatnam, which is loose, white and sandy. The cause of this colour must be the oxide of iron, which appears to enter largely in the composition of the hornblende ; since, like other primitive green-stones, it affects the magnetic needle.

Among the rocks, before reaching Bangalore, gneiss seems to predominate. It is composed of the usual minerals, forming regular strata conformable to each other, in some of which at one time the mica, and at others the quartz, predominates, sometimes to the exclusion of the other two minerals (No. 30). The quartz is white and transparent, the felspar of a paler hue, and the mica black.

Bangalore.—In the vicinity of Bangalore, gneiss is seen every where, having veins of quartz, or of foliated felspar, or of both together, traversing it. It seems to decompose, or to have decomposed, to a great depth, since we see the loam resulting from it very abundant all about Bangalore, and in some places having twenty, or more, feet depth; such is the case near the bazar behind the Barracks (No. 33). The clay that is found in this loamy soil is reckoned excellent for tiles, bricks, &c.


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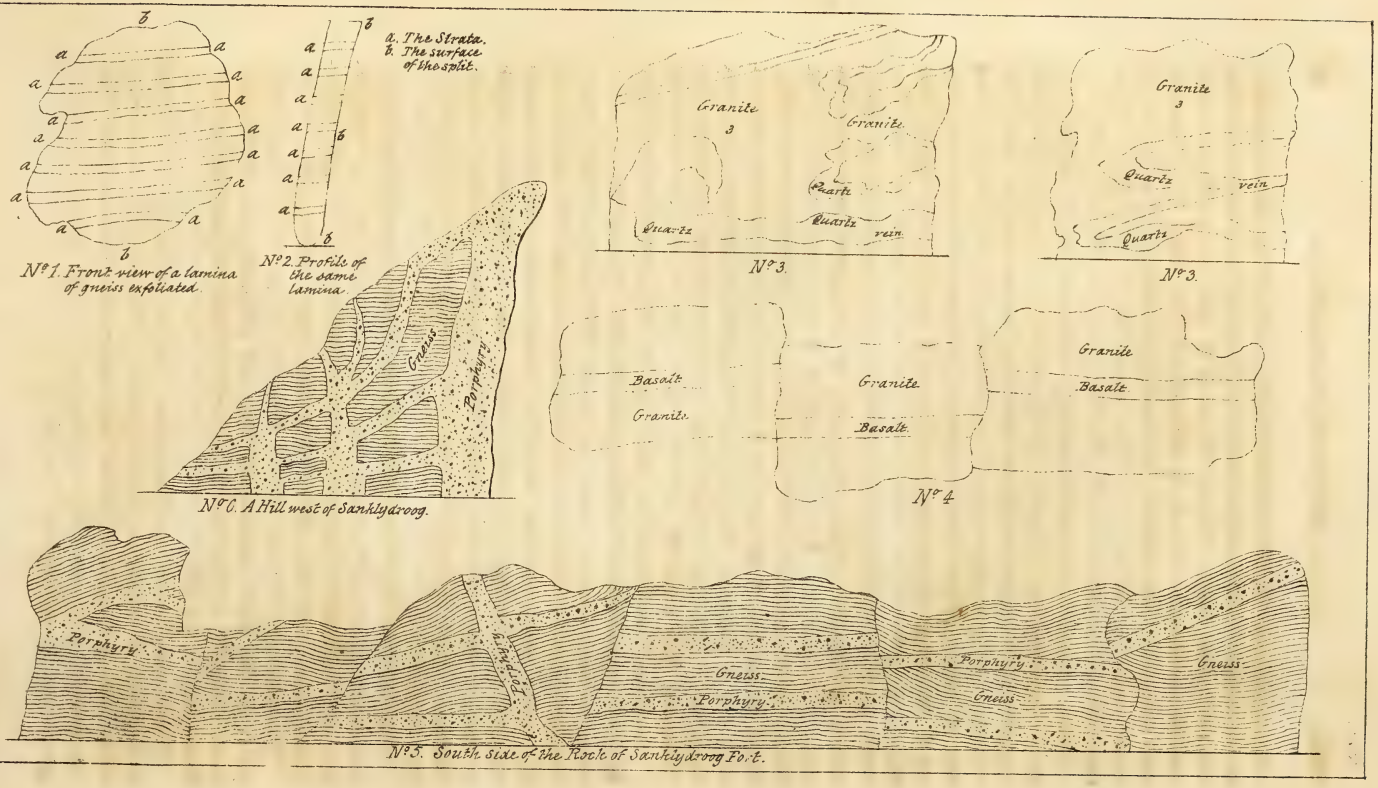
a. The Strata.
b. The surface of the split.
Nº 1. Front view of a lamina of gneiss exfoliated.
Nº 2. Profile of the same lamina
Granite
3
Granite
Quartz
Quartz
vein
Nº 3.
Granite
3
Quartz
vein
Quartz
Nº 3.
Basalt
Granite
Granite
Basalt
Granite
Basalt
Nº 4
Gneiss
Porphyry
Nº 6. A Hill west of Sankly droog.
Porphyry
Gneiss
Porphyry
Porphyry
Gneiss
Gneiss
Nº 5. South side of the Rock of Sankly droog Fort.

Going towards the Fort or Pettah, a few yards before the cause-way, we see immense masses of gneiss,on the convex surface of which are thick veins of quartz and of felspar. In many of these veins, which contain both these minerals intermixed, the surface is sometimes honey-combed with numerous little cavities ; an appearance which is owing to the decomposing and falling off of the felspar-pieces, leaving the places they occupied empty.

I must remark here a peculiarity in the structure of this gneiss ; viz. that of splitting, both naturally and artificially, into laminæ, the direction of which is nearly perpendicular to that of the seams of the strata. In fact, in the laminæ naturally detached from the rock, we observed that the strata are seen either horizontal, or vertical *on the surface* of them ; therefore the laminæ exfoliate in a direction at angles with these strata.

We see in all stratified rocks that they generally split in the direction of the strata; so that the surfaces of separation shew only the surfaces of the seam. But, in the laminæ of this gneiss, the case is different; on the surfaces of the laminæ we see the strata, and their seams along *the surface* of the split, and therefore its direction is at an angle with that of the seams themselves. The annexed diagrams shew perhaps better than any words what is meant in the above remarks (Diagram, Nos. 1 and 2).

It appears that the natives have availed themselves of the peculiarity this gneiss has, of splitting in a direction opposite to that of the strata, to obtain laminæ of any thickness. The process to that effect is very simple and economical. On the convex surface of the gneiss they light a fire, the intensity of which is proportionate to the thickness of the slab to be obtained; and, after having kept it up for such a length of time, as experience has taught them necessary for the required thickness, they extinguish it, and pour cold water on the heated surface of the rock.

This sudden refrigeration producing an instantaneous contraction of the heated portion of the rock, extending as deep as the heat had penetrated, it is detached at that depth from the parent rock, and the lamina is easily removed, and cut in as many pieces as required.

The curvature of these laminæ being the segment of a very large circle, in the small dimensions they are generally cut they appear nearly straight, and are used for all architectural purposes, as columns, door-posts, steps, &c.

I have read, I do not recollect where, that the foregoing process is had recourse to, at Bangalore, to split granite. This must be a mis-statement, since at Bangalore, as well as in many other places in India, they use another, and very different, method to split granite, porphyry, green-stone, or other unstratified rocks.

This consists in making several square perforations, little more than an inch deep, with a hammer and a steel punch, in the rock, in a line, and in the direction they wish to have it split. This done, they put wedges in the holes, and strike on them with force, until the granite breaks (*a*). In fact, many of the granitic blocks about Bangalore bear the marks of this last process.

When this gneiss exfoliates naturally (like the blocks of granite), the decomposing causes act deep into its substance, detaching three or more laminæ at the same time. When I say that this gneiss exfoliates both naturally and artificially in laminæ, at an angle with the seams, I do not mean to exclude the possibility, nay the probability, of its often splitting in the direction of the seams. If my memory does not fail me, I think I saw this appearance in the two huge masses close to the nullah, which descends from the front of the barracks south. In the lower part of this nullah, going towards the bridge, the decomposition of the gneiss is clearly seen, perhaps more so than in any other locality about Bangalore.

On the western end of the Esplanade there are many blocks of granite, intersected as usual by numerous quartz veins, in the most fantastical way imaginable; diagram No. 3 represents two of them.

Going west along the road parallel with, and close to the Barracks, a few hundred yards beyond them, there are some clay pits for bricks and tiles; a fine tank, and a Mussulman burying ground are close to them; the steps of the tank being constructed of gneiss, the stratification of which is quite evident.

At this place, turning to the left, we get into the road which leads to the Pettah; for a little way all the rocks, right and left of the road, are granitic, split by numerous fissures both horizontally and vertically, so dividing the block into cubic masses (No. 34).

Proceeding a little farther on, in the field to the right, close to the road, masses of hornblende rock are seen protruding above the soil, in an uninterrupted continuation, with an east and west direction (No 35).

In this same field, flanking this bed of green-stone, are knolls and clusters of granite, through which, it would seem, the green-stone intruded. The thickness of the last mentioned rock, as far as its outgoings indicate, is seventy-two ordinary paces, the blocks extending, with hardly any interruption, for more than three hundred paces. Like many other primitive hornblende rocks, this affects the magnetic needle.

This dyke intersects the road extending a little way in the field to the left; it contains very little felspar, which in some of the masses

(*a*) See Buchanan's Journey, vol. I, page 133.

being totally wanting, the rock then assumes the aspect of basaltic hornblende. This rock, when decomposed, forms a red ferruginous soil.

About three hundred paces beyond the western extremity of this green-stone, there are some clusters of granitic blocks, some placed, tor-like, one upon the other. On examining one of them, I saw a basaltic dyke, traversing it in an east and west direction, having entered the block from the west ; since its thickness on that side is about five inches, and getting thinner as it advances east, it is finally lost in the substance of the granite (No. 36).

Guided by induction, I surmised that probably the dyke, before reaching this block, may have traversed those that were seen about fifty paces west of the first cluster, in which case the trap must have a greater thickness than in this, where it appears the dyke spent itself. My conjecture proved correct, since I saw two distinct dykes of basalt traversing, in all their length, two granitic blocks in this second cluster (No. 37), and of greater dimensions than that in the first rock.

These second masses of granite are not so large, nor so prominent above the soil, as the former ones. They are hardly three feet above the ground, and extend about sixteen in length. In one of them I saw a dyke of very compact basalt, the fracture of which is dull and its texture extremely tough. It has an uniform thickness, all its length, of about three feet, stretching the whole length of the rock. The surface of this basalt was divided into rhomboidal pieces.

In the other block of granite there is a second dyke of smaller dimensions, and only a few feet from the former. The mass, through which this second dyke passes, seems to have suffered displacement from two splits, which rent it into three pieces, displacing the middle one and causing a fault in the dyke ; the diagram No. 4 represents this fault. Both these dykes converge one foot in ten paces.

The granite in contact with the basalt appears to have lost its crystalline structure, and become more friable than the same rock at a distance from the trap. I would have pursued the examination of this dyke further west, but seeing no projecting rocks in that direction, the examination could not be followed up.

I do not recollect to have ever seen in India the gneiss so well characterised, and its strata so much contorted, as in the locality I am going to point out. North of, and near, the European cavalry barracks, there is an extensive tank, the waters of which are confined, on the east side, by an embankment. About the middle of this rises a huge rock, or rather hillock, about 100 feet above the level of the plain, formed of gneiss, the strata of which, as I said, are contorted in the most striking manner (No. 38).

The whole mass of this gneiss has the usual convex surface, and

exfoliates in thick laminæ, portions of which lay, like huge cubic pieces, on the convexity of the rock. The quartz strata of this gneiss are seen sometimes protruding some inches above the surface of the rock, for the reason so often mentioned in the course of these Notes; here, as elsewhere, the gneiss contains nests of mica.

Chinnapatam.—Along the road near Kingairee and Closepet, hornblende slate is the rock jutting above the soil (No. 39). The village of Chinnapatam is situated in a plain, and being surrounded by a dry ditch some feet deep, an opportunity is given of seeing the rock which underlies the soil.

In this ditch the lowest rock is gneiss, in many blocks the felspar being of a flesh colour (No. 40). This mineral, also, in veins, intersects the strata of the gneiss, the surfaces of contact being tinged with a green substance (chlorite ?) (No. 41). The stratification of the rock is clearly seen in the walls of the ditch, where it is in a decomposing state.

The greater number of stones of the walls which surround the village, the gate of the Fort, the several works, the door-posts and steps, are all of this gneiss.

On the outside of these walls, which are constructed without cement, I found some pieces of a rock, which I am at a loss what to denominate. In the few blocks I saw in the walls, the rock seemed unstratified, having a porphyritic appearance. It is composed of red semi-foliated felspar, approaching to compact, and glittering—penetrated by numerous microscopic cavities, occasionally filled with a yellow clay, and containing grains of perfectly transparent white quartz, some of them in regular crystals of that mineral (No. 42).

I was inclined to call it porphyry, but, having lately examined other specimens from the same locality, in which the stratification of the rock is quite evident, I forbear giving a name to it *(a)*.

Mundium.—All the rocks between Chinnapatam and Mundium, and for some miles round, are hornblende slate, intersected in all directions by numerous quartz veins, of divers dimensions and shapes. The soil about the Bungalow is bestrewed with quartz stones and pebbles, chiefly angular, resulting from the breaking up of the quartz veins of the hornblende slate.

In the vicinity of Mundium I picked up some loose pieces of talc-slate, mica slate, actynolite slate, indurated asbestos, green-stone, &c. (No. 41).

(a) Since my examination of this rock I have read Mr. Hardy's remarks on the geology of the country in the route from Baroda to Udayopoor, &c. where he describes apparently on analogous rock, but his is stratified, and he classes it among the varieties of granite.

Seringapatam.—As we remained but a few hours at Seringapatam, my geological observations of that place were very cursory; therefore what I am going to say of its geological features, is the result of the desultory examination of a very confined spot. The localities I visited were the ditch which surrounds the Fort, and the bed of the Cavery.

On entering the Fort by the southern gate, and descending in the dry ditch below the bridge, I remarked the following appearances. The walls of the ditch show a stratified rock in a decomposed state; it is gneiss, abounding with mica, which forms, often exclusively, entire strata, as is the case at Baitmungalum, Bangalore, &c. (No. 44).

Proceeding west along the ditch, towards the Mysore gate, we meet with thick beds of a silicious slate, traversing the gneiss at different places and in all directions. It is probably what Buchanan calls hornstone as found about this place, and in the island of Seringapatam, called by the natives *madi-culla (a.)* No. 45.

The strata of this silicious slate have many feet thickness, and are traversed in all directions by numerous, almost imperceptible, fissures, in the direction of which the rock, when struck, often splits, showing on both surfaces of the separation beautiful, superficial, dendritical appearances, like those occasionally seen in the alpine limestone, and in some novaculites (hones) of the clay-slate formation, produced by the infiltration, through the fissure, of the oxide of manganese, at least as far as it regards the limestone.

This silicious schist, besides intersecting, as veins, the gneiss, overlays it in some places, as is seen, on entering the Fort by the Mysore gate, to the right, where it lays in large tabular masses over the gneiss.

A little farther on, going always west, we see masses of hornblende rock, overlaying the two rocks just described. This green-stone, both as blocks and as dykes, I had seen soon after descending into the ditch below the bridge (No. 46).

This hornblende rock hardly contains any felspar, and it is evidently unstratified—sonorous when struck—of glimmering fracture—and of a black colour. The elegant columns of Hyder's and Tippoo's Mausoleum, beyond Shahar Ganjam in the Island, are of this rock, which however was brought from a different place, as Buchanan informs us, viz. from Cuddahully near Turivicary, about 52 miles from, and N.E. of, Seringapatam, and called by the natives *Carricullu*, or black stone *(b)*.

Some of the masses of this hornblende rock have a variolated surface, which, however, on breaking the stone, does not *seem* to extend into the interior of the rock. I say *seem*, because, polishing on the

(a) Buchanan's Journey, vol I. page 133.
(b) *Ibid.* vol. II. page 61.

stone, the rounded marks re-appear and of a deeper colour than that of the rock itself.

Buchanan took particular notice of these darker spots in the polished rock, and attributed them to the crystals of basaltine *(a)* (so was augite called at the time he wrote) imbedded in the hornblende; in which conjecture I think him perfectly correct, as the mineral is augite which gives the described appearance to the rock, and it is seen clearly marked in the above mentioned columns of Hyder's Mausoleum.

It must be remarked that the veins of the silicious schist, intersecting the gneiss up to its surface, do not penetrate into the overlaying greenstone, showing the posteriority in age of the last mentioned rock.

In going out of the Fort through the northern sallyport, close to which Tippoo was killed, you come upon the right bank of the Cavery, which washes the walls of the Fort at this place. When I visited Seringapatam (March 1834) there being very little water in the river, all the rocks forming its beds were exposed to view, enabling me to judge of their nature.

The principal rock in it, is gneiss, which appears to extend along the course of this river for a considerable distance; since I have met with the same rock, jutting above the waters of the same river, at the ferry of Polleapoliam, nearly 100 miles S. E. of Seringapatam. This is one among the many proofs that gneiss is the universal subjacent rock in the table land of Mysore.

Mounting some of the masses close to the outside sallyport, you stand on blocks of a beautiful porphyry of red colour. This rock cuts the gneiss in the bed of the river in an oblique direction N. E. and S. W. across its whole breadth, and is seen continued on the opposite bank, a little below the northern extremity of Wellesley-bridge.

This porphyry (No. 47) is composed of well defined crystals of red felspar, which occasionally are white, imbedded in a paste of compact felspar of the same colour. Besides these two minerals it contains tourmaline, in numerous needle-shaped crystals distributed through the rock, without having any common direction. The red colour of this porphyritic dyke, through the grey of the gneiss, points it out even from a distance.

Among the numerous pieces of rock, scattered about the western side of the Fort, are found some of a stratified rock of a porphyritic appearance, composed of red felspar, imbedding pieces of white transparent quartz, and having thin veins of beautiful pistachio-coloured actynolite (No. 48).

Just below the southern extremity of Wellesley-bridge, along the right bank of the Cavery, I noticed an enormous accumulation of a friable calcarious tufa, somewhat resembling *osteocolla*, or those calcari-

(a) Buchanan's Journey, vol. II. page 61.

ous incrustations enveloping vegetable substances, when placed in the course of waters abounding with carbonate of lime (No. 49). Many pieces were analogous to the nodular kankar found in the plains of India. From what I shall mention hereafter, it appears that some of the tributary torrents to the Cavery contain a good deal of carbonate of lime.

The hill of Mysore I could not visit, but judging from some specimens I have seen from it, it is formed of granite composed of white and rose coloured quartz, white felspar, black mica and a few garnets (No. 50).

Nunjengode.—Close to Nunjengode flows one of the branches of the Cavery, over which a bridge of fifty-five arches is thrown, and in this place many torrents discharge their waters into it. One of these rivulets appears to have its waters overcharged with carbonate of lime, which is deposited all along its course, from its junction with the Cavery upwards.

Over this torrent, where the road crosses it, there is a small bridge, below which the high banks of the torrent are entirely formed of calcareous tufa (No. 51). In this spot the deposit is so white, so spongy and light, that it might be taken for pumice.

A few yards above the bridge of this rivulet we see on both its banks a stratified rock; it is chlorite slate (No. 52); its fracture being dull and earthy, and intersected in an irregular manner by veins of different thickness, both of white quartz and of red felspar, which, with the green of the chlorite, form a very elegant looking stone (No. 53). The red felspar veins, however, do not occur so frequently.

Among the seams of this chlorite slate, the same kind of calcareous tufa is deposited, which not only penetrates for some lines into the seams, but also projects some lines, and even inches, beyond the surface of the rock, like fungous, or mammillated, excrescences.

As the strata of the chlorite slate are not in perfect coaptation, the seams gape a little, and the carbonate of lime insinuates itself pretty far into them, so that when the projecting blistered portion of the calcarious deposition is broken off, a thin stratum of kankar is seen between the strata of the slate, and might be taken as an inter-stratification with them. But, by examination it is soon seen, that this calcarious infiltration does not penetrate beyond a few lines.

Besides this new kind of kankar, I found, jutting from the soil or loose on the surface, large pieces of the ancient kankar (No. 54), which is very different from the modern, being more compact, semi-crystalline and sparry in the fracture, and concretionary in its structure; in short, very much resembling the ancient *travertino* of Italy.

All the blocks along both sides of the Cavery, and projecting above

the water, are hornblende rock, with thick veins of quartz, which seems also to be the prevailing rock all over the plain.

Goondlapet.—This is a walled village, with a dry ditch round it, which gives an opportunity of examining the rocks below the soil, while the different kinds of stones, employed in the construction of the walls, show those which prevail in this neighbourhood.

Many of them have a stratified appearance, in which the prevailing mineral is actynolite, with hornblende and a flesh coloured felspar (No. 55). In the walls I also found many blocks of a very crystalline sand-stone, and some of quartz rock (No. 56); there are stones of a beautiful chloritic porphyry (No. 57), some of green-stone, of gneiss, of granite, &c.

All these stones must have been brought from some distance, since the only rock about the place, *in situ*, is the actynolite schist, to be seen in the lower parts and floor of the ditch, and in the streets of the village (No. 58). This schist has strata of quartz, conformable to those of the slate.

Between the western wall, and the houses of the village, the actynolite schist is coated with a thick deposition of ancient kankar, as hard as the old travertino, although its texture is not so crystalline. It is composed of a calcarious paste of a grey colour, imbedding chiefly angular, or slightly rounded, pieces of a reddish limestone, besides pieces of quartz, actynolite slate, hornblende, felspar, talc, &c. In short it forms a real breccia.

Besides incrusting the schist, this ancient kankar is seen in large isolated pieces implanted in the soil, and in the streets of the village.

Goodloor.—Goodloor stands at the commencement of the ascent to the Neilgherries, at the foot of a very high hill of the Wynaad group. The blocks all about the village are sienitic granite.

End of the first Journey.

Second Journey.—The geological appearances of the country, between Madras and Allampaucum, having been described in the foregoing pages, I shall begin the notes of the second journey from the last mentioned place, whence we diverged towards the south.

Leaving Allampaucum, and proceeding west, the blocks, on both sides of the road for some miles, are of foliated felspar with very little quartz (No. 59).

As we approach Arcot these masses in the plain are granite, and we are informed by Buchanan that the hills about Arcot and Vellore are granite (*a*) (No. 60).

(*a*) Journey vol. I. page 17.

Judging from the numerous blocks of basalt, loose, and protruding through the soil, and with which the water courses (where they intersect the road) are paved, trap must be abundant in this vicinity, either as dykes or as an overlaying rock (No. 61). Nevertheless, with the assistance of a powerful telescope, I could not distinguish any different coloured rock, either at the summit, or on the sides, of these hills.

On approaching Arcot, the first hills we see have the appearance, characteristic of many others in the plains of India. They shoot up in a conical form from the horizontal plain, and have the appearance of a cone placed on a table. No talus round them, no rising ground, no inequalities in the soil above them, but the line of demarcation, between the foot of the hill and the plain, is sudden and decided. This appearance is the same, when the hill has a ridgy form instead of the conical.

The hills which succeed these have a different aspect—the first, being granitic, have sharp outlines and a barren naked appearance; the latter are rounded, with very few rocks projecting, and are covered with thick vegetation. Close to the road I saw some boulders of a chloritic stratified rock, similar to that near Sautgur.

Palliconda.—This village is beautifully situated near the confluence of two branches of the Pallar river. West of, and within a mile from, the Bungalow of this place there is a ridgy hill with a N. and S. direction, which, in my opinion, is very interesting in a geological point of view.

In the year 1834, while halting at this place, I made an attempt to ascend this hill, but I was baffled, on account of the many difficulties I met at the place where I endeavoured to scale it (about the middle of the ridge).

This second time, however, having taken a good guide, I started for the summit, south of the ridge on which the pigmy Pagoda, dedicated to Chillima Kali, stands—and, although I succeeded in reaching it, I underwent more fatigue than I had anticipated.

There is neither road, nor even a foot path up to the summit, and the guide led me scrambling along the furrows of small water courses, as the only places which afforded a penetrable passage through the dense shrubby jungle, rendered almost impassable by the thick and tall tufts of the lemon grass.

This ascent caused me more fatigue than I ever experienced, even in ascending the summit of Vesuvius, for here I toiled an hour and an half to reach the Pagoda, and there I was on the brim of the crater in three quarters of an hour.

I was quite exhausted when I reached the huge mass on which the Pagoda is erected. The blocks of rock, in this place, are heaped up in the greatest confusion imaginable, having betwixt them terrific chasms,

over which you must leap to reach the Pagoda; and, in the weary state I was, it was rather a nervous feat to leap over an abyss yawning under the feet.

The view, however, from the summit more than repaid me for the labour I had undergone. The whole plain, for many miles on both sides of the rivers, was partitioned into thousands of fields regularly laid out like the beds of a garden, or park, presenting a most lively green expanse, which, carpet-like, was spread out over the plain. It was the new grain, growing luxuriantly in all places, that gave this lively appearance, while the rivers (then become one) were rolling their waters majestically through the plain which they rendered so fruitful.

The village of Palliconda itself is a striking object, in the midst of so much industry and fertility, but my eyes were wandering about in vain to find the habitations of the thousands, for whom Providence had so bountifully provided, and whose exertions produced so much fertility—Palliconda excepted, I saw no other village, or hamlet, in that plain.

Sitting on the pinnacle of the highest mass (higher than that of the Pagoda), I rested myself, admiring the magnificent prospect under me—I wished to enter the Pagoda, but a chasm intervened, which I would not venture to stride over, being on the brink of a precipice, the vicinity of which makes at all times giddy.

The rocks of which this hill is formed are very interesting to the geologist, as offering a luminous proof and example, how necessary and just is the distinction between *sienite*, properly so called, and *sienitic granite*; the former generally associated with eurite, porphyry, basalt and other trap rocks, and, therefore, differing in geological position, and posterior in age to the latter, which, although resulting from the aggregation of the same three minerals, is associated with primitive rocks, in primitive countries.

It was Dr. Macculloch, in his masterly description of the geological features of Glen Tilt, who first shewed that, besides the sienite associated with trap, there is a rock, having the same composition and aspect, but of a different age, being in an older geological position. The specimen,which served as a type for his nomenclature,was brought from the neighbourhood of Dresden, where the sienite is associated with porphyry and other trap rocks. Werner, seeing that the Dresden rock contained the same minerals as that of which some of the Egyptian sculptured works are formed, called it *sienite*, from *Siene* in Upper Egypt, where the material was quarried. Accurate observation proved to Macculloch that, besides the sienite so called by Werner, which is an overlaying rock of a posterior origin to granite, there was one in Glen Tilt, which, although composed of the same minerals, was associated and contemporaneous with primary rocks: in short that there was a

granite of primary formation, which contained hornblende instead of mica. By reasoning of this strictly scientific character, to avoid confusion, he proposed the term *sienitic granite* for the primary rock, reserving that of *sienite* for the overlaying rock, which is associated with porphyries.

As far back as 1813, Brongniart, in his classification of rocks, admitted the *sienite granitoïde*, which is synonimous with sienitic granite. Humboldt, in his *Essai geognostique sur le Gisement des Roches*, not only recognized the essential difference of the two rocks (the one an overlaying rock of posterior origin to the other, which he clearly states to be a true primary granite, with hornblende instead of mica), but he was the first to point out the mistake of Werner, who thought the Dresden rock to have the same geological position as that of Egypt.

From Europe let us pass to the writers of this country. Voysey adopted the name of sienitic granite in the same sense as the proposer of the term. Mr. Hardy (see his geology of Udayapoor) writes as follows: "the granite there is the true granite, viz. quartz, felspar and mica; sometimes this last is wanting, and then it passes into pegmatite, and then into sienitic granite; then into hornblende rock, some kinds of which resemble the green-stones of the trap formation."

This limited signification of the term sienite is perfectly correct, when applied to the rocks in some of the localities of southern India; the rock being there often associated with porphyries, as I have had more than one opportunity of observing at Tripatoor, Pallicondah, &c. where porphyry and eurite accompany it.

Many of the blocks scattered in the plains, between the foot of the hill and the Bungalow, are sienitic porphyry (No. 62), having well defined crystals of felspar, imbedded in a paste of hornblende, differing in this from the porphyry of Tripatoor (to be described hereafter), the paste of which is compact felspar.

Level with the soil, and near the skirts of the hills, there are numerous outgoings of basaltic dykes, decomposing in concentric layers (No. 63).

Proceeding to the foot of the hill the sienitic porphyry assumes the structure of true sienite (No. 64), that is, an uniform mixture of hornblende, felspar and quartz, not in regular crystals, which both in Europe and in America is associated with basalt, eurite and other trap rocks; this is also the case with this rock of Palliconda. As we ascend the hill we see the same rock, sometimes with a porphyritic, and at others with a granitic, structure. Indeed the transition between these two appearances is quite insensible, and often seen in the same block.

Dykes of basalt are found traversing this sienite, their direction being (at least of all I examined there, more than six in number) uniformly

that of the ridge itself, that is nearly N. and S. This of course must be understood of their trunks, because the ramifications had no particular common direction, but shot from their sides at different angles (No. 65).

This sienite, at the points of contact with the basalt, and for some inches in its vicinity, acquires a greater degree of hardness, the felspar assuming the appearance of the compact variety; while in the same block, at a distance from the basaltic dyke, the sienite is in a friable decayed state; the same changes in compactness occur in those pieces of rock which are entangled in the trap. In the sienitic porphyry it is not rare to find some veins of chlorite (No. 66).

On arriving at the foot of the masses below the Pagoda, a bed of an euritic rock is met with, seemingly in tabular masses, jutting through the sienite. It is of the same composition and structure as the blocks placed, mantle-shaped, on the declivity of the ridge further north, where it also appears to form the summit of the hill.

In appearance, this euritic rock resembles the silicious schist of Seringapatam, but I saw no fissures, nor dendritical infiltrations, in this rock. The smaller pieces of this eurite assume a prismatic form, well defined.

The huge masses at the summit are of a very hard, tough and compact sienite, its felspar being of a pale brownish colour, which, together with the black of the hornblende, gives to the rock a greyish appearance (No. 67). The soil resulting from the decomposition of this sienite is clayey, crumbling when dry, not tenacious, and of a grey colour.

Tripatoor.—About three miles from, and east of, the Bungalow of Tripatoor, there is a hill in the form of a ridge running N. and S. that is precisely in the same direction as that of Palliconda, which last seems to be a continuation of this of Tripatoor, having probably been erupted by the same convulsion, at the same remote period, and through the same fissure in the crust of our planet. It rises abruptly from the plain, having, in all its length, uniformly the same height, about eight or nine hundred feet above the plain. Its sides are steep, stony, and overgrown with thick bushes and a few trees. The only part I examined was about three miles along the foot of the south side.

Over the whole plain, before reaching the hill, were scattered loose masses and pieces of a porphyritic rock, which appears to form the entire hill. On arriving at its foot, we see nothing but porphyry, with an occasional block of sienite.

This porphyry (No. 68) is composed of regularly formed crystals, in general of a pale flesh colour, but, not unfrequently, they are white, imbedded in a paste of compact felspar, of the same colour as the crystallized mineral; so that the rock has an uniform hue.

These masses of porphyry, which are near the sienite (to be describ-

ed hereafter), having an intermixture of a little hornblende, are somewhat similar to those of Palliconda.

On the surface of some of these porphyritic masses, the crystals of felspar are more than an inch long, and project a little above the surface of the rock, on account of the partial decay of the imbedding paste. In the blocks of the porphyry which are near the sienite, there are nests of hornblende, and then the porphyry in contact with it has a reddish tint, probably from being penetrated by a little oxide of iron of the hornblende; of this porphyry the large blocks have a rounded form, the small ones are prismatic, pyramidal, &c.

Judging from the colour and appearance of the masses on the summit of the ridge, they are also porphyritic.

Proceeding eastwardly, about two miles along the foot of the hill, we meet two hillocks formed of sienite (No. 69), analogous to that of Palliconda, and having, like it, some thin veins, or grains, of chlorite.

In both these rocks I remarked many fissures, of which the direction is invariably perpendicular, never parallel, to the horizon, so that they assume prismatic, pyramidal, columnar, or spheroidal, forms. This sienite decomposes into a red soil.

Returning to the Bungalow, about half a mile from the foot of the hill, I saw jutting out from the soil, three or four large oblong masses, only a few feet above the ground, of a rock rather interesting, and rarely met with in India (No. 70).

It belongs to the endless varieties of the hornblende rocks, which, Proteus-like, change appearance and composition in every locality in this part of India. It is of a black colour—texture loose and friable—traversed by veins of quartz and of felspar. It is composed of bottle-green hornblende, intimately mixed with nearly the same quantity of black mica, in a greater state of hardness than usual. I think it is the same rock mentioned by the late Dr. Turnbull Christie, as found with numerous other varieties of hornblende rock, at the stupendous falls of Garsipa (*a*).

It is to be remarked that the portion of the rock, in contact with the felspathic or quartzy veins loses its colour, becoming of a light green, and powdery. Basaltic boulders are not rare in this plain.

The three rocks, already described as found near Tripatoor, are evidently unstratified; and, judging from the desultory examination of a small portion of the hill, it would seem that the porphyry overlays the sienite. It would be desirable that a thorough examination should be made by some geologist, who could devote a few days to the geological survey of this interesting mountain ridge.

Gneiss appears to underlay these three rocks already described—

(*a*) Edinburgh New Philosophical Journal, 1829, p. 8.

abounding with mica, of which alone some of the strata are exclusively formed. The outgoings of some are seen below the tank near the Bungalow, where the usual contortions in the strata of this rock are strongly marked (No. 71).

Adamancotta.—All the plain, in the vicinity of the Bungalow, and as far as the Cavery, has numerous quartz pebbles, some angular, and others rounded, which proceed, as every where else in the south of India, from the decomposition of hornblende slate (which is the surface rock at this place), and consequent disintegration of the quartz veins invariably intersecting it (No. 72).

The stratification in the rock here is well and clearly developed, the minerals composing it occasionally alternating in separate strata; so forming what might be called sienitic gneiss.

It is not an unfrequent occurrence in this schistous diorite to find some of the strata composed of two minerals only, to the entire exclusion of the hornblende; the felspar and quartz being regular crystals. In this case the rock assumes a pegmatitic composition, and, like that rock, decomposes into kaoline (No. 73).

Loose pieces of quartzy magnetic iron ore are frequently met with in the plain, but I was not fortunate enough to find any corundum, which, I have been informed, exists in this neighbourhood.

Salem.—The whole tract of country, between Adamancotta and Salem, is hilly, and full of inequalities, on account of the many branches and spurs, proceeding from the Shevaroy-hills, which intersect it in all directions.

The composition of the rock forming these hills is the same as that of those they are the prolongation of, that is, hornblende slate. I do not recollect to have seen the stratification of this rock any where in India (Mookoorty Peak excepted) better marked than in the hills through which the new Pass has been constructed, where the sections for the road shew it clearly, and also in the beds of small rivers near it (No. 74).

As in many other places in India, this schistous diorite near Salem, contains thick veins of quartz, which, protruding above the soil, form small knolls and ridges, which may be taken for a quartz rock formation; the general dip of the strata of this slate is west.

As we were to pass Salem by night, and the magnesite formation being situated only five miles before reaching that place, I should have been sadly disappointed, had I to proceed with the whole party, and to pass through it without seeing this interesting spot; so I had it arranged that, as soon as my Palanquin arrived at the place where the chunam is found (they call the magnesite so, thinking it lime), the

bearers should halt in the road till day-light, to enable me to satisfy my wishes, and then join the party at MacDonald's choultry.

I reached the magnesite at midnight, and remained in the road till day-light, when I got up and began my examination. About five miles N. W. of Salem, the schistous diorite, which we have seen forming all the hills in this neighbourhood, is intersected by numerous veins of magnesite, of different thickness, and crossing each other in all directions, so as to make an intricate net-work in the rock (No. 79).

The masses containing the magnesite have hardly any elevation above the soil, and the area, occupied by this formation, may have about fifteen miles circumference, the surface being undulated with a few knolls and nullahs.

Nearly all the veins of magnesite are vertical, and the only ones I saw in an horizontal position were those in the banks of the nullahs. These veins vary in thickness from a few lines to three or four inches, and they are not uniform in their dimensions, sometimes thinning, and at others thickening, along their course.

Generally speaking the rock intersected by the magnesite is decomposed into an ophitic stone (No. 80), sometimes quite friable and powdery; at others it resembles decomposed wacke (No. 81). Those masses of hornblende slate which have either very little magnesite or none at all, maintain their crystalline structure. In more than one block, between the magnesitic veins and the rock, I found thin veins of asbestos, of an indurated earthy structure, and in some other masses, instead of it, talc slate and nephrite (No. 82).

The outgoings of these magnesitic veins, in general, are rough and bristled with numerous sharp points; but many others, particularly the loose pieces, have a mammillated, botryoidal, or cauliflower-like, surface. In more than one of these last mentioned pieces the surface is excavated by little furrows (No. 83). These veins are nearly all formed of simple magnesite; there are, however, some in which the magnesite is contained in a breccioide mixture, its angular pieces being imbedded in a pale red kind of cement (No. 84).

This magnesite is extremely heavy and compact, so as to strike fire with a hammer; of course I mean the most compact kind. Its fracture is semi-conchoidal, earthy, and has the dull waxy appearance of some of the varieties of the alpine lime-stone, except that it possesses greater whiteness. It effervesces slightly with acids.

This mineral attracted the attention of European gentlemen, who first visited the place, particularly Dr. MacLeod, and others, who accurately examined and analyzed the magnesite, and made numerous experiments, not only regarding its medical qualities, but also as to its utility as a cement, particularly for works constructed under water.

Judging from the few trials I witnessed at Madras with the magne-

site for the purposes of architecture, I think it one of the best materials I have ever seen or heard of; perhaps equal, if not superior, to the cement made with lime and puzzolana.

For its analysis I must refer to Dr. MacLeod's report to Government, which I am told contains the most accurate description of this magnesite (*a*).

After calcination it absorbs water with great avidity, and forms, even by itself, a hard cement; but, if mixed with a due proportion of sand, it makes a marble-like cement, which, by what I have seen of the well-conducted experiments and trials of Col. Monteith, is by far superior to all those I have seen, Parker's not excepted.

By the description we have of the magnesites found in various parts of Europe, this of Salem differs from them all in its geological position, and in its composition.

As, among the European magnesites, there are some effervescing and others plastic, probably none of them possessing both qualities at the same time, Brongniart classed them under two species, the effervescing and the plastic. This of Salem seems to differ, then, from them in this respect, being both effervescing and plastic.

It differs also in its *gisement*, since those near Madrid, Paris, Salinelle, in Moravia, Piedmont, Elba, Silesia and Styria, are all imbedded in rocks of secondary formation, and generally associated with limestones and silicious minerals, such as chalcedony, chert, jasper, opal, &c. while the Salem mineral contains none of these (*a*), and is imbedded in a primary stratified rock. The only magnesite which in Europe appears to approach to the age of this of Salem, is that near Turin, which is imbedded in serpentine.

I am informed that in another locality, Yedichicolum near Trichinopoly, close to the Cavery, there is another, and more extensive formation of magnesite, which contains, besides the minerals above enumerated, chromate of iron; I could not find a trace of this iron in the formation of Salem (*a*), but it must be remembered that I only examined a very small space of the large area that it occupies.

This second formation of magnesite, besides the additional advantage that could be obtained from the chromate of iron, and from the circumstance of its being near a navigable river, has the quality of being more easily calcined than this of Salem.

The Shevaroy-hills, and those either near or connected with them, are all of hornblende slate, and this formation seems to extend for some miles west (No. 85).

About five miles W. of Salem, in the nullahs, ravines and beds of torrents, we see masses of gneiss (No. 86), which is the principal un-

(*a*) See Note at the end of this Journal—*Editor.*

derlaying rock in all this district. Some of the projecting rocks assume the appearance of mica slate, for the reason so often mentioned.

Proceeding towards MacDonald's choultry, we see some small ridges of white quartz rock, which are distinguishable even from a distance, on account of their colour, different from the greyish hue of the gneiss, and the black of the hornblende slate. They are the outgoings of the beds of quartz in the gneiss (No. 87).

Although the last mentioned rock is seen as subjacent to the hornblende slate, still the diorite continues to form all the hillocks and eminences, on both sides of the road. This rock is clearly seen, eight miles west of MacDonald's choultry, as a subordinate rock to the gneiss, in a deep nullah near Conjamallee hill, where the gneiss occupies the lowest situation in it, while the green-stone slate forms the whole hill.

The hornblende slate formation terminates, or at least is interrupted, about ten miles west of MacDonald's choultry, and is succeeded by a granitic rock, or, more properly, by protogine, containing, besides felspar and quartz, some plates of talc (No. 88). They say that in this rock occasionally aqua-marine is found.

By far the greatest number of the masses along the road are porphyritic in structure, or real porphyritic granite; but in those blocks, in which the mica is disseminated uniformly through the rock, and the felspar in granular pieces, it assumes the aspect of granite (No. 89).

For miles before reaching Sanklydroog, we clearly see that the hills we are approaching, are of a different formation to those we have just left; to the tame, rounded, blackish outlines of the hornblende hills, covered with thick, shrubby, and arboreous vegetation, we see succeed the abrupt, precipitous, naked and whitish appearance of those we are approaching.

Sanklydroog.—In all the neighbourhood of Sanklydroog, the elevated places, such as hillocks and rocky clusters, are of the porphyry we are going to describe; but in the ravines, nullahs, water-courses, and, in general, in the plains, the protruding rock is gneiss (No. 90). It forms the lower skirts of many of the hills east of the Fort; and even in the declivities of some of them, the gneiss is seen traversed by veins or dykes of porphyry. In this gneiss the mica in strata is as frequent, as in the places often mentioned in these Notes.

This porphyry is composed of large crystals of pale flesh-coloured felspar, imbedded in a paste of the same mineral in the compact state, and of the same colour as that of the crystals. Some of the masses have hardly any imbedding material, but are an assemblage of fragments of crystals confusedly mixed together. This rock contains neither mica nor quartz (No. 91).

From the Bungalow, going to the only accessible side of the rock, all the blocks fixed in the soil are gneiss. In the enormous masses forming the rock, this gneiss is entangled often in the thick veins of porphyry, which burst up through this primary stratified rock; the diagram No. 5, represents this striking intrusion of the porphyry through the gneiss.

Owing to the contrast between the colour of the traversing, and of the traversed, rock, these porphyry dykes are seen even from a distance; diagram No. 6, represents a hill, not two miles west of the Bungalow, seen through a powerful telescope.

Polliapolliam.—The country between Sanklydroog and Polliapolliam is level; and the whole of the protruding rocks, gneiss, which forms the bed of the Cavery at this place, all the masses jutting in the river being of that rock, analogous to the gneiss forming the bed of the same river at Seringapatam (No. 92).

Avanashy.—The rocks seen in the nullah near the magnificent Pagoda, celebrated for its sanctity, close to the Bungalow are of a stratified rock; quartz being almost the only mineral forming it, with very little hornblende and felspar.

It is, undoubtedly, one of those immense veins of quartz which traverse the hornblende slate formation; an anomaly in composition, which sometimes happens in the same rock, when another of the minerals composing it, the hornblende, forms strata by itself, to the exclusion of the other components (No. 93).

The stratification of the rock being quite evident, and the hornblende in such small proportion, we might be induced to call it sienitic gneiss; but, considering that the outskirts of the Neilgherries, as well as the plain for miles round, have hornblende slate for surface rock, I class under this last formation the rock at Avanashy.

All the buildings attached to the Pagoda are constructed of this rock, which contains imbedded nests of hornblende.

Mottipollium.—Near Mottipollium, and as we approach the Neilgherries, the hornblende is seen, not, as hitherto, forming elevations and hills, but only clustered masses jutting above the soil.

As in other localities, it contains veins of quartz and felspar, numerous pieces of which, when the imbedding rock decays, are scattered on the soil—close to the ferry of the Bowhany river, at Mottipollium, I found some boulders of granite, the felspar of which is reddish, containing abundance of mica (No. 94).

A few yards south and near the ferry, there is a knoll of a kind of stalactitic iron ore (No. 95); and in the plain I picked up a loose piece

of kankar, which offers an appearance and composition rather interesting. It is the modern, tufaceous, botryoidal kankar, coating a piece of black mountain limestone, of which last rock there is not a trace to be found within hundreds of miles of the place *in situ.*

Close to the foot of the Neilgherries, and up the lowest part of the Koonoor Pass, the strata of the hornblende slate are very much inclined, dipping eastwardly.

Conclusion.—From what has been stated we may draw the following conclusions.

1. That the geological appearances, in several places along the coast of Coromandel, render it probable that the whole coast was heaved up at some remote period.

2. That extensive estuaries must have indented the coast, previous to that period, to account for the fossil remains, both pelagic and terrestrial, many miles removed from the present shore.

3. That granite is the lowest rock in the localities mentioned in these pages, which is seen likewise forming isolated hills, and as erratic blocks on the plains.

4. That gneiss is the most abundant subjacent rock, to which the other inferior non-fossiliferous stratified rocks are subordinate.

5. That the trap rocks, such as basalt, porphyry, eurite and sienite, either as dykes, or as overlaying rocks, are injected through, and in, all the above-mentioned rocks; and that the basalt of this part of India cannot be classed with the floetz trap, as is the case with that further north in the Vindhya range.

6. That the laterite and the kankar of these places, the former being a conglomerate (like the molasse, the nagelfluh, &c.) and the latter a concretionary rock, must be considered as deposited from water; the kankar being of two sorts, the one ancient, and the other modern, still forming. In these two last re-conformations no organic remains have hitherto been found; much less in the inferior stratified rocks.

Quo magis his debes ignoscere, candide lector,
Si spe sunt, ut sunt, inferiora tua.

Ovid: Trist: lib: 1 Eleg: XI.