XV. *Remarks on the Geology of the Country between Tellicherry and Madras.*

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THE road between Calicut and Tellicherry runs near the sea all the way, but seldom affords a view of it.

Comparing this country with the Carnatic near the sea, it is infinitely more fertile and populous; and where the land is not cultivated, the bushes and grass are greener. The villages are composed of huts not built close together, but each is in its own enclosure, which is separated from the next, not only by a fence, but by a very deep narrow lane. The commonest trees are coconuts and arekas,* which are the most valuable production of the coast. Jack trees,† and a kind of slender banian,‡ are also much cultivated; while innumerable forest trees spring up spontaneously, round all of which the pepper vine is seen winding its graceful tendrils, and climbing almost to their tops. The Malabar huts are remarkably neat: the thatch is thick, and the eaves come very low, to keep the violent rains of this coast from the walls, which are

* Betle nuts, Areca Catechu, *Linn.* † *Artocarpus integrifolia*, *Linn.* ‡ *Ficus*?

merely composed of mud. The Hindoo inhabitants, of both sexes, wear no clothes above the waist, but the Maplar women wear a loose short shift over their petticoat, not unlike that worn by the Arabs, their ancestors.

The face of the country in general below the Ghauts is hilly. These hills are low, of a rounded form, and composed of the ferruginous stone so peculiar to India, called by Buchanan laterite. In this porous rock, the red ochry part is the matrix, and the kidney shaped interstices are filled with white earth: the whole is alluvial, being formed from the washings of the Ghaut mountains. In these, the hornblende uniformly decays into a red oxyd, and the felspar into porcelain earth. Why these are aggregated in their present form, the red particles forming the matrix, the white the kidneys, I cannot explain. Whenever the alluvial rock, thus formed, is exposed, the white parts are washed away, and a porous ferruginous stone is left behind. Such is the general formation of Malabar. The primitive rocks underneath possibly appear in many places above this coast: I know them to do so, at a place about midway between Calicut and Tellicherry, at Moy, and at Tellicherry. Four or five miles inland from Calicut, there are two low hills, composed of cubic iron ore.* These are probably in beds in the primitive rock of the country, though I could perceive nothing but the laterite around. From Tillicherry, the laterite forms the hills, until you arrive at the foot of the Ghauts, which mountains are composed in general of a compound rock, which I call gneiss, though in some

* This iron ore, though it has been occasionally worked by itinerant artisans, is now not used. It appears to be very rich, and I have understood contains 75 per cent. of iron. It is sometimes mixed with a green crystallized mineral, which is probably hornblende; and with another substance, which resembles bronzite in colour, but is probably the preceding mineral in a state of decomposition.

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places quartz is intermixed with mica. The mountains formed by this rock, and which line the western side of India, are not of very rugged outline; on the contrary, they are in general wooded to the top: they are very high. Bannason hill, which is among the highest, is said to be 7000 feet above the sea. This rock is every where in strata highly inclined, almost vertical. It has in some places more quartz, in some more felspar, in some more hornblende; thus varying in colour, and aggregating in streaks. Further on, between Peria and Manantoddy, it contains much precious garnet, and is exceedingly tough. In its decay it becomes of an ochry red. Near Manantoddy, there is no fresh exposition of rock: there is indeed a quarry of laterite, about a quarter of a mile from the hill, on the old Madras road. It is worked close to the surface, and the workmen seem never to cut down beyond the depth of a few feet. The instrument used is an axe, for the rock is of a consistence between stone and clay when fresh. This axe is of the annexed shape.

Perhaps two points of contact are less apt to break the stone than one. When the workman has chopped away at the four sides and made the stone flat at the top, he makes a cut or two horizontally underneath, and the mass immediately splits in that direction. The stage from Manantoddy to Bavally Nulla is very hilly, but the hills are never steep; their composition, however, changes from the greenstone above mentioned, to a rock of a small wavy texture, which appears to be chlorite slate. There are also fragments of a

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compact dark grey rock, with veins of sienite running through it. The soil is now no longer ferruginous, but a black mould, and where rain has fallen, a black mud. This soil, in general, covers the rock so completely, that it is difficult to gain a sight of it, and it is never exposed but in small nodules or fragments, by which one cannot judge how it lies. Close to Bavolly hullah, rock to the extent of many feet appears above the surface, and this is reddish sienite. As we advance beyond Bavally hullah, this sienite gathers more and more hornblende, and when become quite a dark rock, it is intersected by veins of light sienite. Here, also, are seen among the sienite, masses and perhaps strata of compact basaltic rock. Portions of felspar lie on the surface, as well as quartz. This latter I had observed further back, disseminated like flint in chalk, through the decayed fragments and mould, of which the surface of the greenstone mountains above was composed. I may observe, that these fragments, and wherever the rock had been cut away to form the road, split in angular and generally rhomboidal masses. Between Bavally hullah and Antersuntah, wherever the rain had formed channels, glittering black sand, like that smelted at Chittoor, and which will be alluded to hereafter, was deposited. The whole of the country between Canute and Antersuntah, is one continued forest with underwood, and it has been so time out of mind. Though one of the most beautiful countries in the world, yet it is unfavourable to geological observation, because the rock is seldom exposed. Between Kakuncottah and Antersuntah, the first rocks I met with, about four miles from the former place, were of green compact felspar coloured by hornblende: a hundred yards further, I came to a block, which I take to be cyanite and garnet. Here was also greenstone and hornblende. These rocks we came to previously to arriving at the village of Kairapoorah. All the

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rock between this village and Antersuntah is greenstone, with what seems compact felspar. Whether the latter is all in veins, or whether mixing with the greenstone in strata, I cannot tell: from its quantity, (for it is lying in abundance on the surface in many parts of the road), I should think the latter. From Antersuntah to Humpapoor, a distance of seventeen miles, I made no observation, as I travelled in the middle of the night. The jungle now becomes lower, and the bamboo clumps disappear: it is therefore no longer fit shelter for elephants. The hills become lower as you recede from the forests, and the soil changes to a red hue, from the black, which seems to be decayed vegetable matter mixed with the charcoal of parts of the forests that have been burned.

From Humpapoor to Chittunhully, the road runs over low waving hills, covered in most places with high bushes. The rock is exposed above the surface in many places; in the first part of the stage, it is deposited in layers almost perpendicular, and dipping towards the south-west. It is impossible to follow the alternations of these layers. In one place I observed a layer of quartz, then another of greenstone, then one of quartz, then one of lapis ollaris. This last is the most abundant rock in this stage, and is sometimes more talcose than at others. Some of these layers, both of quartz, greenstone, and lapis ollaris, are several feet thick. Between Cheltunhully and Mysore, the ground is strewn every where with angular pieces of quartz, greenstone, or lapis ollaris. The quartz is sometimes of a red hue. It is remarkable, that although when broken with a hammer it has a vitreous fracture, the action of the air seems to decompose it angularly; it assumes also a horny appearance. The rock, in situ, at an exposition of it about the middle of this stage, seems a stratified mixture of granular quartz

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and hornblende; further on, pure hornblende appears, and within three miles of Mysore, an extensive stony plain is passed over, consisting chiefly of small fragments of the rocks already mentioned, but also of small irregular masses, of what, from its weight, I take to be a very pure magnetic iron. The compass within which this ore is found strewed does not exceed a few miles; probably some vein or bed runs through the rock below. From Mysore to beyond Muddoor I travelled at night, but from this to Chinna-patam, the rocks begin to assume that variegated appearance, which a mixture, sometimes in masses, but generally in contorted layers of hornblende, quartz, mica and felspar produces. A little before arrival at Closepetta, a rock juts up by the side of the road, which, though not above two or three yards broad, contains perhaps a hundred of these alternations, some so distinct as to be called veins of quartz; others differing but slightly in colour from the layer next them: some parts of this rock contain garnet. In general, these strata are very much inclined, but some are twisted into numerous serpentine directions. As we advance beyond Closepetta, the hills close near us. These are all very abrupt and perpendicular, though with rounded tops; their sides do not present sharp ridges and furrows; they are of a smooth form, but too steep to admit of the formation of a soil. I took specimens from immense fragments and boulders near their feet; and these were all of a coarse sienite, in which the crystals of felspar were very large, and the hornblende distinct. The former was generally of a reddish hue, but it was sometimes white, and passed with the hornblende into a greenstone, while through this again, veins of quartz ran. In the variegated rock mentioned above, whole masses of hornblende were visible. I am inclined to think that all the high mountains of Mysore are of this

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sienite,* and that the variegated rock will be found at a lower level. There had been much rain, and in all the little channels in the road there was a deposit of bluish black sparkling sand, which did not intermix with the white sand or red soil: this is the same as that smelted at Chittoor for iron. All the black rock which I have seen in Mysore, is hornblende, more or less perfectly crystallized, passing sometimes into basalt. The rocks continue of the same nature as those last described beyond Biddidy, and within a few miles of Bangalore, where there is a most remarkable exposition of their irregular veined appearance: no marble was ever more so. In many places on the road the soil appears to some depth; it is red, and frequently covers large heaps and masses of decaying and decayed felspar. Quartz fragments, many of a red colour, are also very numerous on the surface.

From Bangalore to Ooscotta I travelled at night, and beyond this place there is no appearance of rock, the country being high open land, as it is all about Bangalore. The first rocks that appear are nearly midway between Ooscotta and Norsapoor: they are low rounded masses, pushing but little above the surface of the ground, and are composed of felspar and hornblende rather intimately mixed. At Nursapoor, low rugged mountains appear, the sides of which are covered with masses, so that they seem rather gigantic heaps of stones than natural rocks. The most of these rocks are the compound of felspar and hornblende mentioned above, but they begin here to be veined, and to contain masses of a dark rock which is probably inclining to basalt. It is in truth little different from hornblende, for we have a series from the most crystallized to the

* Dr. Heyne also observes (*Tracts on India*, p. 42) that the inland range of the Ghauts is composed of sienite as well as the eastern Ghauts, differing but in the colour and proportion of felspar

earthy fractured rock. When the surrounding matrix decomposes, which it does more readily than these contained masses, they become exposed on the surface of the ground, retaining more or less the shape they had taken when imbedded, and rounded more or less by weather. They seem all to have a tendency to split in concentric layers, but are exceedingly tough. They are the masses I have mentioned as basalt in former journeys. I remember to have seen at one corner near the base of the upright obelisk called Cleopatra's needle, an imbedded portion of black rock of the kind I am now describing: perhaps they are common in sienitic rocks; they certainly are so in India. This black stone is that used by the natives in all the finer kinds of sculpture: all their idols are carved in it, the most beautiful of the stone ornaments at Congeveram, and the pillars forming the verandah of Tippoo's tomb at Seringapatam. From the peculiarly sharp and unbroken edge of its angles, its durability and hardness, it is well adapted to sculpture. The natives sometimes give it a high polish, and greatly increase its blackness by oil. The country as you proceed from Colar is open, and only here and there a few rocks are seen above the surface: these seem more compact and less veined as we advance, which is proved by the few stones and fragments covering the ground. The dark rock especially is close grained. The rocks however do not otherwise differ in their nature. Low mountains are seen in front, which stand on the borders of the eastern Ghauts. The mountains in the highland of Mysore are not in general very high, on the average perhaps not more than 700 feet. They are rugged and stony, of a longish form and generally barren: this applies rather to the country east of Bangalore than to the west. They do not lie in lengthened ranges, but two or three are near each other, and then the land is clear between, except from low rocks here and there. These

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rocks, especially on the east side, are frequently in sloping ledges, and some of the mountains themselves have steep sloping ledges also. Their decay leaves a whitish soil beneath the surface, I suppose from the quantity of felspar they contain. The dark particles of hornblende become ferruginous, and this is in general the top of the soil, which is reddish. Little fragments also become rounded, and in some cases, as at Bangalore, the whole is settled into the ferruginous stone mentioned as seen on the Malabar coast. In the detritus of these rocks, it does not seem that particles of felspar are washed away until they are decomposed; on the contrary, water seems to percolate through the mass, and carry off the other constituents of the sienite, leaving the felspar in a decayed state in mass. Between Tompelly and Moolwagul there is much decayed rock. From Moolwagul to the top of the Moogly pass I travelled at night. This pass, down to the Carnatic, consists chiefly of a chain of wooded mountains, which run northerly and southerly; and though the road passes up and down these for some miles before arrival at the lower land of the Carnatic, yet there is not a decided and continued descent except in one place. The rocks which compose these mountains I omitted to write a description of on the spot, so that they will be best known by an inspection of the specimens collected. The country below continues nearly as rocky as above: the low mountains run far beyond Chittoor into the interior, and rocks push up every where above the surface. Two great divisions of the rocks still continue, the one being the greenstone with a vein of quartz, the other the black rock. This latter, being found in particular places sticking up in blocks above the surface, I am led to believe runs sometimes in dykes or lies in beds. This seems of a more harsh feel than that which is found imbedded in the sienite, and it tends to split angularly, not concentrically. The composition of

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the mountains in the neighbourhood of Chittoor may be known by inspecting the specimens. On these I can only remark, that different parts of the mountains are composed of the different varieties of sienite apparently casually, and that the dark rock is in imbedded masses. From Chittoor to Arcot, the road in one place passes near a mountain which is of the same nature as those of Chittoor, only much decayed. White rock is seen on the surface in this stage, and the usual rocks here and there jut up above the surface. As we advance into the Carnatic from Arcot, there are no mountains seen to the eastward nearer than those of the Mount and Sadros, but rocks are seen in many places pushing through the soil, which though some of them having veins shew no signs of stratification, are of a more vitreous and intimately mixed rock, varying in colour, but usually pretty dark. This rock seems to be the chief one in the Carnatic, and it is uniform in its composition.

In order to complete this very imperfect outline of the geology of a line drawn from the Malabar coast at Tellicherry eastward to Madras, I may observe that the flat form of the Carnatic, that is, of all the country east of the eastern Ghauts of Mysore, leads to the notion that at some former period this track of country was covered by the ocean. In confirmation of this hypothesis are the following remarks, which the digging of a well in Colonel Marshall's garden, about two miles from the sea shore at Madras, afforded me the opportunity of making. From the surface for five feet there is a stratum of brown clay, chiefly intermixed with sand. Then follows a stratum of blueish black clay, in which, at the distance of 21 feet, there is a thin and scattered layer of large oyster shells which all lie in a horizontal position, and into the lamina composing the shell the black clay has penetrated, so that they split asunder with great facility. There are also shells of the cockle, and other kinds. At the

depth of 27 feet the springs of water begin to gush ; the stratum becomes softer, and more and more mixed with siliceous sand, still however of a dark slate-black colour. This continues to 37 feet, the lowest point to which the well was dug, when lumps of what I suppose to be green martial earth were found intermixed with sand.

In order to give a notion of the level of the peninsula from east to west, in the line which I have followed, I subjoin a list of barometrical heights. These I took at most stages both going from Madras to Callicat and returning ; and I have in such places given the result of both observations. The reason they sometimes differ so much may be a change in the atmosphere between the observations, which I had not the opportunity of correcting by the usual means. I merely took an observation at one place, and then at the next perhaps 15 miles off, and no allowance is made for difference of temperature. Wherever there was a rapid ascent or descent, so that not much time elapsed between the observations, as for instance in mounting the western Ghauts, my barometrical observations taken at different times agreed very well. It is remarkable, too, that the average heights up to Bangalore, summed up, give the same result within a very few feet, as is stated in Arrowsmith's map of India to have been obtained by Major Lambton. They are probably therefore pretty correct.

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	Observ. going.	Average.	Returning.
Arcot above Madras.....	626	624½	623
Chittoor above Arcot.....	512	432½	353
Moogly above Chittoor.....	585	578½	572
Pullamaury above Moogly.....	568	579	590
Nungily above Pullamaury.....	128	116	104
Moolwagul above Nungily.....	498	437½	467
Colar above Moolwagul.....	+57	-3½	-64
Nursapoor below Colar.....	-23	+26	-75
Ooscottah above Nursapoor.....	+81	+14	-53
Bangalore below Ooscottah.....	-30	+70	+170
Biddidy below Bangalore.....	474	530	586
Chinnapatam below Biddidy.....		333	
Seringapatam above Chinnapatam.....		38	
Mysore above Seringapatam.....		283	
Antersuntay below Mysore.....		5	
Bavally Nulla above Antersuntay.....		44	
Manautoddy above Bavally Nulla.....		314	
Peria below Manautoddy.....	79	159	239
Top of Ghaut above Peria.....	211	251	291
Midway hut below top of Ghaut.....	992	973½	955
Bottom of Ghaut below Midway hut.....	1327	1320½	1314
Mr. Dyer's House, Tillicherry, below bottom of Ghaut.....	259	329½	400
The Sea below Mr. Dyer's House.....		119	
Malabar Sea below Bangalore.....	2839¼	2698	2981
Differs from Lambton.....	-69	-210	+73

Note. The marks of + and — are placed where by one observation a place was above another, and by another below it. Where only one observation was taken, the result is placed under the head Average.

	Lambton.	Mine going.	Average.	Returning.
Bangalore above the Coromandel Sea..	2908	2912	2878	2926
		4	30	18