The PRIMITIVE rocks or strata, are such as do not contain in themselves, nor rest upon any beds which contain organic impressions, and they were hence considered as having been formed previously to the existence of animals or vegetable life. They consist of granite, gneiss, mica slate, clay slate, primitive limestone, sienite, hornblende rock, and some of the porphyries.

The TRANSITION rocks extend from the beds of clay slate where organic impressions are first formed, to the old red sandstone or grauwacke of the Germans, or to our mountain limestone, which lies immediately under the coal formation. Others make it extend to the coal inclusive: this difference arises from the coal beds in Germany being unconformable to the strata on which they rest, which makes them be considered as the commencement of a new formation, whilst in England they are conformable to the transition.

The SECONDARY rocks extend from the last mentioned point, up to the chalk, inclusive.

TERTIARY is the term now generally given to the beds above the chalk: these extend from the chalk to the uppermost compact strata. Above these lie beds of detritus, gravel, sand, &c. &c., such as we now see forming in vallies or at the mouths of rivers, from the matter brought down by them, which latter beds are termed ALLUVIAL; but since the former often cover the tops of hills and elevated ground, and seem to have been occasioned by some extensively acting cause which has ceased, they are termed DILUVIAL.

DILUVIAL beds, as above mentioned, consist of detritus: they have been formed previously to the excavations of the present vallies: in them are found the bones of animals not mineralized, but of species distinct from any now inhabiting the surface of the earth, though sufficiently near to be referred to the same genera, particularly of the elephant and hyppopotamus. Above these beds, as has been already mentioned, come the ALLUVIAL beds. The formation of these is still in progress, from the decomposition of mud and gravel at deltas and in other situations. An advantage from the above divisions in the nomenclature which it introduces, is that it at once gives the mineralogical name of the rock, and refers to its place in the series which is its geological or geognostic position, as a primitive limestone or granite, transition, &c. &c.

An eminent geologist has lately endeavoured to introduce a new nomenclature of rocks, which refers only to their geological position, so that the same rock as granite and gneiss, if found in one point in the series, has a quite different name from what it would have in another; but this does not seem likely to become general.

II.—*Letter from the Himmalaya.*

The following letter was written by a friend several years ago. Although the topics it touches on have all been previously brought before the public, yet, as there are many of them new to the generality of our readers, we have thought they would not be unwilling to see them treated in a familiar and interesting manner.

"I have before remarked that several very eminent snowy peaks are called *kylas*, by the mountaineers, one of which is near the Mansarowa lake; another a very magnificent three peaked mountain I saw and nearly approached to in Kunaur up the bed of the Satlej in 1818; its base is washed by that great river, where it leaves the broken plains of Bhót or Tartary, and enters the Himmalaya; but there is one *kylas* celebrated in the extravagant legends and fabulous mythological stories of the Hindoos, which may perhaps be grounded on geographical facts, though much obscured by nonsense. This *kylas*, or *caitasa*, is supposed, by them, to be the chosen Olympus of Mahadeo and his heavenly choir, where they sing, dance, dally, and drink nectar, and otherwise enjoy themselves much in their fashion. There, according to them, the Ganges rises at the feet of three peaks, and clad in snow, and lofty beyond all human measure; their summits shining with gold, diamonds, and all manner of precious stones. If this rhodomontade is founded on any matter of fact, the place we are now at may be the *kylas* in question, and Mahadeo's votaries will not thank us for reducing his altitudes. Many of the Hindoos were of opinion, that the earthquake at Gangotri was a demonstration of his displeasure at our prying into his secrets; but we attempted to convince them that it was only his method of giving us welcome, as it could not be supposed he could receive us without noise and *dhumdam*, and that neither demons nor devils had any power over Britons. When we returned to Gangotri, I assured an old Bramin whom I left here, that I had seen Mahadeo. In-

stead of laughing at me, he seemed to take it gravely. I have since repeated the fact. We accounted for the natives with us not being honored with a sight, from the circumstance of their want of new light to see the same. The measures we took of the peaks St. George, &c. must not be considered as decisive of the heights of the Himmalaya: those measures were not taken under favorable circumstances either in the barometrical or geometrical parts of the operations, but I judge that the error does not exceed 200 feet on the whole. The question of the heights of the snowy peaks is determined from a very extensive trigonometrical operation proceeding, instituted for the purpose, and carried on with excellent instruments, much care and labour, and upon just principles. An account of these operations will be published in all its detail for the satisfaction of the scientific. The height of some of the peaks in this survey is about 23000 feet above the level of the sea, but there is one in the Camaún survey, upwards of 25000, which is, as far as we know, the highest mountain on the earth. People in Europe are unwilling to believe that the Himmalaya are higher than the Andes, but the examination of our data will satisfy them that every precaution has been taken to confine the effects of terrestrial refraction within very narrow limits, by modes which it would take up too much room to describe here, but the chief principles of which are to take reciprocal observations of elevation and depression, and so to dispose the terrestrial arcs that they may be only of a moderate extent, and the angles of apparent elevation as large as possible. We find that at low elevations, as 1° 40′ and 2°, and at distances of 40 to 60 miles, mountains of from 6500 to 12000 feet are subject to be affected by refraction in the ratio of nearly $\frac{1}{12}$ of the subtended arc. In only one instance, and that on a long arc (Karnál and the Chúr peak) and in dark weather too, it was so great as $\frac{1}{4}$. Within the mountains, where the air is light, clear and drier, it is $\frac{1}{13}$ and $\frac{1}{20}$, a small quantity where the arcs are only of 15 or 20 miles and the angles of elevation 5°, 8° and often more degrees. You are to understand by this that the arcs are expressed in feet and turned into arcs of oblique circles; but, for the sake of explanation, we may roughly consider as geographical miles the distances from station to station, and take a large ratio of refraction as $\frac{1}{10}$th. Thus, if a peak at the distance of 120 such miles appears elevated above the horizon 2°. or 120′, its apparent elevation is to be reduced 12′, its true angle then is 1°. 48′; and 12′ being a large proportion when the quantity of refraction is only *assumed*, it is not satisfactory to rely on such long arcs and small angles of elevation of objects seen through a moist and dense medium, as is the atmosphere of the plains. But they are of great use in comparing the heights determined on the whole arc, with the sums of those given by smaller arcs and greater angles of elevation; and the comparison proves, that even giving to calculations made hitherto, often on long arcs, an extreme quantity of refraction, the peaks of the Himmalaya surpass the heights of the loftiest of the Andes by some thousands of feet, which that prince of travellers and excellent observer, M. F. Humboldt, will prove if he comes, and I wish he were here to do so. His researches also will throw great light on the geology of our mountains, and their vegetable and mineral productions, and other subjects beyond our skill: but as to the measurements of their distances, their latitudes, longitudes, and heights, I think he will fully confirm what we have done. Perhaps in England they think that officers of the army are unequal to the task, but really it is not mysterious; good instruments, time, care, perseverance, and a moderate skill in calculation, are all that is required. We have followed the methods of those skilful observers, Roy, Mudge, Dalby, and Lambton, in the English surveys, and those of Delambre and Le Gendre in the French, in calculation, principally the latter, as their calculations are the most ready: but they all give the same results. In the observations themselves, we adhere to the English practice, which is adapted to our instruments. Excellent as the French repeating circles no doubt are, and easy to transport, their construction requires several corrections and calculations, which take up time, and may lead the unwary and less skilled into mistakes when much is to be done; but the English circles, by Troughton, which give, when well adjusted, direct angles, horizontal and vertical, are, though less portable, more direct and downright in use. We returned to Gangotri, of course, by the same route, and as all things are more or less wild by comparison, that edgeway, and by us once considered remote place, seemed like a welcome home. We found our people all well, but rather hungry. Thence we went by Bhairoghatie and Deráli to Súki. Having now no object in view, except to return, the ways seemed rougher, and we were more fatigued. We arrived at Súki on the 6th of June, when the rains began in earnest; it rained night and day till the 13th, with a degree of violence I never before witnessed, and our situation was very unpleasant, having no other shelter than our very little tents, smaller than those used by the

jemadars of the native infantry. There were a few ruinous and dirty stone houses, but we durst not inhabit them on account of the earthquakes which happened almost every day. I had a portable stove, which there, as elsewhere, was our greatest comfort; however, we were in a safe place, not overhung by any cliffs. We were generally shrouded in cloud and mist, but heard more than we could see. The tremendous and unceasing crashes, caused by masses of rock, loosened by the rains and melting snow, were awful. By day and night this uproar went on, but we got used to it; though sometimes, when some great piece of cliff from the steeps across the river was precipitated, the noise was really alarming; and even the apathy of the natives was roused, and they ran out to try to see through the thick gloom if the end of the world was coming. Occasionally the mist cleared away a little, and we could see the vast bounds made by the falling rocks, and the havoc they had caused among the pines; and how much the face of the mountain across the river was altered! It rose steeply from the stream to the height of several thousand feet. The river was about 1000 feet below us, and its roar contributed to the confusion around. We saw, with some alarm, that it rose rapidly, fearing it might take away some of the *sanghas*, when we should have been prisoners, and our grain, (a supply of which had been luckily sent from Raital,) was nearly expended, and no one durst go to Raital along the bed of the river while the rocks were falling. For ourselves we got a few *monáts* (*Phasianus Impejanus*), but were relieved from our anxiety on the 13th, when the rain ceased, and, making a few observations, we set off for Raital, finding the *sanghas* all in good order. Right glad we were to see, at the distance of several miles, the old Union waving over it. We were absent from that village 28 days. From Raital we returned by Barahát to the Dún and Seharanpúr, and then I afterwards joined the reserve of the grand army, under Sir D. Ochterlony.—This letter has now run to such a length, that I must defer giving you an account of my excursions in other parts of the mountains up the Satlej within the Himmalaya in Canaúr, of my passage over the snowy range, in June 1816, and journey to the source of the Jumna at Jumnotri, in April 1817; but I will, in a general way, notice, among many other peculiarities of the mountains, some of the most remarkable. And first, of the earthquakes, which are much more frequent in their occurrence, and more destructive in their effects than in the plains. In one month, in 1817, about the same time we experienced so many shocks, forty, I understand, were counted in the Camaún mountains, all slight I believe, and not felt in the plains, except that of the 21st May, which alarmed us so much at Gangotri, and which was smartly felt over the north-west provinces of Hindustán. You may have heard of the earthquake of 1803, which was considered violent in this country, and many buildings were damaged over the whole extent, from Bengal to the Penjáb, but in the mountains its effects were terrible, and a great part of the population perished; whole villages having been buried by the fall of cliffs and sliding down of the faces of the hills. The scenes of that havoc have often been pointed out to me. The imagination can hardly form an idea of a more terrible event than such a catastrophe! What can be the cause of these more frequent and violent shocks in the mountains than in the plains? We saw no volcanoes, nor heard of any, and I believe there are none. Thunder and lightning are much less frequent in the upper mountains than in the plains, and I do not recollect any, except once on the way to Jumnoutri, at a place near the bed of the river, and not above 8000 feet above the level of the sea. The earthquake at Gangotri was by far the most alarming phenomenon of nature I ever experienced, and the frequent, almost daily, recurrence of shocks, though slight, made us uneasy, as it showed there was some active agent at work, perhaps, under our feet, which might at any instant bring down the cliffs under which we scrambled along on our hands. To avoid a few falling blocks is difficult, and might be impossible; but no activity could save the traveller from his fate in those extensive falls, among the ruins and rubbish of which our path very generally lay. You know how keenly the question is agitated among some philosophers of Europe, whether certain appearances on the surface of the earth have been caused by the action of water or fire? For my part, so far from presuming to give any opinion on such subjects, I confess that I have so little geological knowledge, that I am not able to describe accurately, or in terms of science, the nature of the various rocks and soils which compose the mountains from the plains of Hindustán to the heart of the Himmalaya. But one small range of hills, that which is next to the plains,—as for instance, that which divides the Dún valley from the low country,—certainly appears as if it had been the deposition of water. It is about 6 miles in depth, and the height of its various sharp eminences were from 500 to 1300 feet. This particular range extends from the Ganges, at Haridhuara, to the

Jumna, at Padsháhimahl; but the same sort of hills rises from the plains, the north-eastern frontier of Bengal as far as the Satlej, and probably further to the north-west, its direction being nearly parallel to the great Himmaláya, or from east 25 south, to west 25 north, and the features of these small hills have, in most places, a miniature resemblance to the snowy peaks, their *apices* point the same way, *i. e.* about 25° to the west of south, the south western profile being steep, and the north-eastern less so. In going to the Dún from the Doáb plains, we pass through broad, strong water-courses upon slight acclivities, more than two-thirds of the way, and then gaining the crest of the pass, descend to the Dún valley, but the descent is shorter than the ascent. The water-courses are bounded by precipitous walls of soft sandy rock and large rounded stones of granite, quartz, and gravel: these components are arranged in strata, alternating several times; some of the layers are only 3 or 4 feet deep, others 30 or 40, and they point upwards in angles of from 25 to 35, and perhaps 40 degrees. The rounded form of the stones, one is apt to imagine, must have been caused by the powerful and long continued action of water; and the general appearance of the strata is not unlike what would, in miniature, be represented by a section cut through the sand and gravel at the high-water mark of the sea. Can these small hills have once been the boundary of the ocean, when, as we may suppose to have been the case, the plains of the Gangetic provinces were yet under the waters? These plains, you know, contain few stones, and are so little elevated, that Seháranpúr, though at a great distance from the sea, is only 800 feet above its level. Supposing such to have been the case, the Dún may have been a safe harbour; call it the *Downs*, (Doona signifies a valley.) The Dún between the Ganges and Jumna is about 44 miles in length, and in breadth 11 generally. Though somewhat uneven, it is a very beautiful valley; the slopes are shaded with the saul and other forest trees; it is well watered by the Soang and A'san rivers, and many brooks; and some parts of it are carefully cultivated. Its southern and western boundaries are the small hills above mentioned; but on the N. E. side, larger mountains, as Bhadráj, Súrkanda, and others, of the heights of 5000 to 8000 feet, rise abruptly from it. During the winter months, the summits and parts of the sides of these are covered with snow. From the base of these commence that huge jumbled mass of mountains, which fills up the whole space to the feet of the grand Himmaláya, towards which, they, for the most part, increase in height, but the summits are not so sharp as those of the snowy peaks or of the little range which rises from the plains. From the higher elevations of Bhadráj, &c. we enjoy a noble view, which commands the admiration, and rivets the attention of the most phlegmatic, of the towering pinnacles of the Himmaláya, shining with pure and brilliant snows, and rising far above the intermediate irregular mass of mountains, which resemble the billows of a stormy ocean; and to the S. E., S., and S. W. are seen the plains of Hindustán stretching far away, and entwined by the shining streams of the Ganges and Jumna, and other rivers. An unrivalled Panorama! It appeared to me that the rock at the bases of these intermediate mountains, where laid bare by the action of water, was chiefly of granite with much quartz and mica intermixed, under an outer coating of soil and friable sandy stone; and occasionally large masses of calcareous rock present themselves, both near the beds of the torrents below, and on the sides and summits of ranges of 5500 feet high. Of this nature is the Sain-ka-Dhár, between Jaítac and the Chúr: some of the points of 6500 and 7000 feet high, are chiefly composed of coarse slate and quartz, as is Baírát. Both the base and summit of the Chúr, which, though only 27 miles in direct distance from the plains, is one of the most remarkable, if not the highest of the mountains of what I will call the second order, (i. e. from 12000 to 15000 feet high) is chiefly composed of coarse granite, with large nodules and bands of quartz and other ingredients, though in the flanks and sides there is much soft sandstone and shining particles, and small sheets of talc, but little lime. Several of the mountains abound with iron ore; the iron is of a good quality, and some is exported to the plains. Every where, I think, quartz is to be found. Of the nature of the rock of the Himmaláya, I have taken notice as I passed along, and I sent specimens of it to Calcutta: it proves to be granite, of one sort or other, as I suspected. Lead is found in the hills above the Tóns in tolerable abundance, and there is copper in some places, but it is difficult to work, and the population is so limited that people enough cannot be spared from the labours of agriculture to make that of mining advantageous. You know that the red wood used for black lead pencils is usually called cedar: it is really a species of juniper, (*Cedrus Juniperus,*) and red cedar is a small relation of the family: it is found in Cunáur. I found it at our bivouac near the source of the Bhágiretti, at the height of

12914 feet above the sea. It there had the form of a large creeper, (not of a tree;) some of the branches were 6 inches in diameter and of a considerable length; in some places they were above the spongy soil, and in others below the surface. We used it as fuel; the wood has the same red colour, brittle and soft grain, and pleasant smell, as the pencil wood. But Lieutenant Herbert, when he went up the Jahnavi river, found this juniper cedar in the form of a small tree. Botanical writers also mention expressly that the wood used for pencil is a juniper. But the tree which I have in this note denominated cedar, is the Great *Pinus Cedrus*, the cedar of Lebanon, with the description of which it agrees in every particular;—the cones, the leaves, the spreading branches, great size of the tree, the durability yet brittleness of the wood, and its peculiar smell. This noble tree, which towards the Satlej is called *Cailon* or *Cailang*, but in Garhwál and the eastern mountains, Deodár, flourishes on the N. W., N., and N. E. faces of the mountains, and at the elevation of from 6000 to 9000 and 10000 feet, though occasionally below and above both those limits; its nature seems to suit best with an elevation between them. The northern faces of the mountains are very generally shaded by large forests of cedars, and there the snow always lies from 2 to 6 months in the year; the northern faces of the mountains are always less steep than those of the southern ones, and have more soil on them. I have frequently measured the larger trees, and found them 24 feet in circumference, or 8 feet in diameter, at 6 feet from the ground; but those of about 18 feet in circumference are more common; their height, though great, is not, I think, quite in proportion to their thickness, and they are, perhaps, exceeded by some of the more slender pines: one of these last, which had fallen, I measured, and found it to be 169 feet. It was of the *Rai* kind, and exceeded by others standing near it. The largest cedars often separate into two upright branches at the height of 30 or 40 feet, but the middle sized trees generally have but one bole, and are very straight. The wood, of which I will send you specimens, is nearly similar in colour to deal, but rather darker: has a fine, but brittle grain, and a peculiar though not unpleasant smell, which it retains for ages: it is reckoned the most durable of all timber, and most valuable in house building, but it is too brittle for ship's masts. No insect will eat it. When the bark is cut, a fine white resin distils in large quantities from the tree: this resin and the oil obtained from it are much esteemed, and it is said it was used in Syria to preserve dead bodies from corruption. Much oil is also obtained from the cones, which are of an ovate form, about 3½ inches long and 2½ in diameter, the scales close pressed, the cones stand at right angles from the branches. The leaves are in small bunches, of a deep green, bristly and 1¼ inches in length; the bark coarse, and about ¾ of an inch thick. The branches shoot off nearly horizontally, with sometimes a slight sweep downwards in the center, recovering their straightness towards the extremities; the lower arms are the longest, but where the trees grow near each other, the bole has often no branches, but only the marks where they have been when the trees were younger and occupied less space; as there is little underwood in the forests of the cedars, the shaded and solemn passage under them is seldom obstructed. It is needless to say that it is impossible to transport large trees from the mountains, but cedar planks may be carried from the north side of the Chúr to the plains. Many kinds of large timber grow in these regions, and one regrets the impossibility of removing them: some of the stately pines afford the finest deal, and would make excellent masts; their wood is far superior and very different from that of the small pines, called *Chír*, which were cut in the low hills near Haridhuara and sent to Calcutta: even those spars were thought of some value. I. A. H.

III.—*On the Different Methods of Shading Mountain Land.*

A map may be considered to be an orthographic projection (reduced to a small scale) of any portion of the earth's surface, sufficiently limited to be synonimous with a plane, at least as to sense. In this projection the eye is supposed to be at an indefinite distance, and consequently the rays are all parallel.

But as the surface of the ground in mountainous countries is far from even, and consequently cannot coincide with a plane even as to sense, it is evident that an orthographic projection of points in such a map will not give a correct idea of their relative position. Thus, in the annexed diagram, representing a section of the earth's