XIX. Remarks on several Parts of Scotland which exhibit Quartz Rock, and on the Nature and Connexions of this Rock in general.

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Jura.

AS I considered that the mineralogical history of Jura had already been amply detailed, I ascended its well-known mountains rather to gratify my love of the picturesque, than with the hope of acquiring any new ideas on the subject of its structure.

Yet as the predominant opinions seemed to have determined that the tract in question was composed of a granular quartz, and as it had been compared with the northern part of Scotland asserted to consist of the same rock, with the ridge of Schihallien, amply described as such by Professor Playfair, and with numerous other foreign rocks described by various authors under this designation, I had with others admitted the term, and the æra of formation which this term implied. My own researches having given me reason to differ in opinion from these authorities, I have thought it necessary to describe the appearances which I saw ; the question of its rank in the great society of rocks can only be determined after all its circumstances have been fully investigated.

The whole island extending to a length of 30 miles, and varying

in breadth from one mile to six, is fundamentally composed of this one rock, which is also to be found extending through Scarba on its northern, and through a great portion of Isla on its southern shore. The other rocks which occur, with the exception of an important series to be immediately described, either occupy small spaces apparently subordinate to the general mass, or consist of veins which traverse it. The highest part of this tract forms an irregular elevation, of which the three well-known Paps of Jura attaining the height of 2500 or 2600 feet, are the most remarkable and prominent features. These occupy a point in the island much nearer to the southern than to the northern extremity. The interval between them and the southern shore is low, the mountains declining with a tolerably uninterrupted slope to the sea. But that between the Paps and the northern side is occupied by a succession of hills which also decline gradually from the highest elevation, and form a broken ridge extending to the northern shore of the island. If we look from any of the highest summits towards the north, a view of almost unexampled singularity and grandeur is afforded. A series of ridges and broken elevations appears under the eye, but so far beneath it that their irregularities are nearly lost in the continuity of the straight lines which guide the sight to the further extremity of their range. These seem to rise from beneath the feet, and to converge to a distant centre, according to the strict laws of perspective. On investigating the cause of this striking disposition, it is easy to perceive that the effect is produced by the disrupted edges of strata of rock rising from the east at a considerable angle, and broken away towards the west.

However much the continuity be here and there apparently interrupted by the predominance of some particular hill, it is obvious

on comparing these apparent interruptions with the actual causes which produce them, that the fundamental evenness and direction of the strata is no where altered, and that their discontinuities are only the effects of partial elevations interfering with the visual line, all the strata being straight and parallel to each other through their whole extent. This line extends to the north north-west, and the strata dip to the east north-east. In the Outlines of the mineralogy of Jura, this angle is said to be 45° . It appeared to me considerably less, but this sort of observation is not easily made, except in favourable circumstances of position, and I was at no pains to verify it accurately, considering it of no importance in a case like this, whether the elevation were 10 or 12 degrees more or less. It is only in cases where it is necessary to compare particular strata, either with the neighbouring ones or with each other, that accuracy is required, and this accuracy is I fear much less frequently attained than pretended to. These strata are generally thin, often not exceeding six or eight feet in thickness, and I nowhere observed that they were distorted or interrupted by veins of any magnitude, or that they alternated with other rocks. It is true that at an inaccessible part of the summit of the one on which I stood, I observed a mass of dark-coloured rock, which the guide informed me was a slaty stone. Future observers may find detached specimens of it, and thus ascertain that which I attempted in vain to investigate, but which the sequel of these remarks will prove to be more than probable.

Such is the appearance of the rocks as observed from the Paps of Jura. In descending to the lower grounds, the stratified disposition becomes more obscure, in consequence of the interruption to the continuity of the rock from the thick covering of heather, and from the irregular form of the surface which prevents a connected

view of large tracts. In many parts of the shore, however, the disposition of the strata is evidently changed, and they are observed occupying every possible variety of position, from the horizontal to the vertical. The steps by which these changes succeed each other eluded my observation, and perhaps are not to be traced.

I will now describe the principal modifications which this rock assumes, so as to give an idea of its mineralogical character, before I attempt even to conjecture its place in a geological system.

It exhibits the following varieties :

1. An extremely compact granular stone, consisting of grains of quartz, of unequal sizes, united without cement.

2. The same, containing grains of clay, which appear to be decomposed felspar.

3. The same, with more numerous grains of felspar, which appear on examination generally to consist of rounded fragments.

These rocks are traversed by veins of quartz, of which the aspect is also granular, but they are distinguished from the body of the rock by their snow white colour. They often appear so incorporated with the rock that the line of separation cannot be distinguished.

4. A similar rock containing angular grains of quartz of half an inch in diameter, and bearing every mark of having been formed from a disintegrated granite, except that it exhibits no traces of mica.

5. The same rock containing a flattened oval pebble of quartz, perfectly smooth, and having uniform curved surfaces, as if from long attrition. The pebble is two inches in length, and one and a half in breadth. It was so firmly united to the rock, that on one side it has been broken in the attempt to separate it.

6. Grey quartz rock, with a basis of a compact splintery appearance, containing imbedded grains of transparent quartz.

7. Small grained breccia, of which the basis is an earthy-looking mixture of felspar and quartz, resembling claystone, or compact felspar, and uniting angular and rounded fragments of quartz.

8. An uniform aggregate of large grains of felspar and of transparent quartz, without the aspect of granite, since all the grains appear to have been mechanically rounded and re-united.

This quartz rock in the several varieties now described, although as I have already remarked, it forms the essential and fundamental part of the island, does not occupy it to the exclusion of all others. Beds of a rock resembling both mica slate and graywacke, of common graywacke, of finer graywacke slate, and of perfectly fine and uniform clay slate, together with beds of chlorite slate, appear in various places, all difficult to trace through their whole bearings, yet all apparently superimposed on the quartz rock. It is necessary to describe these rocks somewhat more particularly, as they are intimately connected with the quartz rock, and serve to illustrate its history. The following are the most remarkable varieties :

1. A mixture of quartz in grains, with mica slate, of a character intermediate between quartz rock and mica slate, or rather resembling some of the varieties of that graywacke which I have described in my account of Aberfoyle, (p. 447.)

2. The same, of a much larger grain, with distinct scraps of mica slate.

3. The same, with the mica slate so predominant that the compound forms a dark rock, in which the grains of felspar and quartz bear a small proportion to the slate.

4. The mica slate still increasing, and the texture still granular.

5. The same, with a slaty fracture.

6. Coarse graywacke slate.

7. Fine ditto.

8. Perfectly fine and uniform clay slate, of a dark blue colour.

It is important to remark, that the beds which are found at the foot of the mountain, are of a coarser texture than those at the summit, and these are probably the uppermost beds of the deposit. Many of them are nearly black from the quantity of clay they contain; in others are found grains of mica, and in some there are imbedded large fragments of clay slate and chlorite slate.

In hand specimens a gradation may be traced from the finest and most compact quartz rock, down to a perfect breccia, containing fragments of slate, although the ground does not admit of our tracing the sequence of the beds.

If therefore we consider the circumstances which I have described as existing in the finest quartz rock, the rounded pebbles of quartz which it contains, and the gradation that may be traced in it through all the series which I have above noticed, and which are generally confounded under the term graywacke, we need not hesitate to conclude that the quartz rock of Jura is a mechanical deposit, or a rock recomposed from the fragments of older ones. I know that authors have talked of primitive sandstone, and even of primitive breccia, but the awkward nature of this compound renders it desirable that we should, if possible, discard a phraseology which involves a contradiction in terms. It is perfectly true that many of the beds in Jura contain large tracts of a granular quartz, often very pure and compact, and which from its crystalline texture might in the hand be supposed a primitive and chemical deposit; but the occurrence of blunted fragments, and of rolled pebbles, suffice to shew, that like many other rocks it possesses at least the compound structure both of a chemical and of a mechanical deposit. Neither

is the perfect crystalline texture of quartz any proof of a primitive formation ; since the strata of Kirkaldy, which belong to the flætz and coal *formation*, contain beds of highly crystalline and translucent quartz, alternating with coal and organic limestones.

The mode in which the felspar exists in this rock proves also its mechanical construction, and shews that it has very probably been derived from the wearing and deposition of antient granites, by whatever means we may attempt to account for its present highly compacted and often crystalline structure.

Having thus, as I trust, clearly proved that the rock of Jura is a recomposed rock, as far as regards its structure, and that it cannot from its compound nature be properly entitled to the name of a granular quartz, it is our business to consider its geological appearances, and the probable nature of the process by which it acquired its present disposition.

Before examining this question, it is requisite to premise an observation of professor Jameson, whose accuracy is not doubted. He remarks that the " Quartz rock rises at an angle of 45 degrees from under the micaceous schistus." Here then we have a rock formed of a mixed mechanical deposit, lying under a rock which is held to be primitive, and the third in succession from the first and fundamental of all rocks, granite. I did not observe this fact, but have perfect reliance on his observations, because they coincide with what I have myself observed in other places. Either then this mechanical deposit must be considered as a primitive rock, or micaceous schistus is a rock of more recent formation than it has been generally esteemed.

This latter supposition may perhaps admit of further proof, but I cannot enter into it in this place.

Leaving this additional difficulty out of discussion at present, it is

obvious that there is no provision made for this rock in Werner's classification, if I have succeeded in proving that it is as little entitled to the name of quartz, as to that of granite, and that it is not a purely primitive and chemical deposit. Its mechanical structure deprives it of a right to the latter title, and its connexions and disposition prevent us equally from arranging it with the latest stratified or "floetz" rocks. If it is a necessary condition of the "transition" rocks to contain organic remains, then this rock is also excluded from the intermediate or transition class, as much by this as by its position in respect of the mica slate, universally esteemed among the primitive, or to speak more properly among the most ancient rocks.

Such are the inconveniences of artificial arrangements, whether they are groundless, or founded on partial views of natural productions. It has been proposed indeed to call this rock graywacke, a quartzose graywacke. But this is in fact to confound all distinctions for the sake of an adherence to a system, which may without disgrace admit a new member into any of its series, should it appear that a member hitherto unobserved does actually exist. The name graywacke has been already too much abused, and is become a fruitful source of confusion and error. It is incumbent on us to diminish instead of increasing this evil, by a more careful application of that, as well as of other geological terms, and by limiting its use within the rigid compass of definition. On that definition I need not now insist; nor will I attempt at present to assign the true place of the quartz rock in the general arrangement. It will be done with greater facility when I have described its connexions in the other places where I have observed it.

Assynt.

Although I have to regret the limited extent of my observations on this district, yet as they tend to illustrate the nature of the rock which forms the subject of this notice, I am unwilling to suppress them. They may at least serve, in conjunction with the remarks which I have made on this rock in other places, to extend its history and connexions, as well as to stimulate future observers possessed of better opportunities, to continue this inquiry, and to assist in determining the composition of that extensive and as yet little known country which constitutes the northern mountainous division of Scotland.

The mountains which form the districts of Coygach and Assynt may be distinguished even from the island of Sky, by their peculiarly smooth and conical outlines, and by the whiteness of their summits, so dazzling in the sunshine, that to a spectator unaware of their composition, they appear as if for ever retaining the snows of winter. Their strong resemblance to the Paps of Jura, both in the even unbroken line which forms their summits, and in the peculiarity of their colour, immediately however, explains their composition and confirms their similarity; for, like those mountains, they are formed of a rock which has here also been called "granular and primitive quartz." In a distant view they are remarkable too for another peculiarity, which in other situations has been supposed characteristic of the mountains of this class, and that is, their detached position. The accompanying sketch of the coast, Pl. 32. fig. 2. will better explain than words can, both the singularity of their form and that independence of position which they assume; circumstances which when compared with the irregular outlines and crowded groups of granitic and schistose hills, will strike the most careless observer. The

sketch to which I refer, will doubtless also remind the spectator of the view given in Dr. Fitton's paper, of the hills in the vicinity of Dublin. The conical form of these hills appears to arise partly from the rapidity of their decomposition, as far as regards their mountainous bulk, and partly from the permanent nature of the resulting fragments. To the same cause also is owing that particular and arid appearance of sterility, which is so characteristic of this class of mountains; an appearance which those who have seen Jura will readily recognize, combined with a difficulty in ascending them, which the geologist who has laboured in the attempt will not easily forget. The peculiar whiteness which the surfaces of the fragments show is however adventitious, as the fresh rock exhibits a variety of grey, yellow, and brown tints, which long exposure to the atmosphere will ultimately bleach. A narrower examination of unaltered specimens would possibly have prevented mineralogists from ever applying to this rock the improper designation of granular quartz, how much soever the weathered surfaces may resemble this substance.

On a nearer inspection, these mountains appear to consist of a stratified rock, or to be formed of various beds of grit, which, where the declivities are so steep as not to admit the lodgment of fragments, become easily visible. In my remarks on Jura, I have described a distinct and continuous bearing of the strata, but I was unable by the aid of a spying-glass to perceive at any of the various points from which I viewed the mountains of this coast, a similar tendency through any considerable space. I should conceive their tendencies to be exceedingly various, and that no general system of inclination or direction predominated among them. But of this I must needs speak with much diffidence, as I had no opportunity of ascending any of the summits, from whence alone an accurate observation of this nature could be made. Those who have been occupied in

similar investigations well know how difficult it is to ascertain the disposition of large tracts of country unless observed from situations so elevated as to raise the spectator above all the obstructions which the varying forms of high ground throw in the way of this great natural perspective. The remarks of Saussure on the highest summits of the Alps, which relate to this subject, are well known. It is not material to the purpose of determining their stratified structure, whether this stratification be continuous for a large space or whether it be various and interrupted; however desirable it might otherwise be to ascertain its disposition over the whole extent which these mountains occupy. From the low positions in which I was compelled to view those strata which I saw at hand, they appeared to be in some places horizontal, in others occupying various angular elevations, sometimes inclining to the north, and sometimes in a direction the very reverse. Such perhaps would also have been my opinion of the strata of Jura, had I not attained its highest summits. Future observers who shall ascend the Cuniack hills, the Sugar-loaf mountain, or Ben More, will be able to ascertain what I have left undone. Want of roads, want of horses, want of population, want of every thing, render this country among the most impracticable of Scotland.

The nature of this rock is exceedingly various. It is often a compact stone of a yellowish colour, and uniform texture, resembling a granulated quartz, simple in its composition, and breaking with an imperfect conchoidal fracture. Occasionally it assumes a coarser and looser texture, and in these cases the weathered surface becomes white, and acquires a harsh and sandy feel and aspect. However uniform the fresh specimens appear when broken, they almost invariably disclose some internal mechanical arrangement on weathering, which betrays the nature of their original formation, a circum-

stance highly instructive with regard to the composition of many other rocks. Of these natural analyses, a very common one is the appearance of laminæ of red and white matter, alternating either in flat plates, or in that peculiar undulating form so well known in the *floetz* sandstones, and marking the action of water on loose sand. An occurrence of equal importance and greater singularity is that of imbedded cylindrical bodies which they occasionally exhibit. I may previously remark that they have a frequent tendency to break into rectangular solid masses, similar to those which occur in many *floetz* sandstones. In these fragments the weathered surfaces present on the upper part, or that which forms the plane of the stratification, a number of circular protuberant spots, apparently arising from the circumstance of their hardness being greater than that of the general mass. The lateral plane of the same fragments exhibits on the other hand a similar number of corresponding cylinders, of a hardness in the same way superior to that of the surrounding parts. If I might venture on a comparison as vulgar as it is explanatory of this appearance, I would compare it to the two sections of a piece of larded meat. I may further add, that in these cases the cylindrical bodies are of a much whiter colour, as well as of a more compact texture than the rest of the stone; and that on breaking the stone to examine further into this structure, the whole disappears, and an uniformity of texture is exhibited throughout.

This peculiar appearance is familiar to all those who are conversant in the varieties of *floetz* sandstone, and the superior hardness of the cylindrical or vermicular bodies in the sandstones of this class is equally notorious, as they often continue to project for the space of even half an inch beyond the decomposing rock, appearing as if nails had been driven into it. The coast of Fife about Burnt Island affords excellent examples of this fact. I know not that any attempt

has been made to explain this circumstance in the *floetz* sandstones, but it probably arises from the remains of some animal, a *Sabella*, or other marine worm. Whatever it be, it is sufficient to establish the similarity in the original structure of this mountain rock, with that of the present *floetz* formation. I am the more particular in calling the attention of the Society to these resemblances, because I am unable to produce such decided instances of rolled pebbles as I have described in the rock of Jura, and am therefore apprehensive that the arguments by which I would prove the recomposed structure of this rock, may not appear sufficiently conclusive. But I have little doubt that many instances even of this occurrence, will be found by those who may have more time to bestow on the investigation, and who with better fortune may collect such specimens as might easily have eluded my cursory search. Proofs however are not wanting of mechanical attrition in the component parts of many beds of this rock, although the fragments do not absolutely reach the size of a pebble. A rock resembling ferruginous sandstone, of a highly compacted nature, is found in beds, alternating with the finer and more compact quartz rock, the grains of sand and gravel bearing most evident marks of attrition; and the whole mass being indurated to such a degree, that a hammer makes no more impression on it than it would on a mass of iron. It is still more satisfactory to find in certain positions, strata of absolute and perfect *breccia*, similar in aspect to those which now alternate with our older *floetz* sandstones, but possessing the same extraordinary degree of hardness which I have just noticed. If there are any marks of organic remains in this rock less equivocal than the vermicular structure which I have described above, I did not see them, nor do I consider them necessary to establish its character, since our oldest *floetz* sandstones are equally destitute of them. Under all these circumstances both of position

and of structure which I have detailed, I think that I am justified in considering this rock, like that of Jura, to be a recomposed, and not a purely chemical deposit, being with it equally ill entitled to the name of granular quartz. Its characters would seem to prove that it has originally been a stratified sandstone, which by some of the revolutions of this globe has been both chemically and mechanically altered, consolidated in some places to the apparent loss of its original texture, and so changed in its position as to show but faint indications of its former regularity.

It now remains to enquire into the connexion of this rock with those which accompany it, a part of the subject, and a very important one, on which I must regret that I have so little precise information to offer. On the sea shore at Kylescuagh, and on the shores of Loch Lowie, a very indurated and compact gneiss appears to lie immediately below the quartz rock, but I could not discover their connexion. In the very centre of the district I found hornblende slate, gneiss, mica slate, and syenitic granite, together with numerous veins and detached masses of compact epidote. Here also, unfortunately, I could not trace their connexion. Such is the meagre account I have to render of what it would be of prime importance to ascertain, whether these rocks are every where inferior in position to quartz rock, or whether the older schistose rocks do not here, as in other places, alternate with it. Circumstantial evidence renders the latter probable. In the description of Jura I have remarked that mica slate does, according to Professor Jameson, lie above the quartz rock, and Williams considers the rock I have described, which he also calls granular quartz, to be, like granite, the rock on which micaceous schist usually rests. Professor Playfair also in his *Illustrations*, (P. 166,) speaks of a "granitic sandstone in vertical beds," and mentions its alternation with "micaceous

and other varieties of primitive schist." Since this paper was originally drawn up, I have seen the country he here quotes, (Arisaik) and have confirmed that his "granitic sandstone" is the rock which I have been describing, and that it is the same rock which he has also described as constituting the ridge of Schihallien, a place of which I shall presently have occasion to speak. Possibly these authors, impressed with the notion that this rock was a "granular quartz," and that granular quartz was a primitive rock, have not thought it necessary to push their investigations as far as they might have done, nor made the important deductions which must needs follow from this fact if proved. On the geological consequences which would result from its being established it would be useless to speculate till the fact be fully ascertained, as I trust it will be in the sequel of this paper, but it is obvious that it would occasion the removal of mica slate out of the chemical deposits of the Wernerian system, and place it among the mechanical, or at least the mixed ones: a change which seems to be called for by many other circumstances attending the formation of mica slate. But I must leave this part of the subject for future consideration.

The true nature of this rock being now, as I trust made out with regard to Jura and the western part of Sutherlandshire, we are next led to inquire what evidence there is to prove that all the mountains of "granular quartz" are not of a similar nature, and do not belong to some of the ancient recomposed rocks. The mountains of Scuraben and Morven are cursorily described by Jameson, the former as having a summit of quartz, the latter as possessing the peculiar white aspect so characteristic of the hills I have noticed on the western coast; and in his work on Geognosy, they are actually quoted as examples of quartz rock. Mr. Pennant

too, although not an authority in a case of this nature, describes quartz about Loch Broom, and more cursory observers have given us reason to think that the generality of the higher mountains of this northern tract of Scotland are composed of "quartz." There is little doubt that the whole of this elevated tract is of the same formation as that under consideration, and it ought therefore perhaps (according to the remarks I have already made on Jura) to be ranked with the *Transition rocks*, if we adopt the divisions of Werner.

If this be proved it will be highly interesting to ascertain the positions of all the strata throughout this whole district. Of the unstratified rocks it will always be difficult to determine what portion has been removed, or what changes of the original position may have taken place, as we have no guide to conduct us in our judgment, ignorant as we must generally remain of their original forms. With the stratified rocks the case is otherwise, their existing forms furnishing us with a palpable index, by which we may discover either the changes of position they have suffered, or the waste they have undergone. Certainly the north-west coast of Scotland gives evidence of an enormous waste of the surface, and opens an ample field for the speculations of those who have attempted to assign the causes of that waste: to them I must at present leave it.

I have already, at the beginning of this paper, remarked the similarity which the outline of the mountains of Sutherlandshire bears to that of the Wicklow mountains. These, in the paper of Dr. Fitton, above mentioned, are also called granular quartz. As I have neither seen the mountains themselves, nor any specimens from them, I am unable to decide whether they are actually similar in structure and geological character to the Scottish quartz mountains,

and I can only suggest their suspicious aspect, as a reason for a further examination of them. I am inclined to entertain the same doubts relative to the quartz mountains described by authors in various parts of the world, most of which exhibit the detached and conical forms so often mentioned, and from some of which specimens have come to my hand precisely similar in their mineralogical characters to those which I have described. If such should be the fact, the necessity of finding a place for this rock in the list of formations will be more apparent than before, and it will be the duty of those geologists who lay stress on such distinctions, to ascertain the true rank it ought to bear in their system.

Schiballien.

This mountain, already highly interesting from the important geometrical operations performed on it by Dr. Maskelyne, and the subsequent mathematical computations of Dr. Hutton, has again been called into notice by Professor Playfair, in his Lithological Survey, established for the purpose of correcting the results deduced from the labours of those mathematicians.

As Mr. Playfair's remarks on the geological structure of this mountain, although chiefly referring to the particular physical object he had in view, seem to involve some important conclusions respecting the rock described in the two foregoing memoirs, I shall, I trust, be excused for stating the considerations to which they have given rise, and to which I have already alluded, since they may serve to call some further attention to its mineralogical and geological history.

The mountain itself forms the most elevated part of a ridge which may be considered as rising near Fascally, and extending in a south-westerly direction till it meets that complicated group from which

the ridge bounding the southern side of Glenco takes its rise. This ridge contains the other considerable elevation of Ferrogon, and separates, not the "valley of the Tay" but that of the Lyon from that of the Tumel.¹ The reason for making this correction will appear in the sequel.

Mr. Playfair's accurate description of the spaces occupied by the rocks which constitute the summit of Schihallien, renders it unnecessary for me to enter into any such detail. I may merely remark, that by his report the whole of the mountain, except the central ridge, consists of the various modifications of mica slate, hornblende slate, and the usual associated limestone, which are so well known as constituting the greatest tracts of the highland mountains. The result of my own examination, which was however exceedingly limited, coincides with his. All these strata are vertical, or very nearly so, and the central ridge, or the "granular quartz," appears to be placed in a position absolutely perpendicular.

This quartz rock is stratified, although vertical, in beds which, as far as they can be seen, appear absolutely and nicely parallel, their lines of separation being defined with a most mechanical exactness. They have a tendency to break into rhombic and prismatic fragments, by fissures perpendicular to their stratification, and being thus broken, they have fallen on all sides around the summit, producing the same appearances as those exhibited by the Paps of Jura, and the mountains of Assynt, and, for the reasons which I have assigned in my observations on these hills, contributing to form that elegant conical outline for which the summit of Schihallien is so remarkable.

An ample account having been given by Mr. Playfair of all the modifications of this rock which he could observe, it will be superfluous for me to enter into its history, particularly as I have already pointed out its leading characters in describing the rock which forms the

summits of Jura. There is, in fact, no essential difference between them, as they consist in both cases of highly compacted grains of quartz, with interspersed grains of felspar, often earthy, and never, I believe, so perfectly crystallized as they are in granites and porphyries, but having the aspect of fragments rather than of crystals. I did not meet with any specimens on Schihallien of a formation so decidedly mechanical as those which I have described as occurring in Jura, but must rest the proofs I am desirous to bring forward of the mechanical and therefore secondary structure of this rock, on other and more circumstantial evidence. Possibly future observers, bearing this doubt in their minds, may with more time and opportunity discover such positive proofs of this nature as I failed to find, since our acquisitions in specimens are generally in proportion to our previous knowledge.

It will doubtless be admitted that if of two rocks precisely similar in the generality of hand specimens, similar also in structure and position, and possessing the same characters in general aspect and disintegration, the one is proved to be a mechanical deposit by its containing rounded pebbles or beds of breccia, it affords a very strong presumption that the other is of the same nature. But we have yet to see what further evidence of this may be found in the neighbouring rocks, as the occurrence of a single bed of a recomposed rock in a situation so remarkable as the ridge of Schihallien, might excite rational doubts, unless we could discover a greater extent of similar rocks connected with it. It is here necessary to remark that the whole country to the north of this ridge consists for a considerable space of rocks of the class called primitive. The vale of Tumel and the hills which bound it are composed chiefly of mica slate, which continues till it meets the granite of the central Grampians. The case is different on the southern side of Schihallien.

The ridge of Ben Lawers, it is true, (that ridge which does actually bound the valley of the Tay) consists of chlorite slate, with mica slate, and the other rocks of this character which need not be described. But the valley of the Lyon exhibits a formation totally different. The river Lyon runs with a very gentle fall through the greater part of its course into the Tay, proving that there is no very great difference of level between their respective vallies. In passing through Glen Lyon, the mica slate may be seen terminating on the south side of the river, in some places indeed long before it meets the bottom of the southern side of the valley. It is also obvious that the boundary of almost the whole northern side, as far at least as from Meggarney to Fortingall, consists of a sort of compact sandstone or "granular quartz," a rock in no way differing from many of the varieties of quartz rock already described. This is the ridge which declines from the south of Schihallien, and which is intimately connected with the main ridge of that mountain. The sandstone itself exhibits a texture of infinite variety, but in all cases it possesses the same aspect of antiquity and induration which characterizes the rocks of Jura and Schihallien. It would be necessary to traverse the whole of this ridge to the top of Schihallien before we could ascertain positively whether the rock which forms its summit is connected with that of Glen Lyon, and what is the mode of this connexion; a task of considerable difficulty. Yet I have very little doubt that they are parts of one great deposit, similar to that which constitutes the north of Scotland and the Island of Jura.

Future and more extended investigations may perhaps enable us to assign even from this spot the relative antiquity and position of a rock hitherto but ill understood, and possibly from the more accessible parts of Schihallien determine the very important fact of its inferiority to, or alternation with, mica slate, a fact which however

will appear fully determined by the other examples of this rock, which are described in the supplement to this communication. But this circumstance, already mentioned as being supposed to occur in Jura, does really appear to receive further confirmation here, since if the central ridge of Schihallien is surrounded by mica slate, a fact of which Mr. Playfair entertains no doubt, and if this ridge is connected by any system of alternation with the sandstone of Glen Lyon, mica slate will appear to be a rock formed posteriorly to, or alternately with a rock of recomposed structure. Thus a "*primitive*" rock will be found to alternate with a "*transition*" one, an anomaly which either renders this distinction as useless as it is artificial, or compels us to modify the definition of transition rocks, or to form that total change of arrangement which I have more than once suggested with regard to the primitive and transition classes. It is, I trust, quite superfluous to say that it can have no title to the name of "*granite*," with which it certainly does not possess any one common feature.

Supplementary Remarks on Quartz Rock.

Having had an opportunity since I presented the foregoing memoir last year, of examining some other parts of Scotland where a similar rock occurs, I have thought it right to lay these supplementary observations before the Society, partly for the purpose of correcting the errors and supplying the defects of that communication, but principally for the sake of elucidating the history of a substance as yet but imperfectly understood, and but ill arranged, although it must already be obvious that it occupies a considerable space among the older rocks, and is entitled to rank as a principal

member among them. In the former notices I have already in some measure described its general aspect and connections, although the limited extent of my researches prevented me at that time from pronouncing decisively as to the latter. I am now, from more recent observations, enabled to confirm the suppositions there made with regard to its place among the older rocks, and to add such a further description of its mineralogical character as to include many more varieties. I shall content myself with merely pointing out its geographic situation in those places which I was prevented from examining more particularly, in the hope that some future observer may direct his attention to them, and ascertain that which I have left undone.

This rock may be seen in Mar accompanying the Dee during part of its course through a country consisting of granite, followed by the usual covering of micaceous and clay slate, a country even in the Wernerian use of the term, primitive. It appears to be stratified, but of its more immediate connexion with the schistus I can say nothing, as I had no means of examining into it. Following the military road which extends from Braemar to Tomantoule it may be observed in various places, and appears to form the whole or considerable portions of the hills which, declining from the granite ridge of Cairn Gorm, accompany the courses of the Don and the Avon, and are principally constituted of different kinds of schistus. Pursuing this line northwards, it occurs more sparingly, but may still be occasionally observed, together with the schist, till the hills decline into the plain country about Fochabers. I can produce no observations through any part of this course to prove that it is a member of this class of schistose rocks; but from its mineralogical character and general appearance, and from the resemblance which it bears to those quartz rocks whose connexions with the

older schists are apparent in other places, I think future observations will confirm my supposition that it is a member of this class of rocks. A highly indurated breccia may be seen near Boharm, on the line now described, consisting of angular fragments of red and white quartz, so compacted that they do not separate from the bed on breaking the rock, but the whole gives way together, as if it were one continuous mass. The same rock now and then contains jaspers dispersed through it in the form of fragments. As I have observed similarly indurated breccias accompanying a similar quartz rock in other places, I suspect that this breccia is a portion of the same formation, bearing such a relation to this quartz rock, or compact sandstone (since it may be often better described by this appellation) as the softer and better known breccias occurring on the borders of the floetz strata do to these latter. I also suspect that greater simplicity of composition and more perfect induration will be found to be leading characters of the breccias of this class, the causes of which must be sufficiently obvious, and that portions of breccia or large grained mechanical formation, will generally be found accompanying the older schistose strata whenever these exhibit the smaller grained mechanical disposition. It is to these that the unfortunately constructed term of primitive breccias has been applied. If we could securely adopt the names of breccias and sandstones of transition, this contradiction in terms would be avoided, but if as I have already shown, and shall presently I hope more fully prove, the quartz rock under review does actually alternate with the rocks called primitive, it is plain that we cannot have recourse to this expedient, but must be content, if we use the term primitive, to bear with the unseemly compound. The adoption of the word primary, in lieu of primitive (a change already recommended) removes this apparent contradiction, since it is only

the correlative of secondary, and involves no hypothesis with regard to the absolute æras of rock formations. But I must pass on to further matter of fact, leaving to the labours of future geologists, the actual connections and origin of these breccias, and the distinctions to be drawn among this very intricate class of rocks.

In the district of Appin the quartz rock may be observed in various parts, and although I have not been able in this place any more than in Mar, sufficiently to trace its connexion with the mica slate of the country, I have little doubt that it immediately follows, and possibly alternates with it. It may be seen not far from the castle of Bercaldine, and forms a large detached rock at Airds. Here it is of a highly indurated character, and bears the marks of a disturbed stratification. I do not think it necessary to describe the particular aspect which each rock assumes, as it most frequently happens that various modifications of it are to be met with in the same spot, and I prefer delaying the general description till I have mentioned the several places in which it is found.

The same rock occurs in the district of Arisaig. It occupies there a considerable portion of the shore, and may be traced forming low hills and interrupted projections, from the point of Arisaig, nearly to Loch Morrer. It seems here to alternate with mica slate, as I have already mentioned in another place, where I have quoted Professor Playfair's remarks on it; but possesses much less of the appearance of stratification than in the other instances which I have enumerated.

In the island of Sky it occupies a considerable space, and forms that large mountain mass which projects from the general eastern boundary of the island, so as to produce, together with the main land, the narrow passage of the *Kyle rea. Here it assumes a

* Kyle rea the smooth strait, Kyle ree the King's strait, but both are corrupt etymologies. Kyle rich, the swift strait.

character considerably different from that which it exhibits either in Jura, in Assynt, or in the other places which I have described. Its aspect is more uniform, and its texture more compact. Its fracture is rather more splintery than granular, and it rarely contains felspar, a mineral seldom absent for a long space in the generality of the quartz rock. It is here of various colours, brown, grey, yellowish, reddish, and white, but its predominant tint is a blueish grey. Its marks of stratification are obscure, yet they may, however disturbed, be traced, and its true character is I think determined by a compact breccia, which in some places may be observed separating it from the schistose rocks, the micaceous and argillaceous slate. It occurs again in Sky under another form, namely, in disrupted portions, forming the tops of low hills in the district of Slate, of a snowy aspect and compact texture, with irregular grains of felspar imbedded, and in intimate connexion with the micaceous schistus.

I have reason to think that the same rock will be found to form a large portion of that ridge of mountains which extends in a curved line to the south of Ben Nevis, so as to constitute the southern boundary of Glen Nevis; but as this conclusion is only founded on a distant observation, and on the peculiar aspect and mode of decomposition which these hills exhibit, I lay no stress on it. Yet as it actually occurs in that part of the declivity of this group which descends into Loch Eil, and is to be found constituting a considerable mass of mountain at Balahulish, I shall not be surprised if future observers assign to it a very considerable extent in this district. It is at the edges of the road between Balahulish and Fort William, that it may be conveniently examined, and it will there also be seen to alternate with a compact argillaceous schist.

On the borders of Loch Leven, and on its northern side, it is most abundant, and appears to constitute large portions of the mountains, having an evident similarity of direction and disposition, to those masses of it which form the principal parts of the mountains of Ben-na-vear on the opposite or southern side of this lake, and which I am now about to describe.

I have already had occasion to mention in a note supplementary to the account of Cruachan, that granite is found at the base of the group of mountains called Ben-na-vear, extending from Bala-hulish towards Glenco in one direction, and for a considerable space along the Appin road in the other. On ascending this group, the granite continues for some way. This is followed by a rock, which, although it forms here as in many other places, considerable portions of mountain masses, has scarcely received a name and an establishment in the system of rocks. It is a sort of schistose quartz; it is not graywacke, nor is it micaceous schist, though it contains grains of quartz, and mica, and clay: neither is it gneiss, although it contains grains of felspar. Previous prejudices might perhaps find it a place among either of these, according as the predominant system dictated. But the best idea of its general structure may be conveyed by saying, that if it was a floetz rock it would be called a schistose sandstone. There is in many cases so strong an affinity between the rocks of the primary and of the secondary, or floetz, classes, that it can scarcely lead to error, if, pursuing this analogy, I should call it a schistose quartz rock. It will in fact be found to form the same connexion between the micaceous or clay slate and the quartz rock, as the schistose sandstones which alternate with thin laminæ of clay slate do between the latest clay slates or shales and common sandstone. And thus, as in other

instances, a connexion in structure and habits is established between certain rocks of the primary and of the secondary classes. In all cases the mica is disposed in lamellæ parallel to the strata or laminæ of the rock; it is never as in gneiss partially disposed in different directions, still less as in granite indifferently placed. This rock is succeeded by quartz rock in large masses. Some beds of a hard or compact schistus, of a character often approximating to hornblende slate, are also found to all appearance alternating with it, and I have already noticed in the paper above alluded to,* that granite veins are found to traverse this particular schist. The hill is, on its accessible face, so covered with soil, that no very positive evidence can easily be procured of the alternation which I suspect; and the precipitous faces are generally inaccessible, always hazardous of access. As we approach the summit of the mountain, the quartz rock becomes established to the exclusion of the schist, and it continues to the top, where it offers that aspect of complete disintegration before described under the heads of Jura and Assynt, which covers the tops of the quartz mountains with ruins, and gives them that acute apex and regularly conoidal declivity, which, as far as I have yet observed in Scotland, is sufficient even at a distance to indicate the nature of the rock of which they are composed. The laminated or stratified structure is by no means so evident in this example as in those I have before adduced from Jura, Schihallien, and Assynt; but it still bears the marks of a broken and disturbed stratification. Such being the case, and such the infinite variety of position, direction, and elevation, assumed by this rock, I think it unnecessary to enter into any details on these heads. I may only remark generally, that it stands at an angle not far deviating from

* Vide paper on Cruachan.

the vertical position, and that this angle is similar to that held by the schistus with which it is accompanied.

The composition of this rock offers through different parts of its mass different varieties, and it will not be useless to enumerate the most leading ones, merely for the purpose of proving in this, as in some of the other instances described, that many of the most remarkable mineralogical varieties exist under the same geological position. Thus the identity of the rocks as an order or division is established, and thus we may legitimately deduce those general conclusions from which its place in the system may be assigned, however in different situations its aspect and composition may vary.

It is often composed of mere grains of quartz, of an aspect extremely various, sometimes highly crystalline, though never defined by geometrical forms; sometimes shapeless and opaque. These are more or less strongly agglutinated, and are occasionally compacted to such a degree that the granular appearance is nearly lost. It contains now and then grains of felspar, imbedded in a compact quartz basis, thus bearing a general resemblance to porphyry. These sometimes appear to be crystallized in an obscure manner, but more frequently they exhibit no regular figure. At times the felspar and quartz are so nearly equal in quantity, that the whole forms a pink-coloured granular mass, often so loose as to crumble in the hand, and in this case the grains seldom bear any mark of crystallization, but are rounded as if they had undergone attrition previously to their aggregation: occasionally, but rarely, it contains imbedded fragments of quartz. It is not often traversed by quartz veins, but wherever these occur they are much confounded at their edges with the mass of the stone. Here then, as in other instances, we see that it exhibits the ambiguous or rather double appearance of a mechanical and of a crystallized deposit, a mixture of character, which,

as I have elsewhere remarked,* is not the least important difficulty which yet remains for geologists to explain.

I have reason to think that this rock will be found to occupy a very considerable space among the mountains in the vicinity of Glenco. In many places the fragments assume a dirty reddish appearance, which at a distance gives them the aspect of granite. Having in various instances made this rash conclusion myself, I think it right to suggest to those who may have an opportunity, the propriety of actually examining the rocks themselves before any opinions are formed of their nature from distant observations. From such investigations, not to be pursued without much leisure and favourable seasons, I have little doubt that the quartz rock will often be found where it was previously little suspected, and that it will be placed in a very leading situation in the system of the older rocks.

The last place which I shall now describe as affording an example of the quartz rock, is Tyndrum. The whole of this tract of country from Killin to Glenorchy in one direction, and from Luss to Loch Tulla at right angles to it, as far as it is visible from the road side, consists of mica slate, and is part of a most extensive district to all appearance formed exclusively of this rock. It is at the lead mine where the quartz rock is visible, and although I did not examine the summits of the neighbouring hills, I think it very probable that it will be found in other places among them. Its alternations with the schist are here not only perfectly satisfactory, but very frequent and numerous, and the works connected with the mine afford the greatest facility in observing them. The characters of both rocks are perfectly definite, and that of the

* Observations on Glen Tilt.

quartz rock is sufficiently various in different parts to establish its identity in the principal leading features, with the more extended masses which I have already described. It is also worthy of remark, that in some cases the same gradation which I have before noticed through schistose quartz rock takes place at the line of alternation. This instance therefore offers a proof easily inspected, and quite satisfactory, of its forming part of the same system of deposits as mica slate, and establishes its rank among the rocks of this class.

The mine of Tyndrum has long been known as a lead mine. Of the ores of this metal it affords only galena, but it also produces brown blende. It is in the quartz rock that the ore is at present found, the mine being wrought by open levels, lighted and aired from above by small shafts. Thus we see that this rock is also entitled to a place among the metalliferous ones, a circumstance which, with many others, should caution us against implicitly adopting those general rules respecting metalliferous rocks, which have been too decidedly laid down.

The nature of this paper has compelled me to chuse a geographical form of detail, which I have further preferred, that others may have an opportunity of examining the evidence on which these conclusions are grounded. But it has necessarily led to an account of the circumstances attending this rock, so detailed and divided, that it will not be useless for the purpose of mineralogical discrimination, to bring under one general view a description of all its leading varieties, and for the purpose of geological science, all the leading facts connected with its history. From the former (perhaps indispensable) details, future observers will be enabled to satisfy themselves of the truth of these fundamental remarks, and from the latter, opportunity will be afforded for a more easy ge-

neralization to those who may wish to assign its place in a system. I have selected for description all the most prominent varieties which have fallen under my notice, distinguishing their geological and geographical position whenever they were known to me, and marking at the same time the several gradations by which quartz rock appears to pass into mica slate, into clay slate, or into gray-wacke.

1. Pure white granular rock, consisting of amorphous grains of quartz, strongly agglutinated :—a perfect granular quartz. Although the grains separately taken are transparent, the mass is necessarily opaque. From Balahulish.

2. The same rock, but containing angular fragments of white felspar dispersed (although rarely) throughout it. From the same place.

3. The same rock, with extremely minute amorphous fragments of felspar in abundance. From the same place.

The rock whence these specimens were taken alternates with a very compact micaceous schistus, and the flat surfaces which have long been exposed to the weather, assume a sort of enamelled appearance, not much inferior to the polish given by the lapidary's wheel.

4. Pure white quartz, formed of semitransparent amorphous grains, but the mass has a fracture intermediate between the granular and splintery. From Sky, and alternating with micaceous schist.

5. A similar rock from Balahulish, of a pink colour, but with an aspect more harsh and dry, resembling common secondary sandstone. In the same situation.

6. Pure granular quartz in the same situation, but the grains of large size, and the fracture consequently very coarse. From Portsoy.

7. White quartz, with a fracture almost purely splintery, the granular texture being invisible to the naked eye, but sufficing to render the stone dull and opaque; alternating with micaceous schist. At Balahulish.

8. Granular quartz, of a dull aspect, in the same situation, and from the same place, with atoms of mica dispersed here and there throughout it.

9. Granular quartz disposed in parallel stripes, alternately white and brown, but containing no foreign substance. From Balahulish, and in the same situation.

10. The same with pyrites, and in the same situation.

11. Granular quartz, deeply stained by iron, from Assynt, of various colours, yellow, red, and brown, but the grains of quartz transparent; reposing on gneiss.

12. Granular quartz of a pale blue colour, containing pyrites; alternating with talc slate. Near Inverara.

13. Granular rock, formed of large grains of quartz of various dark colours, and generally transparent. It contains here and there rounded and distinct grains of red opaque quartz, and of glassy felspar. From Jura.

14. Dark-gray rock, of a granular splintery fracture, with pyrites. From the same place.

15. Dark greenish-gray, of a similar aspect, without pyrites, extremely compact. From Sky; following mica slate.

16. The same, of a darker colour, and from the same place. The influence of the weather whitens it, detecting what the magnifying glass cannot, the existence of felspar as an ingredient, and which is probably the glassy variety, since it cannot be distinguished

from the transparent quartz grains with which it is intimately united in the fresh rock.

17. The same rock in point of external aspect, but evidently formed of highly compacted and rounded grains of many different colours. From the same place.

18. Brown quartz rock, of which the fracture is so little granular that it almost approaches to common quartz ; semitransparent. From the mountains of Mar, Angus, and elsewhere, alternating with micaceous schistus.

19. The same rock, in the same situations, of various shades of red.

20. An almost equal granular mixture of pure transparent quartz, and snow-white felspar, the grains amorphous. From Arisaig and Balahulish, with micaceous schistus.

21. The same, but with fragments of felspar, bearing obscure marks of crystallization. From the latter place.

22. Waxy and perfectly compact quartz, having a porphyritic aspect from imbedded fragments of felspar ; accompanying the same rocks.

23. White granular quartz rock of a moderately fine grain, containing at the same time large angular pieces of quartz, of a diameter from half an inch to many inches. In the same series at Balahulish.

24. White granular rock consisting of felspar and quartz traversed by veins of pure white granular quartz, resembling in colour and texture the finest sugar. From Jura and elsewhere.

25. Distinctly rounded grains of the purest transparent quartz, imbedded in a mass of very fine grained white quartz. From the Cape of Good Hope.

26. An uniform mixture of grains of transparent white quartz and opaque reddish felspar, containing rounded pebbles and fragments

of purple and of white quartz, the pebbles being from half an inch to two inches in diameter. In Jura, forming part of the series of the purer quartz rock.

27. A brecciated mass of felspar and quartz of various colours, compacted by a cement of transparent quartz, forming part of the series at Balahulish.

28. Specimens from Arisaig, from Assynt, Mar, Balahulish, Airds, Sky, Schihallien, and numerous other places, which consist of variable mixtures of reddish felspar, and transparent quartz, sometimes appearing to be nearly all quartz, and at others to contain a large proportion of felspar. The grains are of various dimensions, and the texture of the stone is consequently various. At times it has the aspect of a fine reddish sandstone, at others of a coarse grit; and where the grains are very unequal in dimensions it resembles a breccia. The grains have never a defined form.

29. A rock consisting of narrow and alternating parallel layers, of fine and coarse granular quartz. Large grains of felspar are found in the coarse layer, but none at all in the fine one. From Balahulish.

30. A scarcely coherent combination of large grains of quartz and felspar, the interstices either empty or filled with clay. Part of the series at Balahulish.

31. Compact extremely fine granular splintery quartz, alternating in thin layers with clay slate. From Cowal.

32. Fine sandstones, not to be distinguished from the flœtz sandstones, and like many of them striped in endless alternations by black clay. From the series of Balahulish. These belong to that quartz rock which alternates with clay slate, and show the transitions between those two substances.

33. Fine grained granular quartz, alternating with layers of

parallel mica, so thin as not to be discovered in the cross fracture. From Fassavern, Balahulish and Tyndrum.

34. The same rock, but the layers of mica more conspicuous and undulating. From Balahulish.

35. The same passing into mere mica slate. From the series at Balahulish and Tyndrum. These demonstrate the alternation of the quartz rock with mica slate.

36. A large grained breccia consisting of fragments of quartz cemented by a mass of earthy white felspar, approaching to porcelain clay. From Jura.

37. A rock consisting of felspar and granular quartz, with here and there an atom of blue slaty clay interspersed among the grains. From Jura.

38. Various specimens of the same, with the clay slate increasing.

39. The same approaching still nearer to graywacke, with a basis of clay slate, and ultimately terminating in it. These two from Jura.

These specimens show the transition into common graywacke slate.

40. The same composition of rock, but in which mica slate holds the place of clay slate.

Different specimens of this variety demonstrate the passage of quartz rock into that sort of graywacke which I have described under the head of Aberfoyle. From Jura.

41. The same rocks passing by insensible degrees into a conglomerate, which will by some be ranked with common graywacke. From the same place.

From a comparison of the several characters under which this rock appears in the same place, from the similarity of these characters or of a majority of them in the different situations in which it occurs, there need be no hesitation in concluding that

quartz rock wherever occurring is generically the same, and that it differs no more from itself than the numerous varieties of gneiss, of mica slate, or of graywacke are found to do. It ought therefore to be designated in a geological system by one general name, since, as the designations of rocks are intended for the purposes of geology, rather than of mineralogy, it is preferable that one common term should be applied to the rock in question, than that the several varieties should each receive a separate one, a circumstance tending as much to confuse geological reasonings, as to render them tedious and intricate. It has already received various names, out of which it would be desirable to agree on one. It has been called granular quartz, transition sandstone, quartzose graywacke, and quartz rock. The first of these sufficiently expresses the character of one of its varieties; but its particularity excluding those modifications which are not granular, as well as those which contain felspar, is not well adapted for the purposes of geological description. Could we prove that it was in every case a rock of transition, and that the theory which the term transition implies was well founded, the name of transition sandstone would perhaps be the most applicable. But as I have ascertained that it alternates at times with rocks, which the system here alluded to calls primitive, and as it is at all times desirable to keep clear of those terms which involve an hypothesis, I think we are bound to reject this name. The same argument is valid against the appellation of quartzose graywacke, a term in other respects perfectly inapplicable, since the very definition of graywacke decidedly excludes it; and there can be no greater evil than to confound under one name, substances of different qualities, particularly when that name itself, from its connection with an hypothesis, tends to blind our judgment and pervert our reasonings. I should therefore suggest the superior propriety of the term quartzite or quartz rock, a term involving no hypothesis, and which, at the same time that it is sufficiently general to include

all the varieties which consist of mere quartz, does not exclude those which contain a mixture of other ingredients, more than the terms sandstone or limestone exclude the various bodies which so often are mixed with, or constitute an integrant part of them. When more particular description is required, a term so general admits of being easily combined or modified.

We have now to enquire into the rank which this rock bears in the generally received arrangement, and into its claims on a place in either of the classes of chemically crystallized or mechanically deposited rocks, or of that which is conceived to be a mixture of both; to use language more hypothetical, we must try to assign it a situation in the primitive, transition, or floetz divisions. It appears that it is found, as at Tyndrum and Loch Leven, alternating with micaceous schist, and in many other places with what is called primitive clay slate. Thus its claim to a rank among the first division of rocks is established. Its connection with graywacke in Jura, equally establishes its claim to a place among those rocks which are assigned to the second division. It is thus, like clay slate, a member of both these formations. I have already shown, that at Balahulish, as well as in Jura and in Assynt, the quartz rock contains mechanical deposits, from which it must follow that the existence of a mechanical deposit is not a decisive character for the rocks of transition, since a rock of which one of the characteristic circumstances is mechanical arrangement, is found to exist among the rocks called primitive. As I have also shown in describing the country about Aberfoyle, that a gradation from mica slate to graywacke takes place by insensible degrees, I think we may conclude that no valid distinction, nor any constancy of character, such as ought to constitute a class, is to be found in the rocks of *transition*; and that it would be preferable to return to the

ancient division of primary and secondary, as far at least as relates to those rocks which bear marks, however obscure, of stratification. It will be a separate consideration by what means we can divide those of the former class which contain organic remains, from those which are without them; a distinction, perhaps not less requisite in the one than in the other of these two leading classes, since, however many members of the floetz or secondary division may be characterized by the existence of these remains, a certain set are as invariably free from them.

It is perhaps beyond the bounds of the present notice, to suggest the propriety of separating the unstratified rocks, such as granite, porphyry, and trap, from this two-fold arrangement. Should such a measure be ultimately adopted, it will be further necessary to consider how far any one of the several unstratified rocks is peculiar to the one set of stratified ones, and how far it is common to both. A more accurate knowledge of the various rocks designated under the loose name of porphyry, will be particularly requisite to the forming of this arrangement.

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