
XIV. *On the Rocks in the vicinity of Edinburgh.* By

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ALTHOUGH science has only within these few years acknowledged the importance of Geology, the eagerness with which it has been cultivated, affords sufficient proof of the interest it is capable of creating. Of this we have a recent example in the laborious undertaking of Sir GEORGE MACKENZIE and his friends, who, notwithstanding all the dangers presented by a voyage through the most tempestuous ocean, and the deprivations to which they were exposed, in a journey through a country destitute of the slightest trace to guide the route of the traveller, were not deterred from exploring the inhospitable shores of Iceland. These, and other travellers, have extended our knowledge of various districts on the surface of the globe; but we have still to lament the extreme imperfection of the science, which, as yet, has assumed no decided character or form. This appears principally owing to the want of some simple method, grounded on clear and intelligible principles :

ples; perhaps also, to its having always been the object of those who have treated the subject, to accommodate their observations to a particular theory; and when this is the case, it is obvious, that the mind cannot refuse itself the satisfaction, of dwelling with comparative enthusiasm on facts which appear favourable to the adopted system; while others of a different tendency, are either reluctantly, and therefore superficially considered, or what is yet worse, even studiously avoided.

IN the present state of our knowledge, to divest geology of theory, would be to deprive it of all its interest. We must not despair, however, that by the multiplication of particular facts, and the exposition of others, with which we are still unacquainted, a system of geology may yet be formed, founded exclusively on the phenomena of nature, or at least on reasoning much less hypothetical than is now required.

THE most obvious means of attaining this object, seems to be a careful, minute, and candid examination of every circumstance which appears to convey an explanation of itself, without reference to any theory; and from these we may ultimately hope to obtain some data, equally certain and comprehensive.

It is with this view, that I have always formed my collections of geological specimens; and although it will appear, that the arguments I have deduced are favourable to one set of opinions, yet I can assert with confidence, that the district which it is the object of the present paper to examine, has been faithfully explored, and, I hope, candidly described.

IT is generally admitted, that no city in Europe is more favourably situated than the metropolis of Scotland, for the study and pursuit of geology: even the ground which it occupies, when laid open for the erection of buildings, has occasionally presented some very interesting phenomena. The hills in the immediate neighbourhood, always at command, afford a never-failing source of research; and in the surrounding country, a greater variety of fossils is to be met with, than almost in any space of the same extent.

THE importance of a complete acquaintance with the phenomena which surround this city, cannot therefore, I think, be considered of a trivial nature. Indeed, by the number of ingenious works already before the public, it may be thought that the subject is exhausted. But this is an error I am very desirous to combat, not only because in my own experience I have found it to be one, but because, as science advances, our habits of investigation improve, phenomena become more familiar, we learn to trace and to seize not only the objects we are in pursuit of, but also to detect others, which our less practised eye had originally passed over unnoticed.

WE all think ourselves perfectly acquainted with the rock, on which our Castle stands. But I suspect there are many members of this Society, who will be surprised to learn, that sandstone occurs near its summit, and also at its base. Salisbury

Salisbury Craig and Arthur's Seat appear perfectly familiar to us ; there are phenomena belonging to both, however, of which, I have no doubt, many are yet ignorant. That any circumstance of an interesting nature, should remain unobserved, can only be accounted for, by its being taken for granted, that these conspicuous objects, having already undergone much critical examination, nothing farther remains to be noticed. This is an opinion, which I shall prove in the sequel, to be without foundation.

Arthur's Seat and *Salisbury Craig*, are naturally the objects, which first attract the attention of the geological traveller, on his arrival in Edinburgh ; and to these places he is generally conducted by some one of our *amateurs*, when the favourite theory is introduced, and each corroborative fact dwelt upon, with all the usual keenness of theoretic discussion. This was the ground which, in all probability, first suggested the Theory of HUTTON ; and it was perhaps here, that his comprehensive mind originally laid the foundation, of the structure which he afterwards so successfully reared. But that theory, in itself so beautiful, and in many points so perfect, I am very far from embracing entirely. I am very far, indeed, from following him through his formation and consolidation of strata, or the transportation and arrangement of the materials, of which they are composed. There are other circumstances also, which, though totally irreconcilable with any other hypothesis, are yet but imperfectly explained by his. I particularly allude to the singular contortions, exhibited in what are termed *Transition* strata, so finely exemplified on the coast of Berwickshire. I wish to carry my inductions, just as far as facts will bear them out. It is therefore, only in the regions of unstratified rocks, or in their immediate vicinity, that I have as yet, been able to discover

discover a language, which, if studied with due attention, cannot fail, I think, to become intelligible, and carry conviction to those, who choose to reason impartially on the subject.

IN the writings of Dr HUTTON, we do not meet with descriptions of particular districts, his object being rather to establish a general theory, by the particular facts which these districts afforded.

WE cannot, therefore, look to him for a mineralogical account of the neighbourhood of Edinburgh; and we have to regret, that no other geologist has yet undertaken that task.

IN a short notice, in the Appendix of a work on another county, by Professor JAMESON, this vicinity is mentioned as principally belonging, to what is termed the *Coal Formation* by WERNER, which, according to the system of that celebrated naturalist, forms part of the *Flatz* rocks.

To render these terms intelligible to the general reader, it is necessary to give some explanation, as, without a considerable knowledge of the system to which they exclusively belong, they must be totally incomprehensible.

WERNER is the only person, who has attempted a regular arrangement of rocks; an arduous undertaking, which I have no doubt he has accomplished, with all the accuracy the subject was susceptible of, and so far as the country he examined allowed*.

BUT it appears very evident, that the facts he met with were such, that, in consequence of the hypothesis he had previously thought proper to adopt, it became necessary to invent a theo-

* LINKS from other quarters, having been subsequently added to his formation-suites, by his pupils.

ry capable of embracing all the phenomena, which the construction of his systematic arrangement led him to observe. A peculiar language was therefore indispensable; and as this language has been constructed with so much regard to his theory, unless that is understood and adopted, his terms become useless.

By a *formation* is meant, any series or suite of rocks which usually occur together; hence the Coal Formation is composed of

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| 1. Sandstone, | 6. Limestone, |
| 2. Coarse Conglomerate, | 7. Marl, |
| 3. Slate-clay, | 8. Clay-ironstone, |
| 4. Bituminous Shale, | 9. Porphyritic Stone, |
| 5. Indurated Clay, | 10. Greenstone *, |

with which the Coal occurs in numerous beds, varying extremely in thickness. These, however, never all occur together, and it is no detriment to the Coal Formation suite, even if Coal itself should not be found among them.

AGAIN, the term *Flötz* is given to all the formations, contained between the transition and alluvial rocks, and implies that they are distinguished by their frequent occurrence in beds, which are much more nearly horizontal, than the primitive and transition

* Greenstone is a literal translation from the German; it is an extremely improper name; but as we have no other by which we can distinguish this variety of trap, we must use it till a more appropriate is found, even at the expence of such language as *red and blue greenstones*. In the mean time, it must be understood merely as an arbitrary term.

transition rocks. If directly translated, the word signifies *flat*, and may be correctly descriptive of the districts originally examined by WERNER; but as this construction will not apply universally to this class of rocks, and as it is particularly at variance with those belonging to it in this country, it would be better to follow the example of Professor DAVY, and use the term *parallel rocks*, which is much less liable to objection.

THE Huttonian Theory has no language peculiar to itself, having nothing to describe, that cannot be done in the usual phraseology of any country. This, by the zealous admirers of that doctrine, may no doubt be lamented, as depriving it of an apparent systematic arrangement, to which the opposite theory is so deeply indebted.

IN forming a collection from the rocks in the neighbourhood of Edinburgh, the circumstances above narrated, induced me to begin with those of Salisbury Craig and its vicinity. The collection I have now the honour of presenting to the Society, I began some years ago: it is only part of a series, which, as completed, I hope may be found worthy of a place in their cabinet. I consider it of very great importance, that every geological paper, should be accompanied with specimens, in order that if the former be found deserving of publication in your *Transactions*, those who peruse the description may know, that the specimens referred to, are to be seen in the repositories of this establishment.

SALISBURY CRAIG is situated on the north side of Arthur's Seat, against which its southern extremity rests: from this it extends, in a northern direction, and rounds towards the east, so as to form the segment of a circle, about half a mile in length. It is surmounted by a magnificent façade, which is lowest at the extreme points; towards the middle, the perpendicular rock may be from 80 to 90 feet high. From the base of this precipice, a sloping bank, covered with debris, reaches to the valley below, altogether forming an elevation of nearly 400 feet. From the upper edge of it, a regularly inclined plane, slopes gently, on the opposite side, at an angle of about 15° , in a north-east direction, and forms the left bank of the valley, called the Hunters Bog. On the right of this valley, the rocks again rise rapidly, affording indications of two or three separate façades. These are not characterized in the distinct manner of Salisbury Craig, but are surmounted by a surface, which, though a little rounded, presents an inclination corresponding with that of the Craig, in a very striking manner.

FROM the base of Salisbury Craig, or rather from the base of the debris by which it is encircled, towards the southern extremity, the ground again rises, and presents an inclined plane, similar to its own, but of less magnitude. This is known by the name of St Leonard's Hill.

HENCE it appears, that there are three similarly inclined planes or terraces, of which Salisbury Craig forms the intermediate one, each of them having a different elevation. From this structure we may easily conceive the origin of the Swedish word *Trap*, which has been employed as a generic term, for the

the class of rocks to which this appearance may generally be attributed *.

IF we imagine a vertical plane, to pass from St Leonard's Hill in an E. N. E. direction, which shall cut Salisbury Craig, and continue through the right bank of the Hunters Bog, we shall find the rocks disposed in the following manner :

St Leonard's Hill.

Sandstone.
 Porphyritic Greenstone.
 Sandstone.

Salisbury Craig.

Sandstone.
 Greenstone.
 Sandstone.

Hunters' Bog.

Greenstone.
 Sandstone.
 Porphyritic Greenstone.
 Trap-Tuff.
 Basalt.

The

* One of the greatest difficulties which geology as well as mineralogy has laboured under, is the multitude of synonymous terms which have been applied to every individual fossil. TRAP has suffered from this disadvantage, perhaps more than any other variety of rocks ; as above noticed, that name is derived from the similarity to the steps of a stair, which may generally be traced in the outline of a country, in which this rock abounds ; and as it has been employed as a generic term by mineralogists throughout Europe, I think it proper to use it, to the exclusion of *whinstone*, the name it bears in the writings of Dr HUTTON ;

The two last of these are not comprehended in the Coal Formation suite; they are considered as members of another formation, denominated the Newest Fløetz-Trap.

THE upper sandstone of St Leonard's Hill, and the lower sandstone of Salisbury Craig, are, so far as we know, continuous; but as these, supposing the lines of the strata to be projected, would form a bed of 450 feet thick, it is possible alternations of greenstone may occur in it. Above, I have only mentioned such as are visible.

THOSE on the right of the Hunters' Bog, are not so distinctly exposed as the rest; but the fossils are all found in the order I have stated. Occasionally small seams of reddish-brown coloured slaty clay, and clay-ironstone occur, principally intermixed with the sandstone; but they are so thin, and so unconnected, that they can scarcely be considered as strata.

THE series of specimens I am now about to describe, are those of St Leonard's Hill and Salisbury Craig.

No. 1. is a specimen of the Sandstone of St Leonard's Hill; it is of a reddish-white colour, and extremely coarse-grained. It was taken from the middle of the quarry, and presents a species of conglomerate, the fragments of sandstone being agglutinated by a dark-red ferruginous paste.

No. 2. from the same quarry, is more compact, and presents a streaked appearance, corresponding with the direction of the stratum. There is a considerable degree of irregularity to be observed, in tracing the line of junction at St Leonard's Hill. In some places, two or three folds of the strata are cut off abruptly

a name which, though perfectly understood in this country, is not received abroad, and ought therefore to be relinquished.

abruptly at each end by the greenstone; in another, that substance sinks suddenly as it were into a gap in the strata, and being lost in rubbish, has somewhat the appearance of a dike. Beyond this a double horizontal wedge of greenstone, with the ends turned downwards, appears among the strata; and a little farther, towards the north, a roundish mass of the same substance also occurs; this has very much the appearance of an included fragment, but the decomposition of the sandstone has just begun to expose its connection with the rock above.

ON the sandstone, Porphyritic Greenstone (No. 3.) rests. The colour of this is reddish-brown; the texture is fine-grained; and it contains small specks of flesh-coloured calcareous spar. It is traversed in various places by veins of Hematitic Iron-ore (No. 4.) accompanied with sulphate of barytes. These two specimens have very much the character of some varieties of porphyry-slate, and on breaking one mass, I observed a tendency to a flaty arrangement. In different places of this quarry, the greenstone assumes a variety of appearances (No. 5. and 6.), some of which might be attributed to decomposition. I do not conceive, however, that any external cause has ever had much effect upon this rock, although in some places it has entirely lost its lustre, (No. 7.), and might be mistaken for trap-tuff, were it not for the shape of the crystals.

ABOVE this, the rock graduates into a highly crystalline Porphyritic stone, (No. 8.) the paste of which is of a brownish-grey colour, very close-grained, with an uneven splintery fracture, containing both crystals of felspar and hornblende.

IN this quarry there are several instances of *slikensides*, one of which is rather remarkable, it occurs in an inclined rent in the sandstone: the traces of the slip, (No. 9.), are horizontal,

tal, and extremely well defined ; but immediately over it, in the greenstone, the appearance of the slip is not continued. Some indications of a slip appear a little to the right of it.

IN a part of the Greenstone which is considerably decomposed, a vein, stretching horizontally, of a dark-green fibrous substance occurs, (No. 10.) ; it is soft, and has a shining satiny lustre, like asbestos. I have not anywhere in this vicinity met with any similar substance.

WE now proceed to Salisbury Craig, where the circumstances I shall principally notice, are,

1. The texture of the greenstone rock, with the fossils it contains.
2. The vein of greenstone by which the Craig is intersected.
3. The included mass of sandstone which occurs in the greenstone ; and,
4. The indurations and interruptions of the strata.

NO. 11. is a specimen of the greenstone taken from the lower edge of the bed, at the great quarry, where it touches the sandstone ; the point of contact being marked by a small remaining fragment of the latter, at which the grain of the stone is much finer than at the other extremity. The colour is iron-grey, with small specks of calcareous matter interspersed.

Nos. 12, 13, & 14. are different gradations of texture, taken in a vertical line, from the edge towards the centre, where the stone is always most perfectly crystallised ; from hence it again declines in grain towards the upper surface, where we find it in the same earthy and uncryallified state (No. 15.) observed at the bottom. In the last specimen, there is a small detached
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fragment of the stratified matter imbedded in the greenstone, a circumstance connected with a very important class of facts.

No. 16. This specimen of greenstone is remarkable, as exhibiting a variety of colours; these are not blended, but distinctly divided from each other. The colours are iron-grey, light-grey, dark-red, and brick-red.

No. 17. This specimen is a strong example of the impropriety of the name which it bears; it is a greenstone, decidedly of a red colour. The singular penetration of ferruginous matter, which is exhibited in various parts of this rock, is not easily accounted for; but supposing it to have been once in a state of fusion, it may have obtained this superabundance of iron by absorption, as the adjoining strata frequently abound in that mineral.

IN various parts of the Craig, veins of a peculiar nature may be observed; they are composed precisely of the same ingredients as the rock, and are distinguishable only by the red colour of the felspar, (No. 18). These are termed *contemporaneous veins*, or *veins of secretion*; they are deeply waved, and generally follow the direction of the bed. Some of them present a very bright brick-red colour, (No. 19.), mixed with specks of calcareous spar.

Nos. 20, 21. in these specimens, are small globules of a black earthy substance, which I am at a loss to name. I should have considered it Amphibole, but for the next specimen, (No. 22.), in which the same substance appears to occur in irregular fragments.

No. 23. Analcime with crystallised Calcareous Spar. I before noticed, that it was in the heart of the bed where the substance of the greenstone presented the crystalline texture in

the highest perfection. The occurrence of the analcime is connected with the same fact. I have never been able to find it on Salisbury Craig, excepting at one period, when an entire section of the bed was quarried off, and about the middle of this the analcime occurred.

* No. 24. with fulphate of barytes, with calcareous spar iron-ore.

No. 25. part of a very irregular vein. Its sides are formed of calcareous spar iron-ore, which is followed by a coating of hematitic iron. Here the regular stratification, as it is called, of the vein ends, and calcedony, first semitransparent, then opaque, and common calcareous spar, occupy the rest.

No. 26. calcareous spar iron-ore crystallised, with some transparent crystals of quartz.

No. 27. large crystals of calcareous spar, with crystallised and radiated tufts of quartz.

No. 28. red oxide of iron, with a vein of calcareous spar iron-ore.

No. 29. green coloured quartz, with a coating of crystallised quartz.

No. 30. crystallised quartz, with amethyst.

SUCH are the minerals which occur on Salisbury Craig. Some of them are rare, and others to be found only when the rock is working in particular places.

THE next circumstance I have to notice, is the vein of greenstone *. It occurs a little to the north of the spot, to which

* The term *dyke* has been very generally applied to *veins* of this description, and I am not satisfied that it is the least proper of the two; as there certainly is a marked distinction between veins composed of rocks, and what we general-
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which the cart-road, along the base of the rock extends, a few feet beyond a gap, known by the name of the *Cat's Nick*.

I do not think this vein attracted the attention of geologists in any particular manner, prior to 1805. It certainly was observed long before that period, but was not known to extend through the bed of greenstone, till Sir JAMES HALL and myself noticed, that after cutting the sandstone, it continued its course uninterrupted to the top. This observation contributed very much to increase our curiosity, and a man was employed to clear away the soil and rubbish, which had accumulated on the surface. A considerable portion of the rock was soon laid open, below the point from which it was at that time visible. Nothing, however, of much interest, was by this means discovered. The dike, after bending a little to one side, continued its course downwards.

THE space which this dike occupies, may be from six to eight feet wide ; its width varies a little in some parts, and these variations are apparently increased, if the section which is observed be not at right angles with the walls. That portion embraced by the strata, which we found principally covered with debris, was very much decomposed, presenting on the surface a certain degree of nodular exfoliation, of a rusty-

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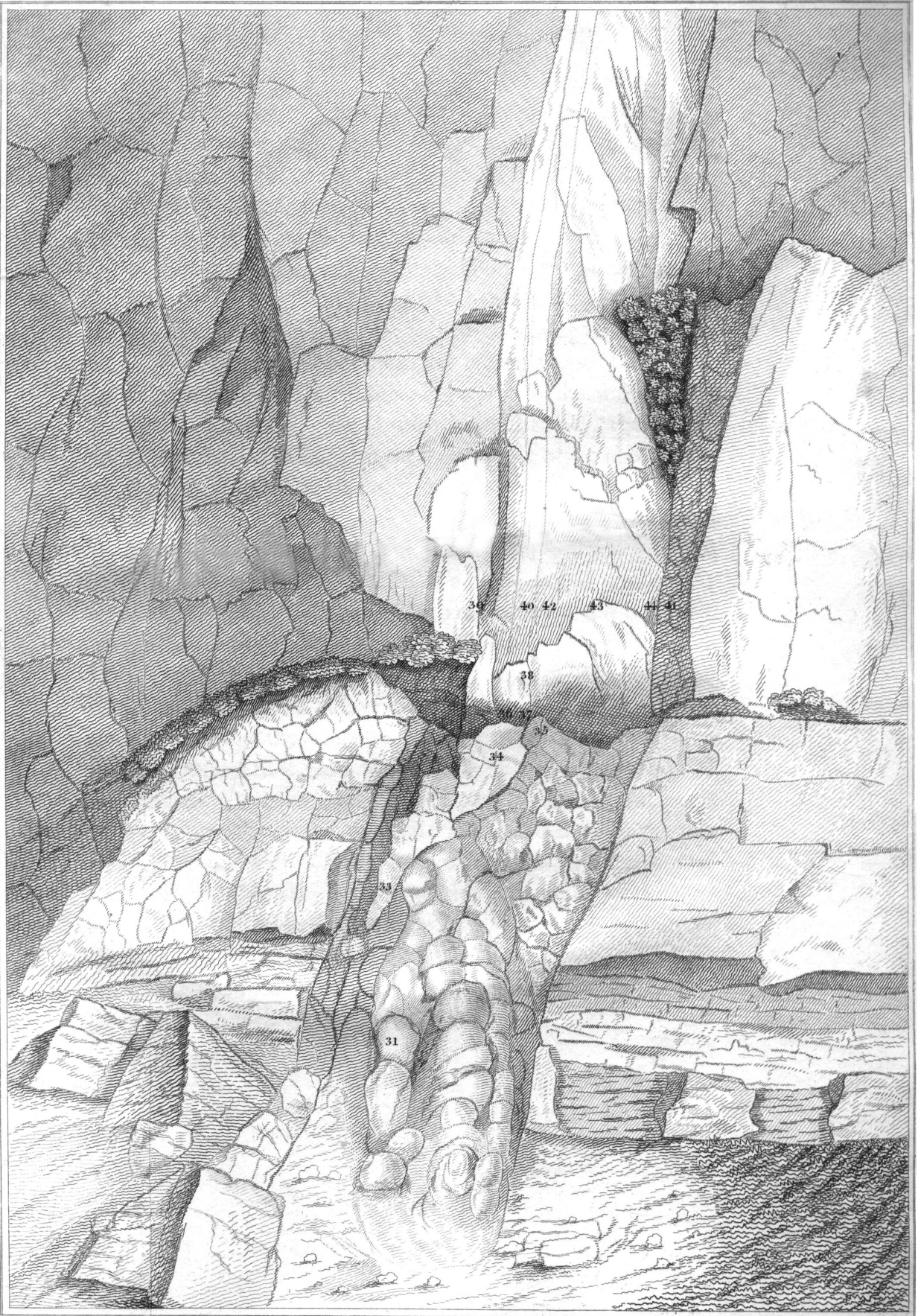
brown

ly understand by mineral veins. The first are formed of one uniform rock, composed in all their parts of the same constituents, and differing only in position, from the beds these materials more usually form ; while the latter, though sometimes formed only of one substance, such as quartz or calcareous spar, are generally composed of a series of fossils, arranged in lines parallel to the walls. No such appearance ever prevails in rock veins, or constituting mountain masses ; therefore, in using the term *vein*, when applied to greenstone, granite, or the like, it must be understood as a generic term, of which these latter, specify the variety.

brown colour. On breaking into the rock, it exhibited (No. 31.) * the concentric lines so common in decomposing greenstone; and beyond this, the stone presented a degree of freshness, with a very coarse grain of a peculiarly light ash-grey colour, and a very dull earthy texture, (No. 32.) Between this portion of the vein and that embraced by the greenstone, there is a very remarkable difference, the latter being of the usual iron-grey colour, and otherwise perfectly characteristic. Before it leaves the sandstone strata, it seems to contain an unusually large proportion of calcareous matter. This may have aided the decomposition, together with the moisture retained by the debris, so lately removed from its surface, and which has left it in a state easily affected by the weather. Since I commenced writing this paper, I made an excursion to the spot, and was greatly surprised to observe the devastation of last winter.

Before the vein rises above the level of the strata, a portion of it, still more decomposed than the rest, of a dark-purple colour, branches off, and embraces a wedge-shaped mass of the sandstone (No. 33. and 34.) indurated in a very high degree. Just at the top of this indurated mass, the whole dike changes its colour, and, I may also say, its consistence. It here presents a light-greyish aspect, deeply stained, with red ferruginous marks, of a dull earthy texture, an even fracture, and a tolerably fine grain, (No. 35.) That portion corresponding with, and immediately over the included sandstone, I found much coarser in the grain, (No. 36.), and in a more decomposed state ;

* Corresponding numbers will be found in the annexed engraving, which will explain more fully the relative position of the specimens.



state; while it differed from No. 37., the stone on the sides, which were perfectly similar to each other in composition.

TRACING the friable purple-coloured portion upwards, I found it gradually became harder, and, of a sudden, change to a fine-grained blue-coloured greenstone; and the part corresponding with the included mass, alter to a hard coarse-grained rock, (No. 38.) I soon observed, that this coarse-grained mass, which is about ten inches thick, continued upwards, maintaining an uniform dimension and position, in respect to the walls of the vein, as high as the eye could trace it in the rock, thus dividing it into two portions; that on the left side being about eighteen inches wide, while the other is about five feet.

ON comparing the texture of the included stripe, with that of the walls on each side, (No. 39. left side; No. 40. included stripe; No. 41. right side,) taken in a horizontal line, about six feet above the strata, I found as close a resemblance as it is possible to conceive; they are all coarse-grained, and highly crystallised. This similarity is not more remarkable, than the difference between the substance of the vein and the included mass. Specimens taken from the junction of these, mark this in a striking manner. No. 42. is from the left side of the right portion of the vein, to which the fine-grained part belongs. No. 43. is from the middle of this portion; and No. 44. from the side next the right wall. These were also taken in a horizontal line, and exhibit the same gradation of grain noticed as existing in the great bed. Even in the narrow portion of eighteen inches, on the left side, this circumstance is quite visible; but the specimens taken from the other are highly illustrative of the fact.

I HAVE had an opportunity of examining many veins of greenstone; but I know of none more interesting in a geological point of view than this.

I THINK it can scarcely be doubted, that the same effort which separated the included portion of sandstone, cleft the corresponding stripe of greenstone from the great bed. This, as well as the gradation of grain, everywhere observable in beds and veins of trap, are remarks, in my opinion, of considerable value to the Huttonian hypothesis. On a former occasion, when I had the honour of submitting some remarks on the north of Ireland to the Society, I took an opportunity of dwelling particularly on the last circumstance. Like the charring of coal, when that substance is found in contact with whin, as has been ably remarked by Professor PLAYFAIR, "few facts in the history of fossils so directly assimilate the operations of the mineral regions with those which take place on the surface of the earth*." This gradation of texture has a strong analogy to many accidental facts observable in furnaces, of glasshouses and the like, and still more so to those experiments made expressly for the purpose of ascertaining the effects of slow cooling, by Sir JAMES HALL and others. One additional argument for the igneous origin of these veins, has been added by the observations of Sir GEORGE MACKENZIE and his friends, in Iceland, in perfect correspondence with the above fact. He there found many veins of this substance, coated on the sides with a glassy covering, exactly similar to melted greenstone, when rapidly cooled.

I SHOULD expect the same circumstance would be met with in veins of porphyry and granite; but I have not been able to extend

* Illustrations of the Huttonian Theory, § 68.

tend my observations so widely, as to embrace the facts respecting these rocks. One remark I shall, however, hazard in this place, respecting an essential difference between veins of granite and those of greenstone. The former seem to be of simultaneous formation with the great body of that rock, to which they may generally be traced, and, so far as I have hitherto observed, are never found to cut it. Veins of greenstone, on the other hand, I have never seen connected with the great beds of that substance; they traverse these just as they do every other kind of rock, and consequently are in all instances of a posterior formation. I am aware, that these ideas are very much at variance with certain received opinions. I therefore wish to be understood as speaking solely upon my own experience.

I HAVE now to mention the well-known included mass of sandstone. Along the edge of the strata, a number of instances occur on Salisbury Craig, affording the most unequivocal marks of disturbance; but it presents only one example, of a mass totally enveloped in the substance of the greenstone*.

THIS spot has been the scene of much controversy, between contending geologists. While the Huttonian considers it as a most incontrovertible proof of violence and of heat, the Wernerian contends, that there is nothing in the least extraordinary in the appearance, and asserts, that the superficies of the apparently included mass, is no more than the section of some part of the stratum, which, if traced, would be found to connect with the rest; that it had been enveloped in the fluid menstruum of the greenstone, when in this elevated position; and that the rock being

* Since this paper was sent to press, others have been observed in different parts of the rock.

ing cut in a certain direction, a section having the appearance of an insulated mass, would of course be exposed to view. There is no doubt that such a circumstance is perfectly possible; but, in the present instance, this explanation will not be found at all applicable. In every other case, where the strata appear displaced, they are not torn from the rest, nor has the greenstone insinuated itself, except as a wedge, supporting the lifted masses. The included mass is of a light greenish-grey colour, in shape quadrangular, and, when minutely examined, will be found shivered into numerous distinct fragments, with veins of greenstone running through it in every direction. It partly retains its original stratified texture (No. 45.) although indurated in a very high degree, and is so firmly welded to the greenstone, that it is no difficult matter to obtain specimens (No. 46.) of the conjoined rocks; one small specimen (No. 47.) in the collection, is twice intersected by that substance. It, therefore, has no resemblance whatever to those pieces of strata, which are only in part detached, and which, if cut in a transverse direction, would, in all probability, exhibit an insulated section. That section, however, would not display the broken and distorted appearance described above, at least if we may be allowed to judge by the integrity of the longitudinal sections, of which there are so many examples in this vicinity. Besides, the colour of the included mass is totally different from that of any of the strata near it, which are here of a deep red (No. 48.), and at this particular spot are remarkable for their apparent derangement. I therefore conclude, that there is every reason to consider this, as a fragment detached from some other part of the sandstone, and left suspended in its present situation, when the greenstone assumed a solid consistence, as was originally conjectured by Dr HUTTON.

I now come, as proposed, to that division of the subject which relates to indurations. By *induration* is meant, a greater degree of compactness, observable in particular parts of stratified rocks, than is usual throughout their mass. One part of a bed may be harder than another, consequently more indurated. But the induration here alluded to, is that which is supposed to have been effected, by an alteration in the density of the stone, in consequence of the action of heat.

THESE phenomena are of a very striking nature, and were first brought into notice by Dr HUTTON; in them, he found evidence, to him perfectly conclusive, of the igneous formation of whin, and, with that ingenuity and perseverance which characterise the whole of his works, he did not fail to generalise his observations, and to place the facts, first noticed in this spot, in such a light, as to render them essentially useful to his theory.

THE anxiety which the disciples of the Wernerian school have always evinced, to undervalue the merit of this observation, is a sure mark of the estimation in which they hold it; and it is, therefore, very properly considered by the supporters of the opposite doctrine, as one of their strongest holds. In the following list, are comprehended most of the varieties, which this indurated sandstone presents on Salisbury Craig.

No. 49. is a junction specimen*, taken near the southern extremity of the Craig; here the greenstone is of the deep red tinge noticed at No. 17.

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No.

* By *junction specimen* is meant, a specimen which exhibits the greenstone and the sandstone conjoined.

No. 50. is another specimen of the same kind; the greenstone is here of the usual colour, and the line of junction most admirably defined. This was taken from the great quarry. The next, (No. 51.), is a specimen of the sandstone in its supposed unaltered state. Nos. 49, and 50. are both from the lower junction. No. 52. is from the upper edge, taken about half-way between the highest part of the Craig and Holyroodhouse. Here the sandstone presents a faceted appearance, an arrangement which may be owing to the superabundance of calcareous matter.

No. 53. is highly indurated, of a deep red colour, with a conchoidal fracture, and a faceted texture.

No. 54. has the same faceted appearance.

No. 55., extremely close-grained, is from one of the contortions north of the dike.

Nos. 56, & 57. These are the varieties of the sandstone which have been called *jasper*. This is an improper name, as it confounds two substances totally different. The most compact contains a large proportion of lime, and in aspect is very similar to some of the limestones of Gibraltar.

Nos. 58, to 61. are varieties of the sandstone, found near the greenstone.

No. 62. Although this specimen was taken very near the greenstone, still it does not exhibit the usual induration. This exception occurs in different places on Salisbury Craig; and it even sometimes happens, that the stone next the whin is less indurated than the one below it.

No. 63. Containing a large proportion of ferruginous matter.

No. 64, to 66. Different shades and varieties of the sandstone, in an indurated state.

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No. 67. In this specimen there is something very like the appearance of an agate ; it, however, is not contained in the substance of the greenstone, but in the stratified matter below it.

No. 68. Another specimen of the sandstone, in its unaltered state, taken about thirty feet from the greenstone.

DR HUTTON conceives, that the induration, so very remarkable in the above specimens, was occasioned by the heat of the whin, when it was injected between the strata of sandstone, causing it to undergo a certain degree of fusion ; and, to this idea, the faceted texture of some of the specimens adds considerable weight, such arrangements being very familiar in stones which have undergone fusion.

THE Wernerian school, to account for the same phenomenon, asserts, that as sandstone is generally porous, the fluid solution of the trap being introduced into the fissure, naturally percolated to a greater or less extent *. Again, that it is owing to the intermixture of the matter of the vein, with the rock that forms its walls † ; and, as a proof of this, it is added, that no induration appears, where the traversed rock is possessed of a quartz base.

THESE arguments occur in different works, but they appear to me very little calculated to support the point in dispute, if not in some respects contradictory. On Salisbury Craig, and generally throughout the neighbourhood of Edinburgh, wherever we find sandstone coming in contact with greenstone, either in beds or veins, we are almost certain, that an induration will be exhibited along the edge of the strata.

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* Comparative View of the Huttonian and Neptunian Theory, p. 130.

† System of Mineralogy, vol. iii. p. 365.

It has already been observed, that there are spots on Salisbury Craig, where this is not so apparent as in others, and it very often happens, that small seams of clay occur, in a perfectly soft state. In Ireland, at Scrabo, in the county of Down, and at Fairhead in that of Antrim, I found sandstone in the former, cut by veins, and in the latter, overlayed by a bed 300 feet thick, where no induration was to be seen. Now, it appears conclusive, that there could not have been a deficiency of induration in any speck of Salisbury Craig, far less a total absence, as in the cases quoted in Ireland, had it in any instance been effected either by percolation, or by the intermixture of the matter of the vein. The superincumbent or included matter, if in a fluid state, whatever its chemical powers were, would, to a certain extent, act mechanically, and be, in all circumstances, possessed of the same power of communicating its moisture to the surrounding masses. It is therefore impossible to conceive, how it should have withheld it in one instance, and parted with it so amply in another, how it should have indurated the sandstone, and left the thin seams of clay in a soft and friable state. It is quite unimportant, of what base the sandstone may be formed; it is a substance, allowed as above to be generally porous, (and, in the cases alluded to, it certainly was so); into that porosity, therefore, the fluid must have percolated, whatever the base may have been.

ON the contrary, according to the Huttonian hypothesis, induration distinctly depends, on the composition of the strata exposed to the influence of heat. Some strata may either wholly, or in part, be capable of resisting much higher temperatures than others. It is consequently to the ingredients of which they are formed, that we must look either for the cause of induration, or the absence of it. This remark originated in observing,

serving, that all the indurated sandstones of this country, contained more or less calcareous matter, while the unindurated specimens from Ireland, did not afford the slightest indication of that substance, when subjected to the same test.

BEFORE I take leave of Salisbury Craig, I must notice one more circumstance, which, so far as I have hitherto seen, is quite peculiar to the spot. I mean the occurrence, in veins, of a substance in all respects similar to the indurated sandstones, I have just been describing. The first of these I observed, is about thirty paces north of the vein. The ground being cut away, in order to see its connection with the strata, it branched out like the prongs of a fork, and had the interstice filled with a red decomposed substance (No. 69.), similar to that which occurred at the extremity of the included stripe of greenstone in the vein. Where the prongs join, it is about three or four inches wide, and is there, partly composed of indurated sandstone, and partly of hematitic iron-ore and calcareous spar. (No. 70.) Higher up, where the vein is narrower, it is wholly composed of sandstone, the specimen, No. 71., being the entire thickness of it. Here the grain is finer than at first, and, higher up, it becomes still more so, (No. 72.) It still continues to taper upwards, and even when reduced to less than half an inch, the substance retains the usual aspect of indurated sandstone, (No. 73.) This vein rises about twenty to thirty feet into the rock, always diminishing, and about that height disappears. I have remarked other veins, also containing substances similar to indurated sandstone (No. 74.), one was of a much larger size than that above described (No. 75.), but the grain not near so compact, (No. 76.)

THESE veins all set off from the lower surface, and so long as they are of any considerable thickness, the including rock is stained

stained with ferruginous matter. This fact seems connected with the singular appearances, which occur in the vein of greenstone, at the level of the junction of the sandstone strata with the incumbent bed.

WITHOUT offering any remarks on a fact as yet so insulated, I content myself with merely mentioning it, in hopes that similar appearances may present themselves to geologists in other quarters, and perhaps throw some light on a phenomenon, which by farther elucidation may prove interesting.

BEFORE I close this paper, I shall take the opportunity of presenting to the Society, two specimens which were given to me by Sir GEORGE MACKENZIE, and which I esteem of considerable value; one of them, a fragment of the rock of Salisbury Craig; the other, of the Calton Hill, marked in the handwriting of the late Dr KENNEDY, as the substances he analysed, and of which an account was given in the 5th volume of these *Transactions*. The great variety in the rock, both of Salisbury Craig and Calton Hill, makes it of importance to ascertain with precision the kind employed in the research of that celebrated chemist; and as the most proper place for their reception, I deposite them in the cabinet of this Society, along with my own collection, under the Nos. 77, and 78.

19th March.

SINCE I had the honour of reading the foregoing paper to the Society, a strong case in illustration of what is mentioned in the commencement of it, has presented itself; I mean, with respect to the constant occurrence of new and interesting matter, even in the most frequented ground.

A FEW days ago, Professor PLAYFAIR mentioned to me, that by the cutting down of a section of the Craig, within thirty paces of the southern extremity, several masses of sandstone had made their appearance, imbedded in the greenstone. I lost no time in visiting the spot, and was greatly pleased to find, a considerable addition to the interesting facts, already exhibited on Salisbury Craig.

AT this part of the rock, the greenstone becomes very thin, being no more than twenty to twenty-five feet thick; it has the appearance, however, of having once been of greater extent, the upper part being apparently cut away by some operation of nature, of which we have now only to observe the effects. It slopes rapidly towards the south, and is covered to a considerable depth with soil and travelled stones. It is at the upper surface of this, that the imbedded masses occur; they appear to be portions of strata, which observe the general inclination of the sandstone of Salisbury Craig, that is, dipping towards the north-east, while the exposed sections are parallel to each other, and nearly horizontal; consequently, being near the surface, they are cut off, or crop out, on the south side. Their appearance,

appearance, however, bespeaks their having been, at some former period, totally included in the greenstone. One mass, indeed, a little towards the north, is unequivocally so; at least we know with certainty, that a short time ago it was inclosed in the greenstone, and not to be seen; and there is at present, great apparent probability, that the next section taken from the same part of the rock, will carry it away altogether.

TILL now, we only knew of one included mass in the greenstone of Salisbury Craig; and with this, these now discovered have considerable analogy; they are of the same colour, and although they appear to be only four or five distinct masses, these masses are all intersected vertically and diagonally, and are split through the whole length of the horizontal line; so that in examining a section of about ten feet perpendicular, no less than nine different alternations of sandstone may be reckoned. Some of them are no doubt very minute; but still they were all observable when I examined the rock.

FROM the most northern mass of included sandstone, I was enabled to procure a few specimens, which I have added to the above collection. The rock rises so rapidly from the south, that although this mass is nearly in the same horizontal line with the others, all of which crop out to the surface, and although it is not distant more than four or five yards, yet it appears to be situated nearly about the middle, between the sandstone and the upper surface, from which it may naturally be inferred, that the masses which now crop out, were like this, once entirely included in the substance of the greenstone. It is highly indurated, and at the extremities, is drawn out into minute veins. The thickness of the principal mass may be from ten to twelve inches, and in length from six to eight feet. This body, as above noticed, is cut in all directions by the
greenstone.

greenstone. The specimen No. 79. shews a portion of the sandstone, with that substance traversing its stratified lines diagonally. No. 80. is a mass of the sandstone, containing a small portion of greenstone, much of the same shape as the double wedge of St Leonard's Hill, and formed, as I conceive, exactly in the same manner. This wedge, on one side of the specimen, is two inches long; but, on the opposite, it is not one; and in the counter part of the same specimen, (No. 81.) it is only to be seen on one surface; it does not penetrate to the other side, though scarcely an inch thick.

I AM glad to find, that interest has been made to prevent this valuable set of facts from being soon destroyed, as, in a few weeks, the rock in which these are contained would have been broken down, and carried off for the repair of the neighbouring roads.

It is on this account, that much activity is requisite to keep these perishable phenomena from being lost, in the neighbourhood of such a town as Edinburgh. Similar things are presenting themselves constantly, but they are opened only for a day, and if not seized and recorded on the instant, will be shut up, and lost for ever.