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1. *On the Parallel Roads of Lochaber.* By THOMAS LAUDER
DICK, Esq. F. R. S. EDIN.

(Read March 2. 1818.)

I HAD last winter the honour of laying before the Royal Society a few hasty remarks on what are called the *Parallel Roads of Glen Roy*, suggested to me by an accidental ramble through that valley, in the course of a pedestrian tour in the West Highlands, during the previous August. My curiosity having been much excited by what I then saw, I was induced to revisit the highly interesting district of Lochaber, in the beginning of last June, and had thus an opportunity of devoting three whole days to a more complete inspection of these remarkable shelves, which I was surprised to find, were to be traced through a much more extensive stretch of country than former observation had led me to imagine. My first visit to Glen Roy was accidental; but upon this late occasion, I went with the purpose of endeavouring to put myself in possession of all the facts I could possibly collect, regarding these curious appearances; and in doing this, I had several advantages which I did not formerly enjoy. I was accompanied by my friend MR MACLEAN, civil engineer, who kindly assisted me in ascer-

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taining the horizontality of the lines. The weather was particularly favourable for our purpose, having been remarkably calm and clear during the whole of our stay in Lochaber. We had also the good fortune to be hospitably received, as the guests of Mr MACDONELL of Inch, whose residence, situated near the junction of the rivers Roy and Spean, afforded us the most central point, from whence we might make excursions in every direction; whilst extreme acuteness of observation in our host, and the great interest he has taken for many years, in the very investigation in which we were engaged, and the constant opportunity he has had of making himself acquainted with the various appearances, rendered him an intelligent, as well as a willing guide. I am, therefore, now enabled to offer an account of these shelves, not only much more particular, but embracing a much greater extent of country. And although I am well aware of the numerous sources of error to which the investigator of so many intricate mazes is exposed, yet I trust I may venture to hope, that my inaccuracies are few in number, and, individually, unimportant. In this hope I am the more confident, from having the highly valuable testimony of Mr MACDONELL of Inch to support me, from whose communications I have even described some particular spots, which I had not an opportunity of visiting in person. Indeed I cannot sufficiently express my sense of the obligations I owe to that gentleman.

In the first part of my essay, I propose to give a general description of the form and appearance of the shelves. I shall next suggest the theory, which may account for the formation of such appearances in general. I shall then give a particular account of the whole shelves of Lochaber, as connected with the topography of the glens where they are found. And, lastly, I shall conclude, by stating the theory, which appears to me most likely

likely to explain the circumstances of their particular formation. My remarks will, I hope, be found more intelligible, by reference to a map, which, however, must be considered as a mere eye-sketch of the country, its construction having been merely aided by the observation of a few angles and bearings, and therefore having no pretensions to geographical accuracy, beyond what is necessary for the purpose to which it is dedicated,—that of giving an idea of the courses of the different shelves, to which I have affixed distinguishing figures. Though the shelves are laid down in continuous lines, it is by no means meant to convey the idea, that they are strictly so in reality: partial deficiencies in their continuity are certainly to be observed, but these are too trifling and unimportant, to be noticed in a general view of them on so small a scale. It should be also remembered, that it is only in the most important points, that the detail of their various lesser bendings is attended to. Where such a point occurs, as at the head of Lower Glen Roy, the attention which has been paid to mark the sinuosity of the lines, as correctly as possible, has compelled me to devote more room to that part, than it would be entitled to were strict proportion observed; and thus Upper Glen Roy is more reduced in size than it ought otherwise to have been. Besides the map, I have ventured to give a few sketches of what appeared to me to be the most remarkable views of the shelves. These are taken from above, or on the same level with them, so as to produce that natural rise of the perspective, observable in the lines of level water. Without this, it is not easy to comprehend their horizontality from a drawing. This, however, lends them the character of bird's-eye views, and consequently gives a more confined appearance to the glens than they present when seen from below. There are also two plates of diagrams, which may be found useful in illustrating the theory of their formation.

General Appearance and Character of the Shelves.

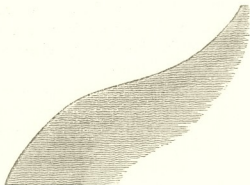
THE shelves run in a series of horizontal lines, along the sides or faces of the mountains of Lochaber*, bounding the valleys of Glen Gluoy, Glen Roy, Glen Spean, and several of their smaller tributary glens. One range of these is to be observed on each side of Glen Gluoy, running at a level somewhat higher than that of any of the linear appearances in the other glens, with none of which it has the least connection. In Glen Roy there are three corresponding ranges, the uppermost being at a level about 12 feet under that of the shelf in Glen Gluoy. The next is about 80 feet below the level of the one immediately over it; and the lowest line of all, is about 200 feet underneath that to which it succeeds in elevation. These two last measurements, however, are merely such as could be accomplished by an ascertainment of the distance of each range from that above it, at different parts of the glen, corrected by a calculation of the intensity of the various slopes, producing an approximation to the truth. The two uppermost shelves of Glen Roy are entirely confined to that valley, and those immediately tributary to it; but the lowest of all, is seen to sweep

* The Gaelic word *Lochaber*, signifies the influx of a lake into a river, or the sea. The district so called, comprehends Glens Gluoy, Roy, and Spean, Lochs Laggan and Treig; and the country stretching in the direction of Fort William, and as far to the westward as the Ferry of Balachulish.

sweep out to right and left, from its mouth into Glen Spean; running on the one hand, by various sinuosities, in the direction of Highbridge, and extending up the north side of Glen Spean, and round the upper extremity of Loch Laggan, whence it returns on the south side of the same valley. There are thus four distinct ranges of these shelves, which, to avoid circumlocution, and for the sake of greater perspicuity, I shall uniformly number from above downwards. I shall, therefore, call that having the highest level, and belonging exclusively to Glen Gluoy, *Shelf 1st*; those two coming next in elevation, and which are to be found in Glen Roy alone, I shall call *Shelf 2d* and *Shelf 3d*; and, lastly, That which is lowest, and which being common to both Glen Roy and Glen Spean, is by far the most extensive, I shall designate as *Shelf 4th*. All these will be found in the map, with their respective numbers attached to them. There are also some other indications, in the bottom of Glen Spean, to be afterwards described, to which, as they appear to owe their formation to causes similar to those of the shelves above mentioned, I have affixed the numbers 5, 6, and 7. All these different shelves are found to maintain the horizontality characterizing the surface of water, throughout all the various windings of their linear extent, and round the hollows and projections of the hills, whether these are small or great, sudden or otherwise; and each respective range, on one side of any of the glens, is exactly on the same level with that corresponding to it on the opposite side. Indeed these lines, which are thus of similar level on different sides of the glens, are manifestly identified. For whenever the level of the bottom of a glen, by rising above that of any one particular shelf, obstructs its farther progress upwards, that shelf immediately winds round, and crosses the bottom of the valley on the same level, in the form of a broad shelving plain, whence

whence returning downwards on the other side, it produces when opposed to that part of it running upwards, the appearance of two twin shelves, when, in reality, they are discovered by examination to be one continuous line. There is, of course, every where, a perfect sameness in the perpendicular height of one range above that which is beneath it. But a deception is produced to the eye, with regard to the apparent relation of the whole shelves, to the valleys where they lie. For, from the inclination of the bottom of the valleys, being opposed to the perfect horizontality of the shelves, the whole of the latter have the deceitful appearance of sinking on the sides of the hills, as they run in a direction towards the sources of the streams; and of rising, as they approach the openings of the several glens. Although the perfect linear horizontality of these shelves, and the correspondence as to level, of each particular part of a shelf, on the two sides of the same glen, has been always admitted, upon simple ocular inspection, yet it is by no means easy to put this important matter beyond doubt. It is indeed impossible to perform a mathematically accurate levelling process, on such rude and indefinite subjects as these shelves are. For although they appear very distinctly, and even sharply marked, when viewed from the glen below, or from some distance, yet when the observer climbs up to inspect them more narrowly, he always finds it impracticable to discover their precise limits, and they are then indeed so very indistinct, that he may even be actually treading on a shelf, without being in the least aware that he is doing so. This shows how very imperfect they are as to form, and how very little they deviate from the ordinary contour of the hills along which they are traced; for whilst their outward edge is very much rounded off, they are united interiorly to the acclivity of the mountain above them, by a highly inclined slope, so as to make

make the section of the line of their profile somewhat like this:



And every part of the breadth of the shelf also, deviates so far from the level, that the sections of it would exhibit an inclination outwards of from one foot in five, to one foot in three, and in some places a great deal more. Their actual surfaces are all so rugged and irregular, that no proper series of operations could be carried along any of them, with a hope of determining their true linear level. My friend Mr MACLEAN and I, therefore, conceived that we did nearly all that could be well accomplished for this purpose, by using the following means, in the course of three several observations, taken on shelf 2d, shelf 3d, and shelf 4th, which, together with the results, I shall now detail.

It was from a very commanding position, marked *d* on the map, that we levelled shelf 2d. From this point we enjoyed very nearly the same view as that represented in plate IV., and had the advantage of observing some considerable portions of the same shelf on the other side of the valley, immediately opposite to the eye, and at no great distance from it, whilst there were also a variety of different distances, receding in perspective behind one another. We employed a very delicate eight-

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teen inch levelling instrument, made by Jones. It was planted, as nearly as we could guess, (where the limits of the subject we had to work upon were so ill defined,) rather towards the lower edge of the shelf, and we endeavoured to adjust it in such a manner, as to make the levelling telescope itself of the same height with what we supposed to be the higher or interior angle of the shelf. Directing the object-glass of the instrument to the nearer and immediately opposite corresponding line of shelf, it applied all along, most accurately, to the horizontal hair; but when pointed to those farther off, (some of which were perhaps five or six miles distant,) they appeared to sink sensibly below the hair, and this in proportion to their distance from the point, where we stood; but they were nowhere observed to do so in a greater ratio, than the allowance for the curvature of the earth at such rectilineal distances demanded. And, what was in our opinion most conclusive, when the telescope was pointed to, and made to traverse along any particular portion, which, from being directly opposite to the eye, might have been presumed to be nearly equidistant in all its parts, it was found to preserve an uniform relation to the horizontal hair.

Our observation taken on shelf 3d, was, if possible, even more satisfactory, from the point we chose, (see *f* in the map,) being still better adapted for the purpose, as we not only commanded a view of the head of what may be termed Lower Glen Roy, (see plate V., the sketch for which was taken from hence,) but we could also see the shelves, running continuous all the way down to the mouth of Glen Turret, to which we were opposite. We could follow them with the eye throughout the greater part of their progress around that tributary glen, and so down the north-west side of Glen Roy, for a considerable distance; forming altogether a line, which, if it had
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been extended, would have stretched perhaps five or six miles, whilst, from its numerous bendings, the rectilinear distance of the farthest visible part of it from the eye, was probably not so much as two miles, and most of it was greatly less than one. And what was still more advantageous in this position, in traversing the telescope of the instrument round, many points could be touched upon which were evidently nearly equidistant from the eye. Here the perfect coincidence of the line with the horizontal hair, was more generally striking than it was in our first experiment.

Our third trial was on shelf 4th, and we were fortunate in selecting a very excellent point of view for that also. The spot, where we planted our instrument was a little to the eastward of the house of Inch, on the south side of the entrance of Glen Spean, (see *b* in the map). It was from thence that I sketched the view of the entrances of Glen Roy and Glen Spean, as represented in Plate II., which, when compared with the map itself, will afford some idea of the great extent of shelf 4th, which we commanded at one *coup d'œil*. We could trace it, sweeping from Ben-y-vaan on the left, up Glen Colerig,—returning from that little valley, and embracing the south side of the round hill of Bohuntine, and disappearing into Glen Roy,—re-appearing on the faces of its southern mountains, till it is again lost behind that of Crag-dhu, which divides the entrances of the two glens,—coming into view again as it circles round the bottom of that projection, and identifying itself with the upper line of a high inclined plane, whence it sweeps into the mouth of Glen Spean, where we could of course trace it much farther, than could be embraced within the angle of vision employed in the delineation of a perspective sketch. We could also trace the same line faintly encircling the isolated rock of Mealderry, which appears in the drawing much nearer the eye. We traversed the telescope

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of the instrument around all these different points, and the results were perfectly satisfactory. In short, from all our experiments, and from all our other observations, there did not remain a shadow of doubt in our minds, that the whole of these shelves were perfectly horizontal in themselves, and that every part of any shelf on one side of a glen, was decidedly of the same level with the corresponding portion of it on the other side.

The breadth, or depth of these shelves, on the steep sides of the hills, is very various, and is evidently much modified by circumstances, particularly by the nature of the ground. That part of the shelf is generally deepest, and most strongly marked, where the face of the mountain forms an acute angle, or rounded promontory; and this is more particularly the case, where the promontory is of comparatively soft materials. In all other places, whether bay or projection, where the surface of the hill is soft, and easily worn away, the indentation is almost uniformly better defined than where a harder soil occurs. Where rock manifests itself, little more generally appears than a slight tracing on its surface, merely enabling the eye to follow out the line with difficulty; but on the fronts of many of the rocks, all appearance of it is lost for a space, until it again manifests itself on the softer surface. The indentation of shelf 4th, on the rocks at the entrance to Loch Treig, is peculiarly strongly marked; and the same shelf is also well defined in its circle round the top of Tom-na-Fersit, a small isolated hill near the same point; but these form, perhaps, the only striking exceptions to what may certainly be considered as a general fact.

These remarks, apply rather to the degree of distinctness with which the shelves are traced along the length of the glens on the steep sides of the flanking mountains, than to their actual breadth. For when any one shelf approaches the point, where, (by the rising of the level of the bottom of the valley)

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it is compelled to cross to the other side, the breadth of it is always greatly expanded, so as to give it the appearance of a broad inclined plane, in some instances so much as half a mile, or perhaps even a mile wide; and this is almost invariably covered, to a certain depth, with a stratum of peat-moss. In such cases, the level of the linear appearance infallibly applies to the upper bounding line of the expanded inclined plane. These expansions of the shelves, are not only to be met with in those places, where they cross from one side of a valley to the other, but are also to be observed in many other parts of their course, particularly where the hills are low, and of a gentle slope, or rather where the shelves run along the bottom of such hills. On a first hasty observation, these expansions may be overlooked, as having nothing to do with the shelves, and it may be supposed, that some cause has here operated to interrupt them for a time. But a little attention to their appearance and level, will at once show, that these inclined planes have been formed by the same cause, as the more properly defined shelves, and that they are in fact nothing more than expanded continuations of them, which, from the very circumstance of their greater breadth, lose that extremely sharp and striking appearance, so remarkable in those parts where the hills are steeper and more lofty.

The shelves are in many places covered with large masses of stone, some of them many tons in weight, lying for the most part quite detached on the surface, and having their acuter angles rounded off in the greater number of instances; in short, in every respect resembling those fragments generally found strewn on the margin, and in the shallow edge of alpine lakes. In some places, where the stones are large, and the shelf narrow, a single block covers its whole breadth. Where rock appears any where on a shelf, its angles are also for the most part rounded. One fact is very important, and

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deserves particular notice: the nature of the soil in each valley, is materially different above and below its highest line of shelf; all above this natural division, being found to resemble the bare moorish soil covering any other mountain; whilst large depositions of alluvial clay, sand, rounded pebbles, and gravel, present themselves every where below that point, and this, more particularly towards the mouths of the different valleys. Marine exuvia, however, are nowhere to be met with. Perhaps the most interesting circumstance regarding these shelves, is, that wherever an isolated little hill happens to rise from the bottom of the valley to a height above that of the level of any shelf, a delineation runs round the little hill, at a level corresponding to that of the shelf on the mountains of the side of the glen.

Such, then, is the general description of the character and appearance of these shelves.

Theory which may account for the formation of Shelves running horizontally along the sides of Mountains confining Glens.

In the total obscurity in which the origin of these singular shelves is involved, some have been inclined to regard them: productions of art, others as the work of Nature. Of these two opinions, I confess I cannot hesitate in rejecting the first. The immensely arduous nature of the undertaking, arising not only from its extent, but from the numbers of accurate measurements and levellings it must have required,—the impossibility of the supposition, that the engineers of those early times which they must be referred, could have known how to make the exact allowance for the curvature of the earth, and the

too, at a period when our planet was believed to be a plain, extending *ad infinitum*;—the difficulty of imagining any rational object for the construction, in such a situation, of such a series of terraces, so precisely horizontal, so equidistant in all their parts, and so exactly corresponding on the two opposite sides of the valley, and in some places sweeping in one continued circle round the tops of detached hills in the middle of the glens;—above all, the actual structure of these shelves, as they at present remain, constitute, in my mind, insurmountable objections to any hypothesis, which would ascribe their origin to human labour and ingenuity*.

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* “As there is nothing left upon record,” says the Reverend Mr Ross, in his account of the parish of Kilmanivaig, (Statistical Account of Scotland, vol. xvii. p. 549.) “respecting the times when, the persons by whom, or the purposes for which, these roads were constructed, we can only mention the common traditions regarding them. One is, that they were made by the Kings of Scotland when the royal residence was in the castle of Inverlochy, which is not above eleven miles from the nearest of them; and, what gives an appearance of truth to this tradition, in the opinion of those who maintain it, is, that the construction of these roads was so vast an undertaking, as could not be effected by any vassal or nobleman, however powerful. Another tradition, which is that of the natives, is, that they were made by the Fingalians, and, under the name of *Fingalian Roads*, they are still known in this country. They are likewise called the *Cassan*, i. e. the *Roads*, by way of eminence. Of this the natives are convinced from this circumstance, that several of the hills of this glen have retained, from time immemorial, the names of some of the heroes of Fingal, such as the Hill of Gaul the son of Morni; that of Diarmid; and of Fillan; and likewise of Bran, the famous dog of Fingal, &c. Now the popular belief cannot be considered as a direct proof of any opinion, yet we cannot help remarking, that the original tradition, (which in this case has been always invariable,) gives a strong degree of credibility to the existence of such heroes, and renders it by no means improbable, that these extraordinary roads have been the result of their labours. The purpose which they were designed to serve, seems to have been, (agreeably to the common opinion,) to facilitate the exercise of hunting; for in ancient times,

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That theory seems to me infinitely the most probable, which attributes the formation of the shelves to the action of the waters of a lake. The perfect horizontality of the lines, and their exact agreement in height on the opposite mountains, added to the fact of their running up the smaller tributary glens, and following the retiring, as well as the projecting parts of the faces of the mountains, with so much regularity and precision,—the circumstance of their encircling isolated hills with a perfect ring, totally unconnected with any other part of the shelves,—the rounded edges of the rocks, and fragments on their lines,—the change which takes place in the soil above and below the shelves,—their expansion into mossy flats or inclined planes, whenever the level forces them to do so,—all combine to show, that nothing but the surface of water could have caused them. That alpine lakes, filling deep hollows amidst mountains, rising from their bottoms with steep and almost precipitous acclivities, do generally form similar shelves around their margins, must be sufficiently well known to every one who has had an opportunity of visiting such scenes. Indeed a little reflection will show, that this must necessarily happen. For if we suppose the almost perpendicular sides of such a hollow to be filled, to a considerable height, with a lake of this character, as exemplified in the diagram, (Plate VII. fig. 5.), in which the dotted line A represents its level, then the

“ and, indeed, till within this century, the valley was covered with wood, which
 “ made it very difficult to pursue the deer, &c. and rendered certain avenues necessary for effecting this purpose; in corroboration of which opinion, it may be
 “ observed, that upon the sides of the roads, there have been found some stakes
 “ fixed in the ground, probably the remains of some of the paling or fences, which
 “ in those days were made use of to confine the game, till they were driven in
 “ upon a field, called *Dal-na-scalg*, or Hunting Dale, where the presumption is
 “ they were killed.”

the agitation of the surface of this lake, by the various winds to which it may be exposed, will naturally drive its waves against some of the points round its margin, as *aa*, and will gradually eat away the bank there by the frequency of their action against it; whilst all being still underneath, it will not be affected any where below. Then, as the water thus mines away the banks, where they are on a level with its surface, the earth and other materials will naturally fall down from above, so as to form two sloping cuts or notches in the side of the hill, as represented by *BB*, between the dotted and black lines. All the smaller and less ponderous substances, such as gravel, earth, and sand, will of course be washed inwards, towards the deeper part of the lake, and immediately on getting beyond the shallow, will sink down, and form an accumulation at the bottom, and on the sides, as represented in the diagram by *D*, between the dotted and black lines. But the violence of the waves of a lake, is seldom such as to move those large masses of stone that may be supposed to be uncovered, loosened, or undermined, and brought down by the almost continual, though gentle, fluctuation of its surface towards its shores. These, therefore, would gradually accumulate on its shelving beach. It is almost unnecessary to add, that the breadth of the shelves (*BB* in the diagram) would vary according to the degree of hardness or softness of the materials forming the various parts of the bank on which the water would have to operate; and that where stubborn rock should present itself, unless it were placed in some peculiarly exposed situation, it might remain for ages, hardly, if it all affected. Wherever there were swells or promontories, these would in general be most acted upon by the agency of the waves, unless other circumstances should prevent it. This is, indeed, the precise character of all mountain lakes, *filling hollows between very steep*

steep acclivities, like those I have supposed. I should have little difficulty in enumerating many such pieces of water. In the earlier part of the very tour which ultimately led to my first visit to Glen Roy, our party accomplished a rather arduous expedition to Loch Aven, a lake very much answering the above description. It is situated in the very bosom of the Cairngorum range of mountains, having that which is more properly called Cairngorum rising on its western side, directly from its waves, almost to the utmost height of the mountain; and on the south-eastern side Ben-mach-duie, the highest point of the whole chain, is seen elevating itself equally suddenly, and with a rocky, and almost overhanging front, still grander and more abrupt. This lonely lake presents an assemblage of every thing that is wild and sublime in Scottish scenery. The gentlemen of our party who were familiar with the ruder parts of the Swiss Alps, admitted that Loch Aven furnished no very insignificant specimen of the terrific scenery to be met with in that interesting country; and the resemblance was rendered more striking, when we saw it, on the 1st of August, from an immense unmelted glacier, which shone through the thin mist floating on the brow of the rocks, at the farther extremity of the lake. Mr ROBSON, who, in his "*Sketches of the Grampians*," has given a very faithful outline of it, is, I believe, the only person who has had the merit of noticing this desert and desolate, but magnificently gloomy spot. As we climbed the rugged, and almost inaccessible front of one of the crags, rearing itself over its upper extremity, by a pass which ascended between two torrents, precipitating themselves with dreadful roar from the glacier on the brow of the mountain above us, I could distinctly perceive, when looking downwards to the lake, that a narrow shallow shelf almost every where surrounded it, within which it seemed, by its sudden

den change of appearance and colour, from an extremely green transparency, to a pitchy blackness, to become all at once of an apparently unfathomable depth. This circumstance, which I remarked at a moment when I had not even a thought of Glen Roy, struck me very forcibly. But I had afterwards occasion to notice, during the remainder of the same tour, that such was almost invariably the case with those lakes having steep shores of the same description. In Loch Lochy, Loch Oich, and Loch Ness, wherever the mountains rose from a depth with a sudden acclivity, the same appearances presented themselves. And what appeared more extraordinary, and what I scarcely expected, in sailing down the salt-water lake or arm of the sea called Loch Linnhe, from Fort William towards Coran Ferry, we even found the same kind of shelf in similar circumstances on its southern side, though on a larger and ruder scale. Since that time, I have had occasion to make the same remark, where the hills rise abruptly from Loch Awe, Loch Lomond, Loch Tay, and almost every other Highland lake that I have visited. Most of the mountain lakes of Switzerland and Italy, having sides of the same precipitous description, are surrounded by the same shelving margin; and, amongst many others, the lakes of Nemi and Albano were particularized to me by an intelligent friend, as being both of this character*. But I wish it to be always understood, that the foregoing illustrations, as well as the diagram to which I have referred, are merely applicable to the formation of a shelf on the *steep side of a mountain*, where, though it may not be found so broad as in other places, it will always be more sharply marked than when the waves are

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* Since this paper was presented to the Society, I have had an opportunity of satisfying myself of the accuracy of this remark with regard to these lakes, as well as of adding to the examples of this general fact, from my own personal observations on the lakes of *Maggiore*, *Lugano*, and *Como*, as well as in the upper part of the *Lake of Geneva*, and several other continental lakes, having precipitous shores.

expended on a more gentle slope, where they will produce shelves less distinctly indented indeed, but much broader. The number of lakes which furnish examples of these broad shallows within the margin, where they have easily inclined shores, is so great as to render it unnecessary to instance any of them. This last remark, however, should be kept in view, because it will be found to apply to many parts of the particular description of the courses of these Lochaber shelves, which it is my intention to give, and will more especially explain those parts of them, where an inattentive observer would be apt to suppose that they disappear entirely, when, in reality, they only become less distinct, by becoming wider, and consequently more gradually shelving.

After subjecting mountain lakes to this close investigation, it will probably strike every one, that the consequence of the sudden escape of the water from one of them, would be the immediate appearance of a glen having a range of horizontal shelf, traced high up on the face of its mountains, and in every respect similar to those exhibited in Lochaber; and this would be either distinctly seen all around it, or would appear only partially, as the nature of the different parts of the sides of the hills happened to be more or less obdurate or friable, and would present all the modifications of breadth, that might have been occasioned by their various degrees of slope, as well as by their numerous promontories, swells, hollows, or bendings. Through the kindness of a friend, who was one of the party in my first visit to Glen Roy, and who is well acquainted with the spot I am now about to describe, I am fortunate in having it in my power to produce a case exactly of this description, where there cannot be a doubt that such an escape of the waters of a lake did unquestionably happen, although the exact time when, and the actual manner how it occurred, is lost in the obscurity of the dark ages. The valley to which I allude is situated a little above the town of Subiaco in Italy, lying about forty-six miles to the eastward of Rome, and twenty-eight from

from Tivoli. The river running through the valley nearly retains its ancient name, being there called the Aniene; but as it approaches Tivoli, it takes the more modern appellation of the Teverone. Subiaco is an Italian corruption of Sublaqueum, by which name it was anciently known. Following the course of the river upwards from Subiaco, the mountains, which are part of the Appennines, and of very considerable height, begin to close around, confining the bottom into a narrow glen; and in about half-a-mile after leaving the town, the valley is observed to be blocked up all at once, by an immense wall of rock, perhaps 100 feet high, crossing it at right angles, (see Plate VII. fig. 1. and fig. 4. A). This appears rent perpendicularly from top to bottom in the centre, as if by some unaccountable convulsion, presenting a chasm, which is only 12 or 15 feet wide, and which it is quite impracticable to enter, as the bottom is filled by the river, which is, indeed, very much confined in its passage through it. This natural barrier of rock, is perhaps not less than an hundred yards in thickness, and although it is quite perpendicular towards Subiaco, it has a slope towards the other side, which faces up the river. The sketch of it, (Plate VII. fig. 1.) was drawn from an outline done by my friend from recollection, and is sufficiently accurate to give some notion of this singular rock, at least as far as regards the present purpose; and the perpendicular section of it, (Plate VII. fig. 2.), supposed to be made on the same line with the ravine, gives an idea of both its steep and its sloping side. The plan of the valley, (Fig. 4.), although it is drawn from a mere sketch from memory, by the same gentleman, will illustrate the description. Having got beyond the rocky wall, (marked A, fig. 4.), the glen to which I wish to solicit attention, is found to be deep and narrow, and about a mile in length. The river Aniene runs along in the bottom, and the mountains on either side rise immediately from its margin, and, with a very sudden and steep acclivity, as is represented

presented in a section of the valley, supposed to be taken across from B to E of the plan, and given in fig 3., in which G represents the river. High up, on the face of the hills on the south side of the valley, are the remains of the Baths of NERO, (E in the plan, fig. 4. and section, fig. 3.), and the remains of the mouth of the Aqueduct by which APPIUS CLAUDIUS conveyed water into Rome, from the lake, which originally filled the valley to that height, (F, fig. 4.) On a level with these, and consequently on a level with the ancient lake, an exact, and perfectly horizontal shelf, in every respect resembling those of Lochaber, runs around the face of the hills on the southern side of the valley, as expressed by the dotted line, fig. 4. But on the northern side, (where B, fig. 4. marks the situation of the convent of Santa Scholastica, and C that of San Benedetto), there is a great deal of rock, and consequently no such appearance of a shelf is to be observed. At the head, or western extremity of the valley, (D, fig. 4.) the river enters it through a ravine, by rapids, and over a cascade. Such is a description of the present state of this singular spot, to which I must beg particular attention, as it will be found to have a wonderful resemblance, in all its parts, to some of the appearances, to be described in the sequel of this paper. The Valley of Subiaco was anciently filled with part of the *Simbruina Stagna*; and the name of *Sublacum* was given to the ancient town, from the circumstance of its being situated under the lake. Of the *Simbruina Stagna*, anciently three in number, none are now remaining. This was the lowest; the other two were formed by the river higher up, and it is very probable, that some interesting appearances, of a similar nature to those I have been describing, may likewise exist on the sides of the hills which served formerly to confine them. But the banks of the Aniene are little known above the valley of Subiaco, the country being so overrun with banditti, that there is no safe travelling beyond the Convent of San Benedetto, where, indeed, the regular road stops. These lakes are more than
once

once mentioned in the classics, particularly by Tacitus, who notices the fact of CLAUDIUS's aqueduct having its origin on the hills on their margin; "*fontesque aquarum ab Simbruinis collibus deductos, urbi intulit,*" (Ann. lib. xi. cap. 13.); and the circumstance of Nero, who had a villa there, having made it an occasional residence, is also established by the same historian, who mentions the fact of that Emperor having been alarmed by prodigies whilst in that retreat: "*Nam quia dis-cumbentis Neronis apud Simbruina Stagna cui Sublaqueum nomen est, ictu dape mensaque disjecta erat,*" (Ann. lib. xiv. cap. 22.) The remains of the baths of Nero, E, fig. 4. Pl. VII. and the mouth of the Claudian aqueduct, F, fig. 4, which are both exactly on the line of shelf running around the face of the hills on the north side of the valley, and which, happily for our illustration, were both of a nature, that rendered water essentially necessary for their several objects, sufficiently prove that it must have owed its origin to the action of the waves of the lake, which must have had its margin there, (as at E, fig 3., where BE represents its ancient surface), otherwise it is manifest that both those buildings would have been useless. The wall of rock, (fig. 1.), as described by my friend, is just the height of the shelf, and composed of what he called "the native rock," or that which is every where prevalent in the neighbourhood. This, we know from BROCCHI's late work on the Geology of the Appennines, is a peculiar sort of limestone, of a pearl-grey, dusky-white, or smoke colour, with a smooth earthy fracture, without lustre. But what forms a very singular and striking physical corroboration of the historical fact, that the river once ran over the top of this rocky dam, is, that the upper surface of it, (A, figs. 1, and 2.) is covered by a formation of the *travertina tufa*, which calcareous incrustation must have been deposited there by its waters, when flowing from the lake at that elevation. The river, as is well known, continues to deposit the same tufa every where, particularly

cularly at the cascade of Tivoli, where this substance is constantly accumulating*.

As the ancients mention the existence of the lake, which once filled the valley of Subiaco, but take no notice of the cause by the operation of which it was drained, it must have occurred at some period between the fifth and the fourteenth centuries. It is as impossible, as it is unnecessary for me, to offer even a conjecture about the nature of this; but I hope enough has been established to prove, that the valley of Subiaco furnishes a decided and well-authenticated instance of a range of shelf, in every respect like those of Lochaber, and which has been unquestionably formed by the waters of a lake. From the particular description I am to give, it will appear that the resemblance between the Glen of Subiaco and those of Lochaber, is rendered extremely strong by a number of circumstances, common to all of them; perhaps the most remarkable of these is, that the waterfalls and ravines of Subiaco, are also found placed in similar situations in the Lochaber glens.

Particular Description of the Shelves, as connected with the Geography of the Country, and the Appearance of the Glens in which they are found.

I PROPOSE to arrange the more particular description of the shelves, which I am now about to give, in the following order; which

* When I was lately at Tivoli, I had the most earnest desire to visit Subiaco in person, not only to make my own observations on the valley, but likewise to enjoy a range of scenery, described to me as being of the most romantic character; but I regret to say, that a variety of circumstances compelled me to abandon the attempt, with very great reluctance. I had, however, some satisfaction, in availing myself of the opportunity of corroborating the description in the text, by the testimony of one or two of my Roman friends, who had been at Subiaco.

which will be easily understood from the map. I mean to begin at Lowbridge, and describe the whole of Glen Roy upwards. I shall then give a general account of the Glen-morna-Albin, or Great Glen of Scotland, the necessity of which will appear, when I come to the theoretical part of my paper. Proceeding from thence south-westwards, I shall describe the more open part of the country about the Spean. I shall trace Glen Roy upwards to the Loch of Spey; return to the mouth of Glen Turret, and describe that valley, and the *High Glen* of its little tributary stream upwards, to where it opens at its north-western extremity into the head of Glen Gluoy. Returning to the mouth of Glen Roy, I shall describe the whole of Glen Spean, Loch Laggan, and Loch Treig; and shall conclude with a description of those very satisfactory and convincing appearances in the bottom of Glen Spean, which are numbered in the map with the figures 5, 6, and 7. and which can be viewed in no other light than as being three inferior shelves, each successively of lower level than that numbered as above it.

The general direction of Glen Gluoy is nearly S. E. and N. W., and its length is about seven or eight miles. Its mouth opens into the Great Glen of Scotland at Lowbridge, and it pours its stream into Loch Lochy, a little way below that place. The hills bounding Glen Gluoy approach one another very closely, leaving no more than room for the river to run in the bottom. They are very lofty and steep, particularly at Lowbridge, over which they rise with a bold front, there forming the side of the Caledonian Glen. They are in general covered with a short grass, and, like all the rest of the hills in this neighbourhood, afford excellent sheep-pasture. From the extreme narrowness of this glen, its shelf is not easily viewed. I am, however, enabled to describe it, by having paid two visits to the valley, in the course of which, I looked
into

into it from the side of the mountain Ben-y-vaan, guarding its entrance on the south,—traversed its whole extent, going up the one side of the river, and down the other, so as to endeavour to secure the most perfect view of the two corresponding parts of the shelf,—and looked down its whole length, from a point on the side of the mountains, at its upper extremity, (see *a* in the map), whence an excellent view of it is enjoyed, (see Plate I.) About three miles up Glen Gluoy, it is joined by a smaller valley, called Glen Fintack, whence a considerable stream, having a short run, pours itself into the Gluoy. Above this, the glen makes several gentle winds. *Shelf 1st*, the only one to be met with in Glen Gluoy, first appears near the top of the mountain, on the N. W. side of the valley, a considerable way below that part of it which is opposite to Glen Fintack. The sides of Ben-y-vaan, which is a long flat-ridged mountain, are rocky; and the whole sides of Glen Fintack are particularly so, presenting every where a very magnificent enclosure, of abrupt and perpendicular precipices of great height. I could not perceive any appearance of the shelf on the S. E. side, until I observed it on the face of the mountain which bends out from the N. E. side of Glen Fintack, into Glen Gluoy. At this point there even appears to be some traces of two lines; but one of these, I believe the uppermost, is not continued, and is probably nothing more than an accidental mark on the angle of the hill. And here I may take the opportunity of offering a caution to future observers, not to decide too hastily as to such faint appearances, unless in situations where the probability of their being portions of the shelf is borne out by a sameness of level. For, aided by fancy, which is always alive in an investigation of this kind, the eye is very apt to lead the judgment into error. I may mention, as one very strong instance of this, that, at one place, on the N. W. side, and nearer to the upper end of Glen Gluoy, I was for some time

time led to suppose, that there was decidedly a second line of shelf, until a more perfect view from the side of the hill directly opposite, completely satisfied me, that the undermost, extending only a short way, was neither parallel to that above it, nor horizontal in itself. On ascending, to take a nearer and more accurate inspection, of what appeared so very distinctly marked when viewed from below, I found it to be no other than a well-trod sheep-track, not more than six inches in breadth; whilst the actual shelf itself, from the steepness of this part of the hill, affords a broader and more perfectly indented specimen, and more perfectly defined, than is to be met with in any other part of the valley. The deception was increased, by a small patch of heath having been burnt by the shepherds the season before, and the line of the sheep-track having arrested the fire, and prevented it from spreading below it, the linear appearance on the face of the mountain was thereby rendered the more remarkable.

The bottom of Glen Gluoy rises considerably towards its upper extremity, which, turning south-eastwards, is rather expanded into an amphitheatre; and from the end of it there is a vista through another glen, falling towards Glen Turret and Glen Roy, and which, to mark the difference between it and those lower-bottomed glens, I have distinguished in the map by the words *High Glen*. The shelf having begun on each side of Glen Gluoy, at the points already noticed, is very easily traced almost every where throughout its whole course upwards. That part of it on the north side, runs around the semicircular boundary of the head of the glen, and just touches the level of the bottom of the stratum of moss, lying in the mouth of what I have called the High Glen, which I shall afterwards have occasion to describe more particularly. From this point the shelf bends round to the south side of Glen

Gluoy, where it expands into a wide inclined plane, and where it is united to, and identified with, the twin portion of it coming up on the faces of the hills on that side of the valley. This broad part of the shelf is about one hundred yards wide, and presents the abrupt face of a bank to the bottom of the glen. By an examination of the map, the river Gluoy will be observed to enter the glen from its southern mountains, whence it throws itself in a cascade, and falls by a series of cataracts into a very remarkable ravine, dividing the inclined plane or broad part of the shelf, at right angles to its line of extent. Throughout the whole length of this singular chasm, which, though only a few feet wide, is perhaps not less than fifty or sixty feet deep, the river has worn out a passage on a level, not much above that of the bottom of the valley, into which it issues, and where it is almost immediately joined by a branch coming from the hills to the north. Some little way below the junction of the two streams, the river begins to lay bare the rock in its course, which becomes more rugged, as it deepens in its progress towards the Great Glen of Scotland.

The *Glen-mor-na-Albin*, or Great Glen of Scotland, enough of which is laid down in the accompanying map, to show its reference to the district under consideration, bisects Scotland in a straight line, from N. E. to S. W. from the east sea at Inverness, to the west sea at Fort William. It is narrow throughout its whole length, seldom much exceeding a mile in breadth, except where it expands towards the lower end of Loch Ness. The mountains forming its sides are every where lofty, abrupt, and precipitous, bearing every appearance of having been severed from one another, by some tremendous convulsion of nature. The bottom is chiefly filled by Lochs Ness, Oich, and Lochy, and has so very small a rise from the two

seas

seas towards the center, that the summit-level, as taken for the Caledonian Canal, is not more than ninety-four feet above high-water mark. Where the bottom of the glen is not occupied by the lakes, it is covered to a great depth by alluvial matter. Even at the summit-level, where the canal is now excavating to a depth of twenty-five feet, the workmen, after cutting through a thick stratum of moss, found nothing but sand, clay, gravel, and rounded stones, the debris of rocks of the primitive series, nor has the slightest appearance of marine exuviae been any where discovered. From the Glen-mor-na-Albin, several others branch off at considerable angles, and there are some lesser cracks and ravines of similar bearing to these dividing the faces of its mountains.

Proceeding from Lowbridge along the road towards Fort William, the mountain of Ben-y-vaan, on the left hand, stretches from the mouth of Glen Gluoy, in a S. W. direction, opposing an abrupt and rocky face to the Glen-mor-na-Albin, and terminating suddenly at a point above a mile from Highbridge, whence it turns back towards the N. E. at an acute angle, and then begins to form the northern boundary of the wider and more open country, stretching southwards towards the Ben Nevis range. The river Spean, issuing from its glen, and immediately afterwards uniting with the Roy, runs across a large basin in this open country, in a direction nearly west, laying bare the rock as it advances, and cutting more and more deeply as it approaches Highbridge, where the ravine, having become of great depth, is crossed by the tall pillars and arches of the picturesque military bridge, which has received its name from its remarkable elevation. Through this, the Spean foams onwards in a series of rapids and cataracts, to join the river Lochy. This latter part of its course divides a range of lesser hills, running from the foot of the mountain.

mountain Ben-y-vaan south-westwards, along the side of the Glen-mor-na-Albin, and, as indicated in the map, sweeping in a semicircular series of still smaller eminences, combining to form a rather elevated moor, stretching towards the western projection of the mountain Aonach-more, where it completes the inclosure of what may be termed the Basin of the Spean.

In the neighbourhood of the House of Inch, which is more than three miles above Highbridge, the mountains on all sides begin to approach nearer to one another, forming what may be considered as the proper entrances of Glen Roy and Glen Spean. The sketch, Plate II. (taken from the hills on the south side of Glen Spean, at the point marked *b* in the map), affords a much better general notion of the situation and nature of the mouth of Glen Roy, in relation to that of Glen Spean, than any words can convey. I may, however, remark in reference to it, that the mountain Ben-y-vaan, after returning eastward from its angle opposite to Highbridge, opens backwards towards the north, making room for a pretty considerable, but much elevated valley, called Glen Collarig, lying between it, and the round hill guarding the western side of the mouth of Glen Roy. This round hill, which is marked on the map by its name, *The Hill of Bohuntine*, is particularly interesting, owing to a number of circumstances, to be afterwards noticed. It is isolated from the neighbouring mountains, by Glen Roy making a great and sudden bend around its base upon the eastern side; on the south and west by Glen Collarig, and the little stream sent by that valley, through a deep dell, to join the Roy; and on the north, by the upper part of Glen Collarig, marked *Gap* in the map, which forms a pass into Glen Roy. The bottom of this opening however, is at a great height above that of Glen Roy, into which it falls suddenly,

suddenly, having the appearance, when viewed from that valley, of a very singular breach, high up in the sides of its north-western mountains. When viewed from Glen Collarig, the Gap appears as in Plate III. fig. 1. (which was sketched from point *c* in the map); and fig. 2. of the same plate, (which was sketched from the point *e* in the map), shows its appearance when looked at from Glen Roy. This Gap, is what, in my former paper, I had conjectured to have a communication with Glen Gluoy; but the description I have just given of Glen Collarig, shows this notion to have been erroneous. Glen Gluoy has indeed no other communication with Glen Roy, than by the *high glen* of Glen Turret, which I shall have occasion to describe afterwards.

The shelf which is marked all along its line with the figure 4 in the map, and which I said I was to designate as *shelf 4th*, makes its first appearance high up on the side of Ben-y-vaan, somewhat more than a mile to the east of Highbridge. From this point it runs faintly eastward, sweeps up the Glen of Collarig, and crosses it just above some cottages, in the form of an extended mossy flat, or rather gently inclined plane, which has steep banks towards the bottom of the valley. It then begins to return indistinctly back, on the western side of the round hill of Bohuntine, increasing in strength as it embraces its southern side; and again winds round it in a northerly direction, till it bends into Glen Roy. Plate II. will show this part of the course of shelf 4th, and Plate III. fig. 1. will furnish some notion of the mode in which it crosses Glen Collarig. In this last Plate, shelf 2d and shelf 3d, are seen coming from Glen Roy through the Gap towards the eye, and terminating abruptly on both sides, as I shall afterwards explain more particularly.

The

The lower valley of Glen Roy stretches in a N. E. direction, from the junction of its river with the Spean, to a point at the distance of about nine miles, where it is terminated by a rock, having a dry craggy hollow on its north side, and a deep ravine, containing the river, on the south, so that it may almost be said to be isolated from the higher rocks flanking the glen, between which it extends across. The country above this point, being of a different character, may be called *Upper Glen Roy*. Though not quite so narrow and confined as Glen Gluoy, yet the green mountains of Lower Glen Roy are as high, and rise with acclivities, which are in general fully as steep as those of the former valley; and throughout the greater part of its extent there is not much more space in the bottom than is sufficient for the bed of the stream. Having wound over the natural boundary dividing Lower from Upper Glen Roy, and proceeding to trace the stream of the Roy upwards, the country is found to open out into a wider and higher valley, expanding, as it stretches eastward, the hills apparently sinking in elevation, as the level of the bottom rises. Into this the waters of the Roy enter, by two several branches, from the sloping hills which bound it. At a point about three or four miles above the isolated rock, the valley becomes extremely flat. It is skirted on the north by a low rocky ridge, which, as it loses itself in the bottom of the plain, offers no interruption to the very gradually, nay, almost imperceptibly rising level, of the mossy ground stretching to the Loch of Spey, the source of the river of that name. From this point, which is the summit level, there is a gentle fall of the country, by the course of the Spey, towards Garvamore. Returning downwards to the head of Lower Glen Roy, we find that the river forces its way, with great fury and precipitation, through the ravine, (marked in
the

the map), which surrounds the south side of the isolated rock, and at a little distance below, it throws itself over a beautiful, and very considerable waterfall. From this point, where the valley widens for a little way, the river runs through a gravelly alluvial, and being soon afterwards joined by the stream from Glen Turret, it begins gradually to display rocks in its bed, through which, as it advances, it continues to cut deeper and deeper, till it approaches the flat ground near the Spean. But although the immediate course of the stream be thus held amongst rocks, yet large beds of alluvial matter, chiefly a red * clay, with rounded pebbles and sand, are every where to be met with, hanging, as it were, on the sides of the inclination of the valley, between the shelves and the river. These beds are stratified more or less regularly, and fine sections of them are afforded by the streams which cut through them in various places, in their way to join the Roy, which, in its progress down the valley, receives several tributary brooks.

I have already traced *Shelf Ath* around the hill of Bohuntine, and into the mouth of Glen Roy. It is continued up the N. W. side of the valley, and runs along the face of the hill, perhaps above one hundred feet below the level of the bottom of the Gap, (Plate III. fig. 2.). From this point it is almost every where very distinctly marked in its course upwards, until it comes to the opening of Glen Turret, into which it expands in a wide-extended inclined plane, above half a mile in diameter, displaying a surface of peat-moss, formed over a deep alluvial deposit of gravel and sand, and presenting a high and abrupt bank to the stream of the Roy, running in a line with the bottom of it. The level of the shelf seems here just to touch upon the houses of Glen Turret,

* Hence, probably, the name of Glen *Roy*, or the *Red* valley.

ret, situated at the upper part of this plane, near the junction of the two streams combining to form that river, whence it stretches under the mountain of Tom-Bhran, and crosses to the south side of Glen Roy, narrowing as it begins to return downwards, till it gradually again assumes the ordinary appearance of a proper shelf. I shall here content myself with mentioning, that *Shelf 4th* is to be traced all the way down the S. E. side of Glen Roy; but I shall postpone the description of its progress around Glen Spean, until I shall come to notice that valley in particular.

By looking at Plate II. Shelf 3d will be observed beginning on the north side of the mouth of Glen Roy, at a hollow on the S. E. side of the round hill of Bohuntine, whence it disappears into the glen. As Shelf 2d does not show itself until a little way farther on, its origin is not visible in this sketch; but a reference to the map will show the commencement of both these shelves, which sweep around the eastern, or Glen Roy side of the hill of Bohuntine, and then bend into the Gap which leads into Glen Collarig, where they show themselves as represented in the sketch, Plate III. fig. 2., and where they appear to terminate suddenly. The same drawing will also show, that they commence as abruptly on the north side, at points exactly opposite to those where they are broken off on the south side. From thence they run back towards Glen Roy, on the same level, sweep north-eastwards into that glen, and continue very distinctly marked throughout all their bendings, in their progress upwards. Indeed there is nowhere a more favourable view of the shelves of Glen Roy, than is enjoyed from this Gap, (see Plate IV. which was sketched from this point). Proceeding to trace shelf 3d and shelf 2d, up the north-west side of Glen Roy, they are found to turn northwards into Glen Turret, and to run around all the sinuosities

of

of that tributary valley ; but as I mean to allot a particular and distinct description to that glen, I shall take up these shelves at present where they return from Glen Turret, sweeping boldly and distinctly around the southern side of the mountain of Tom-Bhran. The side of that hill which flanks Glen Roy, being very rocky, they are to be traced, but faintly, along its face, until they come opposite to the isolated crag that forms the boundary of division between Lower and Upper Glen Roy. Here these two shelves, which have hitherto kept company with one another, are now separated. Shelf 3d being of a level considerably below that of the crag, or rather below that of the upper parts of the bottoms of the ravines on each side of it, and being thus prevented from passing through them, and continuing onwards, at the same level it has hitherto preserved, winds very indistinctly amongst the hollows of the rocks, and along the rugged face of the isolated boundary, and is then to be traced returning along the south-western hills of Glen Roy, gaining a more marked appearance as it proceeds down that side of the valley. But Shelf 2d, running on an elevation superior to that of any part of the bottoms of the ravines, is of course not obstructed by them, but continues to run up through them into Upper Glen Roy, whilst, at the same time, vestiges of it are traced about the top of the independent central rock, some parts of which seem to rise above its level. An examination of the map, will assist in enabling the understanding to follow out the intricacies of this important part of the description. Pursuing shelf 2d above the isolated crag, it is to be traced along near the bottom of the mountains, on the north side of Upper Glen Roy, its level extending as far as within two hundred yards of Loch Spey. It, however, requires considerable attention to follow it out in this upper valley, as in most places it has less the appearance of a shelf than of a widened inclined

inclined plane, which ultimately loses itself in the flattish moss near Loch Spey. This moss appears to be very deep; it therefore seems to me to be probable, that although its gradual increase has raised the surface in this place somewhat above the level of Shelf 2d, yet if a body of water were raised by any means to the level of that shelf, and the stratum of moss were at the same time to be removed, a stream would naturally flow from it towards Garvamore, in the present course of the river Spey. The appearances of Shelf 2d, in its return down the south-east side of Upper, towards Lower Glen Roy, are very similar to what I have described as existing on the north-west side: it returns into the lower glen through the ravine on the south side of the isolated rock.

Let us now proceed to consider Glen Turret. When entered from Glen Roy, its mouth is discovered to have in the bottom that large semicircular inclined plane, which has been already described as an extension of Shelf 4th. The stream of the Turret, in its way to join the Roy, cuts through this vast bed of sand and polished gravel to a great depth. At the cottages of Glen Turret, (the site of which has been already stated to be nearly on a level with Shelf 4th), two little streams unite to form the Turret. One of these branches comes gently from the north, through the low bottom of the glen itself, which here rises very gradually in its level; the hills a little way above, expanding into a considerable circle, around the termination of the glen. The other branch pours precipitately into the lower glen, where the houses stand, from a much more elevated valley to the north-west, marked *High Glen* in the map. Proceeding to trace this stream upwards from the houses, it is found to exhibit a continued series of cascades, particularly at the top of this the precipitous part of its course, where it leaves the more level bottom of the *High Glen*, by falling

falling at once fifteen or twenty feet. This, as will be seen by reference to the map, is the very same *High Glen*, upon the other extremity of which I had already occasion to touch, in my description of Glen Gluoy, where I mentioned it as affording a vista from the head of that valley, into Glen Roy, through Glen Turret.

The two shelves, (Shelf 3d and Shelf 2d), in winding from Glen Roy into the south-western side of Glen Turret, are expanded on a wide, and greatly elevated inclined plane, covered with peat-moss. They are consequently indistinct for a time, and they do not become very manifest, until they cross the stream coming from the *High Glen*, and lay hold of the steeper hill. They are then particularly well defined, and are very clearly marked in their progress all around the bendings of the mountains of Glen Turret, till they return by its north-west side, and sweep around the face of Tom-Bhran into Glen Roy. But the most interesting part of their course through Glen Turret, is that where they cross the tributary stream, as it issues from the *High Glen*. In this place, Shelf 2d is found on examination to touch exactly on the uppermost waterfall, at an elevation about twelve feet below that of Shelf 1st, or the Glen Gluoy Shelf. On tracing up the course of the little stream above this waterfall, it is found to run through the bottom of the *High Glen*, with a gentle current, without creating any excavation, and displaying no section, though the surface of the rock is sometimes descried in the water. It may be about a mile from the highest cascade, upwards, in which distance it has an aggregate fall of about twelve feet. It seems to have its origin, partly from springs on the sides of the hills, and partly from the moisture of a flattish mossy meadow, which continues to have an almost imperceptible rise for about one hundred yards, till, at a point, which is not more than the thickness of the moss higher than Shelf 1st, the level of the

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surface

surface sinks suddenly into Glen Gluoy. In order to have something like an approximation to the truth, as to what difference of level subsisted between Shelf 1st in Glen Gluoy, and Shelf 2d in Glen Turret, I travelled from the cascade upwards, through the *High Glen*, measuring as nearly as I could by the eye, and adding together, all the little falls of the stream, guessing at the addition, and subsequent deduction to be made at the end next Glen Gluoy: the result which I had from this rude process was fourteen or fifteen feet. In order to make certain however, of a point which I considered most material, I requested the favour of my friend Mr MACLEAN to revisit the ground, for the purpose of levelling it properly by means of the instrument; he was so kind as to indulge me, and the twelve feet of difference of level in the height of Shelf 1st above Shelf 2d, is given as the result of his observations. Such, therefore, is the nature of the levels here, that supposing Glen Gluoy to be filled with a body of water to a height equal to that of its shelf, and that, at the same time, the thick stratum of moss were to be removed, the consequence would be, that a stream would be discharged from it by the *High Glen*, and over the cascade into Glen Turret, and so into Glen Roy.

Let us now return to the head of Lower Glen Roy, where Shelf 3d and Shelf 2d, having wound from the ravine on the south side of the isolated rock, run faintly down the faces of the mountains on the south-west side of the glen, gaining greater distinctness of form as they proceed. They become particularly well defined, just at *f* in the map, where they sub-tend the mouth of Glen Turret; and in that part of the south side of the valley, there are appearances which may be worth notice. At first sight, one might be led to imagine, that there are no fewer than seven different stages of shelves here. A sketch could have given no idea of these; but the diagram,
(Plate VII.

(Plate VII. fig. 6.), may be of some use in helping the description of them. In it, the three uppermost lines represent the proper horizontal shelves 2d, 3d, and 4th, whilst all the others below have an inclination downwards in the direction of the fall of the glen, and this inclination, increases in each successive shelf, in proportion to its greater proximity to the river. These inclined lines of shelves can hardly be said to be on the side of the hill, but have rather the appearance of a series of small flats, one below another, between the hill and the river.

Shelf 2d and Shelf 3d, are to be traced, as well as Shelf 4th, with very little interruption along the faces of the mountains running down the south-east side of Glen Roy. Opposite to the hill of Bohuntine, the glen makes a great bend to the south, and afterwards returns to its south-east direction. It is near to this point that the mountains on the south-east side of the valley, though they still keep their roots so advanced as to leave the glen perfectly narrow in the bottom, yet retreat backwards above, surrounding and embracing a high and very extensive semicircular plane, apparently covered with a peat-moss; but soon afterwards they again advance in some degree, and at last finally terminate in the rocky prominent hill of Craig-dhu, which forms the more elevated part of the division between the mouths of Glen Roy and Glen Spean. Shelf 2d and Shelf 3d, being both of elevation superior to that of the bottom of the high plane, naturally bend away from Glen Roy, in a manner somewhat similar to that in which they run into the Gap of Glen Collarig, and winding around the amphitheatre of hills, and returning with them again, all traces of Shelf 2d are suddenly lost, nearly opposite to the point where it begins on the south-east side of the hill of Bohuntine. Shelf 3d runs on a little farther, to the rocky angle of Craig-dhu, where it likewise is abruptly terminated, also opposite to the
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the spot where it is first observed on the hill of Bohuntine. Neither of these shelves are ever met with afterwards, in any glen below these points of termination. Shelf 4th, which is at an elevation below that of the high semicircular plane just mentioned, does not bend into it like the other two; but the hills nearest the river beginning now to sink in height, it continues to run in a more direct sweep towards the foot of Craig-dhu. From the base of this more retired, and more elevated hill, an apparently mossy, and considerably inclined plane, stretches for half a mile in a south-west direction, towards the point of junction of the rivers Roy and Spean. But just above the spot where these streams unite, this plane again rises into the circular and isolated rock called *Mealderry*, which is particularly laid down in the map, and which may be easily recognized in Plate II. as being near the eye, and just beyond the mouth of the valley of Glen Spean. Shelf 4th, as it sweeps from Glen Roy around the base of Craig-dhu into Glen Spean, applies exactly in level to the upper line of the inclined mossy plane, lying between Craig-dhu and Mealderry; and the top of the isolated rock of Mealderry, rising somewhat above this level, is surrounded by a partial delineation, of what the levelling instrument proves to be an independent portion of the same shelf.

Although Craig-dhu, which may be properly considered as the mountain dividing Glens Roy and Spean from one another, thus appears to retreat backwards above, from the actual point where the rivers meet, yet the entrance of Glen Spean is very much confined, by the advance of the lower rock of Mealderry, on the north side of the valley, towards the base of the mountain on the south side. These come bending from Aonachmore, a mountain of the Ben Nevis groupe, and making a vast sweep around the great hollow basin, in the country below

low the junction of the Roy and Spean, push their roots into the very bed of the latter river, just above the House of Inch. From hence they run westward up the glen, forming its south side, with a straight and highly inclined face. The side of the mountain Craig-dhu, constituting the north wall of Glen Spean, has a front as even and as steep, as that of those opposite to it. Just above the narrow entrance of the glen, the hills on each side of the valley are about half a mile asunder; but some miles farther up, they begin to recede greatly from one another, and they seem to sink in their elevation as the bottom of the valley rises. The whole length of Glen Spean, from Inch to the Pass of Muckul, is about twenty miles. This pass, affording an opening between Glen Spean and the Valley of the Spey, is the summit level between them. Although it is not productive of any streams, it disparts the waters that run to the eastern and western seas; and yet the highest part of its bottom, is only elevated a few feet above the present level of Loch Laggan. By a reference to the map, it will be seen, that the river Pattaig, after issuing from its loch, has a directly north-east direction, as if it were about to run towards the river Spey, which is certainly its most natural course; but just before coming upon the bottom of the Pass of Muckul, it meets with the rock laid down in the map, which compels it to make a sudden and capricious bend to the west, at a very acute angle to its former line, and after a slow run of somewhat more than two miles, a considerable part of which is navigable by a boat, it empties itself into the upper end of Loch Laggan. This lake is eight or nine miles in length. On the north side, the mountains are partly of gentle acclivity, but in some places, they rise almost perpendicularly to a very considerable height. Although those on the south side are of inconsiderable elevation, yet they are bold and rocky to the

the water's edge; and, indeed, the whole shores of the lake may be in general called rocky. There is a good deal of wood upon both shores. The river Spean, which issues from the western extremity of Loch Laggan, runs slowly and smoothly for about two miles, cutting its course through flats of deep alluvial earth and clay, and rarely exhibiting any rock. The Spean, in its progress downwards, receives the Gulbean water, which enters it from the south; and, at about four or five miles above the House of Inch, it is joined by the river Treig, which has a run of nearly two miles from its lake lying to the south, the valley of the Spean being here of very considerable breadth.

The opening into the north end of Loch Treig is very romantic, being reduced to a narrow but grand pass, by the advance of the mountains on each side, which present two lofty and rocky fronts, guarding its entrance, (see Plate VI.), from which the lake expands, as it extends in a direction a little to the west of south. The shores of Loch Treig are in general bold and rocky, having their woods of birch-trees scattered over them. Immediately opposite to, and to the north of the narrow outlet of Loch Treig, there is a very singular, round, isolated little hill, with a flattish rocky summit. This is laid down in the map, and is called *Tom-na-Fersit*. After leaving the lake, the river Treig, winding amongst hillocks, rushes violently over the rocks which it exposes in its progress, and as it approaches the point of junction with the river Spean, its bed becomes deepened into a ravine, and it is projected over several falls.

Proceeding to trace the river Spean downwards, after its union with the river Treig, its course will be found extremely interesting; for it is not only bounded, on the great scale, by the mountains forming the proper walls of the glen, at some distance,

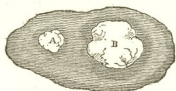
distance, but it has also, much nearer to its bed, a second and interior bounding enclosure, consisting of a line of banks on each side, flattish, and rather plain above, but having steep and abrupt, though perfectly smooth faces, towards the level bottom in which the river runs. These banks seem to be chiefly formed of alluvial matters. They appear immediately below the junction of the river Treig, whence they sweep with various bendings, sometimes at a greater, and sometimes at a lesser distance from the Spean, enclosing a beautiful narrow plain about a mile in length, through which the stream flows gently over a gravelly bottom. This plain is suddenly shut in at the lower end, by the close approach of these banks on both sides. Here the river, suddenly altering its character, pours itself into a deep ravine, which it seems to have worn through a rocky neck of about five hundred yards in thickness, where it is heard roaring along in a series of cataracts, of which the great waterfall of Tulloch forms the grandest specimen. The stream has no sooner effected this turbulent passage, than it enters a second beautiful and level plain, about two miles long, and bounded on the sides by a similar series of banks. Through this it again flows with perfect placidity, until, by a second approach of the sides to one another, at a point a little above what I have called the *Mouth of Glen Spean*, the tranquillity of the river is a second time interrupted by another rocky neck, like that I have just described. Here it again forms into an abyss, of the same depth and appearance as the former, where, besides being hurried over a number of lesser cascades, it is precipitated over the fall of Munessie, equal in grandeur to that of Tulloch. These two necks of rock, through which the Spean has thus cut its way, are both called in Gaelic *Kenmuir*, which signifies, *the End of the Lake*. Escaping from the gloomy and overhanging rocks of this second deep

and narrow ravine, the river again puts on the peaceful character, and flows in a broad channel through the Meadows of Inch. After its union with the Roy, it proceeds, (as I have already noticed), across a hollow and shelving basin in the open country, somewhat more than two miles in extent, till the banks again approaching, and closing in on the river, it a third time, and on a still more magnificent scale, exhibits the deep ravine, and the waterfalls and rapids, which so often arrest the attention of the traveller who crosses it at High-bridge. The shores of these three successive minor valleys, which may be said to be included in the larger, are what I have numbered 5, 6, and 7 in the map.

I must now, again, take up the consideration of the course of Shelf 4th, which having wound from Glen Roy around the base of the hill of Crag-dhu, stretches very distinctly up the smooth and even faces of the mountains on the north side of Glen Spean, the bottom of the valley rising towards it as it proceeds, until at last it approaches so near to it in elevation, that the Engineer of the Parliamentary Commissioners has actually availed himself of the line of shelf, to construct on it a part of the great new Loch Laggan Road. As the shelf approaches within two miles of Loch Laggan, it begins to be identified with the upper bounding line of the flats of deep alluvial earth and clay, through which the river Spean flows from the lake. It is then to be traced all up the north shore of Loch Laggan, being only a few feet above the level of its water, and in most places only a few yards from its margin; and running along the banks of the river Pattaig for about two miles, it crosses that river at Muckul, on a level equal to that of the summit-level of the bottom of that pass, and in such a manner, that it is evident, if a body of water were raised to the level of the shelf, a stream would run from it, through the Pass of Muckul,

Muckul; towards the river Spey. Returning down the south bank of the Pattaig, Shelf 4th is to be traced all around the south side of Loch Laggan; and it exhibits nearly the same appearances on the south side of the river Spean, that I have already described it to do on the north side. As it approaches the river Treig, it sweeps round in the direction of the mouth of the glen and lake of that name, where, notwithstanding the rocky nature of the mountains, it is found to be very deeply marked. It enters the jaws of the pass into Loch Treig in the manner represented in Plate VI.

By far the most satisfactory and perfect example, of any shelf completely surrounding the top of a hill, is to be observed on the isolated one of Tom-na-Fersit, immediately opposite to the opening into Loch Treig. Shelf 4th is most distinctly and broadly traced around it, at the same level that it appears on the rocks where it enters to Loch Treig. And what is still more worthy of remark, the little hill, having a second and inferior rocky top, rising above the level of the shelf, it is perfectly surrounded also, and detached from the principal summit, so as to give this portion of shelf, which belongs independently to Tom-na-Fersit, the appearance laid down in the map, or to shew it on a larger scale, something like this:



A and B being the two tops of the hill rising out of the surrounding shelf. The rocks on the interior angle of the shelf, are here particularly rounded, and have all the characters of those bounding the edge of low and rocky islands, frequently met with in Highland lakes. Where the smaller top is divid-

ed from the larger, a peat-moss has been formed, though the comparatively trifling surface exhibited by the whole of the elevated and rather rounded top of this isolated hill, is certainly a situation where such a deposit is hardly to be looked for.

The numerous torrents that pour down the sides of the mountains of Loch Treig, have very much defaced the course of Shelf 4th around that lake. Although very distinctly seen at its northern end, it is but faintly traced along its eastern side. It is to be observed at the southern extremity, and appears very visible on the western side, where it leads back and winds again into Glen Spean.

After leaving the mouth of Loch Treig, Shelf 4th is easily traced along the hills on the southern side of Glen Spean. It appears particularly well marked on the even faces of the mountains, for a long way before it comes to what may be called the Mouth of the glen; and just above the House of Inch, it sweeps away in company with the receding mountains, where, though faint, it is easily followed, to a ravine called *Corr-a-cloichlich*, whence I thought I could even trace it, though with some little difficulty, through an opening in a thin birch wood, on the side of Aonach-more, nearly as far as the projection of that mountain, where all appearances of it are finally lost. The projection to which I allude here, is the same which, as I formerly remarked, is met by a semicircular range of little eminences, forming a kind of elevated moor, sweeping towards it from Highbridge, and enclosing what I have called the *Basin*, in the open country of the Spean. This moor rises nearly to the level of Shelf 4th, and some of its more elevated points seem even to rise above it. These last observations will be found to be extremely important in the theory which it is now my intention to propose.

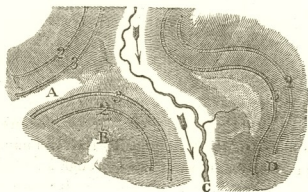
PARTICULAR

Particular Theory of the Causes which may be supposed to have operated in producing the Shelves in the Glens of Lochaber.

ALTHOUGH it appears to me, that no one can examine even a portion of these shelves with attention, without ascribing them to an aqueous origin, and without being likewise perfectly satisfied, that they were formed by the level waters of lakes, yet I have been taught by experience, that it is impossible to go farther in speculation, without a thorough knowledge of all the glens, as well as of every part of the tortuous course of the linear appearances to be found in them. Almost every step I took in this interesting investigation, seemed to lead to some new conclusion, as to what was the probable topography of the ancient lakes; and it was not until I had collected all those facts which I have stated in the foregoing pages, in what I fear will be considered as rather tedious detail, that any thing resembling a satisfactory theory of their distribution, shape, extent, and final evacuation, suggested itself to me. This I now venture to lay before the Society, trusting to its indulgence.

It appears that Glen Gluoy possesses Shelf 1st, which is the highest of all; and that it is to be found in no other glen. From this I would infer, that Glen Gluoy was at one period an independent lake, having a level higher than any of the others in its vicinity. The next two shelves in elevation, which are Shelf 2d and Shelf 3d, are confined entirely to Glen Roy, and its smaller tributary glens; and are found to run down and terminate, nearly together, in the Gap of Glen Coljarig, on the north side, and in the mouth of Glen Roy on the south side of the round hill of Bohuntine, as represented in
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the map, or perhaps more satisfactorily in the following diagram, in which Shelves 2d and 3d alone are marked,



and where A is the Gap of Glen Collarig, B the hill of Bohuntine, C the mouth of Glen Roy, and D the angle of the mountain Crag-dhu. From these facts it would seem, that Glen Roy must have been for some time an independent lake also, having its south-west extremity situated somewhere near the hill of Bohuntine, where it must have terminated in two bays, one on each side of that round hill. And as we see that there are two shelves of different elevations, which are the property of Glen Roy alone, it is equally evident, that its lake must have once existed for a time at the level of Shelf 2d, and must have afterwards subsided to that of Shelf 3d. But we find that Shelf 4th is common to both Glen Roy and Glen Spean; consequently this implies a second subsidence of the Glen Roy lake, reducing it to the same level, and making it a portion of a lake which must have pre-existed in Glen Spean. In the primary state of things therefore, we find an independent lake in Glen Gluoy, which may be called *Loch Gloy*; another in Glen Roy, at a level about twelve feet below that of Loch Gluoy, which may be called *Loch Roy*; and a third, covering the

the whole of Glen Spean, Loch Laggan, and Loch Treig, at a level about two hundred and eighty feet below that of the primary state of Loch Roy, to which the name of *Loch Spean* may be given. As each of the different shelves may be traced around and across, at some point lying towards what is now the *upper extremities* of these valleys, whilst they appear in every instance to be suddenly broken off, at what is at present their *lower ends*, or mouths; it follows, that if there ever were any barriers, to keep these several lakes up to their level, they must have existed somewhere about what are now the lower ends of the present valleys.—Having made these general remarks, it will now be proper to consider, what were the boundaries and outlets of these respective lakes; and, in doing this, we shall begin with Loch Gloy.

The shelf which appears to indicate the former existence of this lake, is found on the north-west side, some little way above the present entrance of the glen. This entitles us to suppose, that the lake at least occupied the extent of the glen, from this point upwards, as far as the present head of it, where the shelf is seen to sweep round, in order to return. But I trust it has already appeared to be evident, from the description I have given, that when the water in Glen Gluoy was filled up to what is its present line of shelf, it must have run by a natural channel towards Glen Turret, by what I have denominated the *High Glen*, (for which see the map). To produce this effect, however, an immense bulwark or barrier would be required, at what is now the mouth of Glen Gluoy, which would in that case become the head of the lake. Let us, in the meanwhile, take it for granted, that some such bulwark did exist, at, or near Lowbridge, and then it would follow, that what is now the upper end of the *Glen*, must have been then the lower end of the *Loch Gluoy*, from whence the river Gluoy would

would naturally issue, and whence it would run by a gentle course through the *High Glen*, into that bay of Loch Roy which is now Glen Turret, and which, in this view of the matter, we must call the *Bay of Turret*.

Let us now consider what was the state of Loch Roy when at its highest level. A glance at the map will show, that the south-eastern extremity of its present glen, must have been shut in by two barriers, or rather two portions of one great barrier, of which the round hill of Bohuntine formed the central part, and of which also Mealderry might, or might not, have constituted a fragment. This barrier then, must have run in a semicircular manner, from the projecting angle of Crag-dhu on the east, towards the south-eastern side of the roundish hill of Bohuntine; and must again have extended itself from the western side of that hill, across Glen Collarig, so as to be joined to the faces of the mountains in the northern angle of that little valley, and having the Gap on its eastern, and Glen Collarig on its western side. The supposition, with regard to this barrier, is founded on the consideration, that it could not have been higher up the glen, since it must have been lower down than the points, where the shelves indicating the existence of the independent Loch Roy are abruptly broken off; and it is not so probable, that it could have been much lower down than this, since neither Shelf 2d nor Shelf 3d, are ever again met with, after they disappear thus suddenly. Moreover, we cannot go farther to the south-westward, without interfering with what must have been Loch Spean,—and then, from the inspection of the ground itself, this appears to be by far the most natural and probable position for such a barrier, of which the very shape of the rounded hill of Bohuntine, seems to testify, that it formed a part. But at the time when this barrier existed, this southern end of Loch Roy must have been
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its upper extremity, from whence the surface of the lake extended all the way to the mossy ground within a few yards of Loch Spey, where we have seen that Shelf 2d is identified with the flat, in such a manner, as in my opinion to warrant the conclusion, that the primary Loch Roy discharged its own waters, and those it received from the tributary Loch Gluoy, down through the hollow of the present course of the river Spey, by Garvamore, to the German or Eastern Sea. In this state of matters, the boundary rock between upper and lower Glen Roy, some portions of the top of which seem to rise a little above the level of Shelf 2d, and around which there is a partial delineation of it, was probably a very low, rocky, and perhaps broken island; and what is now Glen Turret, must have been a large bay, having two smaller ones included in its interior. The Gap,—the mouth of Glen Roy,—and the high plane to the north of the projection of Craighdu, must then also have formed three considerable bays.

I shall now leave Loch Roy in its primitive state, in order to take a view of the boundaries and barriers of that of Loch Spean. In doing this, I must entreat attention to the state of appearances in that part of the mutual valley of the Roy and Spean united, which crosses in a semicircular line, from the south-western corner of Ben-y-vaan on the one hand, to the northern projecting point of Aonach-more on the other. From the same species of reasoning which I employed to establish the barrier of Loch Roy, it appears evident, that the barrier of Loch Spean, could not have existed above the semicircular line I have just described, since the two abrupt ends of Shelf 4th, indicating the former existence of Loch Spean, come, if not quite up to the two extreme points of it, at least to within a very short distance of them; nor is it to be supposed, that this barrier could have been much to the

south-west of these points, since not the slightest vestige of Shelf 4th, has been discovered any where in that direction. But as, in the case of Loch Roy, this also actually appears on an examination of the ground, to be by far the most natural and probable position for the barrier of Loch Spean, since the semicircular range of little hills, or what I have called the elevated moor, which exactly follows the supposed semicircular line I have sketched out, rises even now, nearly, and I believe in some places entirely, to the level of Shelf 4th, so that if the ravine at Highbridge were closed up, and the deficiencies in the elevated moor supplied, the perfect barrier for the confinement of the water of Loch Spean, would be reproduced. I say the *perfect* barrier,—because I believe that the lake had no outlet here at all, but that this was its upper end, and that 'as in the other cases, the former loch and the present valley have changed extremities. The primary Loch Spean, then, must have stretched from a point a little above Highbridge, all the way to the summit-level of the bottom of the Pass of Muckul, a distance of not less than twenty-four miles. There the level of Shelf 4th sufficiently shows, that the surface of the lake had such a relation to the ground at that end of it, that it must have discharged the River Spean (or *Little Spey*, for such is the interpretation of its name), through the Pass of Muckul, by a straight and natural course, carrying it to direct union with the Spey, which at that time brought along with it the Gluoy and the Roy, in addition to the waters supplied by its present source. Whilst matters were in this situation, the river Pattaig must have entered near the eastern end of the lake, to be immediately afterwards discharged by it through the Pass, along with the rest of the water passing from Loch Spean, and in a course much more natural to it than that in which it now runs. Loch Treig must then have been a great southern limb of Loch Spean, and the
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tops of the little hill of Tom-na-Fersit must have formed two small islands; and it would depend upon the circumstance, whether Mealderry was, or was not, a portion of the Loch Roy barrier, (which, by the bye, I am rather inclined to think it was not,) whether its top was also an island in the primary or independent state of Loch Spean, or whether it only became so afterwards. A reference to Plate VIII. fig. 1. will explain what I suppose to have been the primitive state of Lochs Gluoy, Roy, and Spean. I conceive that Loch Gluoy always remained an independent lake up to the period of its final evacuation: but it is evident, that some intermediate changes took place as to the circumstances of the other two lakes; and these will now fall to be considered.

I believe it will be readily admitted, that it is much easier to suppose the existence of former barriers, than to discover the means which operated in their removal; but it must be also granted, that the difficulty of accounting for the destruction of such large masses, does not by any means imply that they never had any being at all, particularly where a number of facts remain to lead us to an opposite conclusion. From all the present appearances, it is extremely probable, that the barrier of Loch Roy, was not only very thin, but of soft materials, at the two parts which have been removed. When we consider in addition to these circumstances, that the level of Loch Roy was about two hundred and eighty feet above that of Loch Spean, and that, consequently, the pressure against this weak barrier must have been very great, it will not appear by any means very improbable, that some partial rupture may have taken place at one, or perhaps both of the narrow necks A and B, Plate VIII. fig. 1., so as suddenly to reduce the level of Loch Roy to Shelf 3d, where it continued to remain for some time. It is proper to remark here, what I

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trust will appear sufficiently evident, if the explanatory diagram I have employed, Plate VII. fig. 5. be examined, that the operation of the waves of a lake, in eating out a shelf on the side of a mountain, will be much more powerful when the surface of the mountain is yet entire, than it will continue to be afterwards, when a certain proportion of sloping beach has been formed, over which it may in some degree waste the fury of its waves. We see that the natural shelves now existing around the borders of our Highland lakes, do not appear to have been very much, if at all increased, beyond the breadth of those remaining from the lakes which we suppose to have been emptied at so very remote a period. The depth, therefore, of the indentation of a shelf, does not form any criterion whereby we may judge of the length of time expended in its formation. Shelf 4th furnishes an excellent example of this observation, for it is as deeply indented, and as well defined, in many parts of Glen Roy, as it is any where in Glean Spean, although it is evident, that the lake which formed it, must have existed much longer in the latter glen than it did in the former. It does not therefore appear to be absolutely necessary, that Loch Roy should have remained long at the level of Shelf 3d, before its second subsidence took place; but it is not very material to the theory whether it did so or not. It is evident, that one material change must have taken place in it, in consequence of the sudden fall of its level. The whole extent of Upper Glen Roy must have been laid dry, and, consequently, it would now no longer discharge the united streams of the Gluoy and Roy, by the channel of the river running from the point at Loch Spey; but leaving the stream from that little residuary lake to pursue its own course, it would now, in the first instance, become tributary to the great Loch Spean, and would be carried by means of its river through the Pass of Muckul,

Muckul, to join the lower part of its former run. This secondary state of matters is represented in Plate VIII. fig. 2. Although it is not very easy to conceive what might be the exact effect of this change, in the course of so very considerable a body of running water, yet there can be no doubt that its power would in time be felt, directed, as it now came to be, against a thin barrier, composed of soft materials, and already so much weakened, as it must have been, by so great a rush of water, as that which pressed over it during the sinking of Loch Roy from the level of Shelf 2d to that of Shelf 3d. Indeed the very circumstance of admitting the possibility of such a breach having ever taken place once, implies that the causes for its happening a second time must have been greatly multiplied; nor can any one hesitate in believing, that if the destruction once began, it would likewise be now proportionably much more sudden and tremendous. Be it remembered, too, that although the perpendicular height to be swept away, was greater upon this second occasion than it was in the first instance, yet it was not necessarily very great,—not certainly of necessity more than about two hundred feet, the difference of elevation between Shelf 3d and Shelf 4th. We see, indeed, by the appearances remaining in Glen Collarig, where there has been little or no change since that rupture, which, during the second subsidence of Loch Roy, let off a portion of its waters there, that the opening which took place in the barrier between the Gap and it, did not extend to half that depth, otherwise the united Lake of Roy and Spean would have gone entirely through there, and would have made an island of the hill of Bohuntine. But where the Roy now flows on the eastern side of that hill, the depth of barrier destroyed must have been at least equivalent to that of the depth of Shelf 4th below the level of Shelf 3d. But as I shall afterwards exhibit causes for the

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the subsequent deepening of the present mouths of the glens, by means of their rivers alone, it is unnecessary to suppose at present, that the barrier was destroyed by the second subsidence of Loch Roy, to a depth much under that which was merely necessary to reduce Loch Roy to the level of Loch Spean, of which it now became an immense arm, as represented in Plate VIII. fig. 3.

The consideration of what I suppose to have been the grand cause which operated in producing the sudden and contemporaneous evacuation of the independent Loch Gluoy, and the great, and by this time united Loch Spean and Roy, again leads me to the Glen-mor-na-Albin, or Great Glen of Scotland. To those who have travelled throughout the extent of this remarkable valley, it seems to me hardly necessary to point out the various circumstances that lead to the supposition of its being an immense rent across the island, produced by some extraordinary and powerful convulsion. Indeed the whole of its appearance is more strikingly convincing to the eye when examined, than any detailed description can be to the mind, however minutely conveyed in words. But if we consider the vast depth of its lakes,—the almost rectilineal straightness of its direction,—its uniform narrowness,—the uniformity also of the general shape of the abrupt and lofty fronts of its bounding mountains,—the seeming adaptation of those on opposite sides to each other,—the wonderful equality of its level from one sea to the other,—and the lowness of its summit-level,—which, as it is composed of vast beds of alluvial matters, must have been even raised by time greatly above its original state,—if all these circumstances, I say, be considered, it will at least appear possible, that it may have owed its origin to some such unusual event. But as I believe the evacuation of the lakes to have been owing to no less magnificent a cause than this, I
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am also inclined to think, that the evidence which they have left behind them, will reflect some strong rays of probability upon the theory I have adopted as to the formation of this very singular glen; and that the Shelves of Lochaber, and the Glen-mor-na-Albin, will be found upon examination, mutually to elucidate the history of each other.

Let us suppose, then, that the lochs were brought to the state which is represented in Plate VIII. fig. 3., and that the Glen-mor-na-Albin having as yet no existence, the whole country to the north and west of what was then their upper extremities, was a solid and undivided mass. An examination of the map of Scotland would at once show, that in such a situation of things, the discharge of the combined waters, generated in all of them, towards the Eastern Sea, by the channel of the River Spey, would have been then much more natural, than it even is now to the Western Sea by their present courses, under the circumstances that exist. Nor can it be doubted that the opening of this vast fissure, would produce all the effects necessary to explain the seeming difficulties, and to reconcile the various incongruities that otherwise encounter us, and perplex our speculations on this interesting subject. The terrible convulsions attending the creation of such a yawning crack, running through ground previously unbroken, although it might not cut exactly across in the very line between the lakes and their south-western boundaries, so as to allow the whole body of the water to escape from each of them in one moment, would certainly so rive and shatter the country, that the weight of the water itself would almost instantly complete the annihilation of any thing that remained to prevent its escape. From the appearances which still exist indeed, this would seem to have been the very manner in which it must have operated with respect to the Spean lake, since

since we see that the middle of the crack, runs nearly in the line of the river Lochy, whilst the western termination of the supposed Loch Spean must have been above Highbridge. It is therefore probable, that the small hills that are scattered like an elevated moor, in a semicircular form, from Ben-y-vaan, by Highbridge, to the projection of Aonach-more, are the remains of the shattered barrier, towards the destruction of which the discharge of the lake added the immediate assistance of a tremendous rush of water. The appearances at the Mouth of Glen Gluoy, and particularly the manner in which the shelf of that glen suddenly stops, on the south-east side, whilst it comes farther down on the north-west side of the valley, would rather seem to indicate, that a smaller crack, (of which there would naturally be several,) branching off from the great rent, had taken a zigzag direction, somewhat in the bent line formed by the mouth of Glen Gluoy and the Glen of Fintack; and indeed the whole appearance of this tributary glen would induce one to espouse such a supposition.

If it be at all admitted, that these lakes ever had existence, which I presume to suppose can hardly be doubted, I have already shown, that the whole water discharged from them, must have run towards the Eastern Sea. If this was the case, it appears to me to be impossible to account for the disappearance of the *terra firma* which shut in their western or upper extremities, in any other way than by the means I have suggested;—means which were fully adequate to produce at once the discharge of the united Loch Spean and Roy, and of the independent Loch Gluoy. It even appears to me to be not unlikely, (though I do not consider the aid of such a supposition to be absolutely necessary to my theory), that in a country where such a great convulsion was to happen, some previous throes might have manifested themselves, which might have even

even had some share in weakening the barrier dividing Loch Roy from Loch Spean.

The present depth of the Glen-mor-na-Albin, is more than enough to have accounted for the escape of the waters of these glens towards either sea ; it is, however, evident, that it has been once much deeper, since the Caledonian Canal is now cutting through great beds of alluvial, to which the debris of the mountains brought down by torrents are every day adding, so much so indeed, as to produce an evident diminution in the extent of the higher lakes. And then Loch Ness itself is so very deep ;—though I am rather disposed to think, that the abyss containing it, may have been produced by some of the last pangs of the convulsion, which perhaps operated with greater violence there than elsewhere. A belief is very prevalent, that Scotland, to the northward of this glen, was once insulated from the rest of the kingdom, by a narrow strait of the sea running through it ; but from the circumstance of the early disappearance of all marine exuviae, in the course of the cut of the canal, from the sea, through the flat ground near Inverness, this notion appears rather improbable. It would, however, be a highly interesting experiment, to bore for nearly a hundred perpendicular feet, at some point about the summit-level of the Canal, in order to discover, what substances would offer themselves. Some very curious geological speculations might be awakened by such a trial, and some additional and unexpected light might thus be thrown, upon the theory of the ancient Lochaber lakes. It is very likely, that much evidence bearing upon this last subject, might also be gleaned, by extending our inquiries to the two extremities of the Glen-mor-na-Albin, as well as to the appearances at the mouth of the river Spey. The few investigations I have made as to these points, have been much more superficial than I could have

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wished, nor can I pretend to found much upon them. The western end of the Great Glen of Scotland, is flanked by such rocky mountains, as to render it impossible to conceive that the portion of water which escaped that way, however great might have been its body, or however violent its discharge, could have produced much effect, so as to leave traces of its action; and the sea also, on this side of the island, being so much nearer the immediate scene of the catastrophe, would naturally counterbalance the violence of the flood, by the sudden influx of its waters. Accordingly, I was not conscious of observing any thing on the west coast, that could lead to any conclusion, favourable to the theory I have ventured to hazard. But, upon the east coast, I thought I discovered appearances that seemed in a very material degree to illustrate and strengthen the views I entertain. In the neighbourhood of Inverness, there are great hills of rounded gravel, and sand, in what may be called the Mouth of the eastern end of the Glen-mor-na-Albin. The *Hill of Tom-na-hiurich*, near the Town of Inverness, in particular, is extraordinary both for its structure, its shape, and its situation; being found standing nearly in the middle of the alluvial flat, like the inverted hull of a ship in form, and presenting the end of its long diameter towards the Great Glen, in such a way, and being so shaven off on the two sides, as to leave little room for doubt, that it stands as a living witness of that terrible flood of water, which resulted from the sudden opening of the Glen-mor-na-Albin.

It remains for me now, to endeavour to trace out the changes which have taken place in the glens left by the lakes, and which may be considered as the secondary effects of the grand catastrophe;—and, first, as to those in Glen Gluoy. The chief streams of this glen are three,—one running from Glen Fintack, and the other two coming from the hills on the north
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and south sides of its present upper extremity. Whilst Loch Gluoy existed, the water of these streams was all discharged by the High Glen, into Glen Turret. But no sooner was the lake broken up at its other extremity, than the water would cease to flow in that direction, and would instantly rush into that which it follows at present. An attention to the southern branch of the river, at the head of Glen Gluoy, (to which, in the map, as well as in my description, I have given the name of the *River Gluoy*), as well as a remembrance of its various accompaniments in that quarter, will afford matter for some curious remark. It is discovered to descend from the hill, by a fall, upon that broad part of the shelf which must have been formerly a gently shelving bay of the ancient lake; where, whilst the water existed, its force would be immediately broken, and the stream would then have no effect in cutting, but would rather add to the shoal, by the deposition of the debris brought down with it from the mountain. But no sooner was the lake evacuated, than all check to the full exertion of the force of its descent would be removed, its powers of excavation would be brought into perfect action; and the violence of its descent would soon cut open the deep ravine which I have described, and marked in the map, as dividing the shelf across its whole breadth; and its power would continue undiminished, as long as any material difference existed, between the degree of declivity of the bottom of the ravine, and that of the lower part of the glen into which it issues. I therefore conceive, that this part of Glen Gluoy is particularly interesting, because it displays in a most satisfactory manner the mode in which running-water always operates, in bringing its course to a regular equality of fall, throughout all its parts. The present depth of Glen Gluoy, at its lower end, cut as it is also into a deep ravine, furnishes no proof that the

to show that the original

original lake was nearly so profound in that quarter. The sudden burst of the water must have done much to scoop it out almost instantaneously, and the river itself would continue active in reducing it, in a proportion exactly equal to the quantum of its deviation from a regular declivity, counterbalanced as it might be, by the various degrees of hardness of the materials through which it had to work. These last observations apply equally to the effects which must have been produced by the rivers of all the glens, after the evacuation of their lakes. We see how the rocks have been cut in the descent of the stream from the *High Glen*, which must have been done in the same manner I have just described, after the water escaped from the *Bay of Turret*. So, after the subsidence of Loch Roy, which laid dry all Upper Glen Roy, the stream would, in the same way, begin to cut the ravine, to the south of the rock, dividing Upper and Under Glen Roy; and the operations there, would be increased by the farther reduction of Loch Roy, to the level of Loch Spean. The inclined shelves opposite to the mouth of Glen Turret (See the diagram, Plate VII. fig. 6.) are evidently the effect of the water of Loch Roy, rushing off at successive elevations, during its final evacuation; or perhaps, indeed, some of the lower ones may have been owing entirely to the after operations of the river. Generally towards the mouth of Glen Roy, and particularly to the eastward of the Hill of Bohuntine, the valley has been much deepened by the river, and the rocks are more and more cut, as it proceeds in its progress down the glen; we are not, therefore, to decide upon the depth of the ancient lake at this point, by what we now see. The same deepening of the channel of the river takes place in the common valley of the united Roy and Spean, as is exemplified in the wild scenery at Highbridge, to which direction the river Pattaig was turned, and whither the whole water of these

these valleys was then sent and discharged, instead of going as formerly through the Pass of Muckul towards the East Sea. The state which matters had now assumed, will be understood at one view, by a reference to Plate VIII. fig. 4. Glens Gluoy and Roy were now completely evacuated of their stagnant water. But of the Glen Spean lake, besides those remnants that remain to this day under the name of *Lochs Treig* and *Laggan*; there were then three smaller portions, as represented in fig. 4. These must have long survived the great catastrophe, since the name of *Kenmuir*, or The End of the Lake, given to each of the rocky necks of land, which served as barriers to confine their western or lower extremities, sufficiently denotes that these minor lakes, must have continued to exist after the Gaelic language was in use. It is a remarkable coincidence, and worthy of notice, that the little valleys remaining after the discharge of these smaller lakes, exhibit the same ravines and falls, that accompany all those on the greater scale in this neighbourhood, and that also appear in the case of the analogous example of Subiaco in Italy. The causes which produced the evacuation of these smaller lakes, were evidently slow in their operation; it must have been gradually effected by the river alone working in obedience to that invariable law, by which running-water has a constant tendency to reduce the course over which it flows, to one uniform and regular declivity.

From all that has come under my observation in the course of this interesting investigation, I am satisfied, that the district of Lochaber, and the country connected with it, will be found to merit frequent and minute inspection; and that it will be considered as affording many facts, from which important geological inferences may be drawn. It appears to me, that the evidence displayed by its different parts, is admirably calculated to illustrate all the varied mechanical operations of stagnant
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and of running water, under every modification; and that perhaps, these could be no where so well established. But this is not all;—for if, as I am inclined to believe, it shall ultimately be decided, that the Glen-mor-na-Albin, not only elucidates the mode in which the ancient lakes of Lochaber were evacuated, but that the shelves left by these lakes also, throw a reciprocal light upon the origin of the Glen-mor-na-Albin, then the science of geology will have reaped no inconsiderable advantage, by the attention of its followers having been directed, as I hope it will be, to such a field of inquiry.

NOTE.

THE descriptive part of this paper, was written from my notes, soon after returning from my last visit to Glen Roy. I have, just had, (January 1818), an opportunity, of reading for the first time, Dr MACCULLOCH's learned and ingenious essay "*On the Parallel Roads of Glen Roy,*" which was read at the Geological Society of London, nearly about the time that the Royal Society of Edinburgh did me the honour of listening to my first remarks on the same subject. I observe, that I have the misfortune to differ very materially from Dr MACCULLOCH, as to the height of Shelf 2d, or the uppermost line of Glen Roy, when considered with reference to Loch Spey. As will be seen by looking at the text, (page 33, of the foregoing), I conceive that this line may be traced to within about 200 yards, of Loch Spey, and that, from the present level of the ground there, having been increased by the accumulation of a mossy stratum, I believe the level of the shelf to be actually

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tually somewhat *lower*, than the surface of the moss lying between it and Loch Spey. In Dr MACCULLOCH's *Tabular View of Elevations*, he makes the highest parallel of Glen Roy to be 1266 feet, and Loch Spey 1203 feet, above the German Sea, and, consequently, the shelf to be 63 feet above the loch. Although my own observations have led me to form so very different an opinion about this matter, and although this opinion has been since borne out by the highly respectable testimony of Mr MACDONALD of Inch, yet I should have almost hesitated in supposing, that so very accurate and philosophical an observer as Dr MACCULLOCH could have been mistaken, did he not himself seem to imply a doubt in his own mind of some error having arisen in the measurement of this very elevation. This he expresses in a note which I hope Dr MACCULLOCH's consideration will forgive me for quoting, as I doubt not his liberality will pardon me for thus expressing my difference of opinion with regard to the state of a fact, of which I feel convinced. The words of this note are as follows:

“ Whatever doubt we may have respecting the general value of the method by which the elevation of the upper line of Glen Roy was ascertained, I must here remark, that this principal measurement receives confirmation, to a certain extent at least, by comparison with the height of that land which is the common division of the Truim and the Garry. This point has been found, by levelling, to be 1460 feet, and it appears probable, from comparing the course of the former river and that of the Spey to their common junction, that the source of the Spey cannot be materially different in elevation, a circumstance confirmed by the barometric observations. The other measures in the Table scarcely admit of any material errors.”—*Geological Transactions*, Vol. iv. Part ii. p. 327.

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The height of the source of the Truim is here stated to be 1460 feet; and it is supposed by Dr MACCULLOCH not to be materially different from that of the source of Spey, which, however, is only 1203 feet by his measurement. According to this statement, therefore, the source of Truim is 257 feet above that of Spey, which, in a question of so much nicety as the present, must be considered as constituting a very material difference indeed. But the difference between Dr MACCULLOCH and me, is only about 63 feet, which, if it can be allowed me, will bring the height of the sources of the Truim and Spey so much nearer to an equality, and will at the same time make the altitudes relating to Glen Roy, in perfect harmony with the view of the state of matters which my observations have led me to entertain.

II.

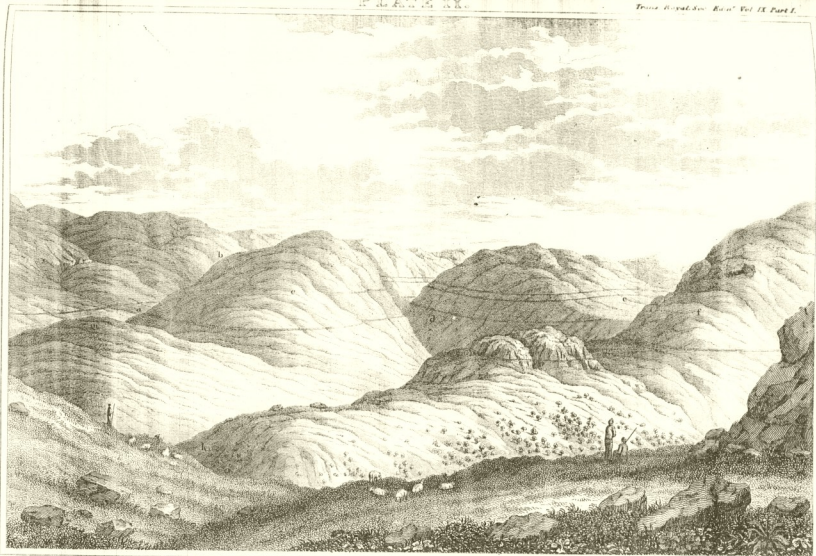


Engraved by Thomas Lister 1843.

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VIEW down **GLENGLUOY** from the hills at its upper extremity from point *a* in the map.

a. Ben Nevis seen at a distance. — *b.* Mouth of Glen Ritzack.



Engraved by Thomas Landis Esq.

Engraved by W. Miller Esq.

VIEW of the mouths of GLEN ROY and GLENSPAN taken from above Inch from point *b* in the map.

a Glen Collary—*b* the Gap—*c* hill of *Pheasants*—*d* Glen Roy—*e* the high plain—*f* Craig Sta—*g* wetland plain—*h* Mulltop—*k* proper point of division between the two Rivers—*m* *Collary*.



The GAP as seen from GLENCOLLARIG taken from point *c* in the map.
a is the hill of *Roburine*.



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FIG. 2.

The GAP as seen from GLENCORRY taken from point *e* in the map.
a is the hill of *Roburine*.



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Engraved by W. Miller Scot

VIEW up GLENROY taken from the GAP from point *d* in the map

The foreground represents a shelf, with a rock in the interior angle



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VIEW of the head of GLENROY taken from point *f* in the map

the foreground is a portion of Staff 31

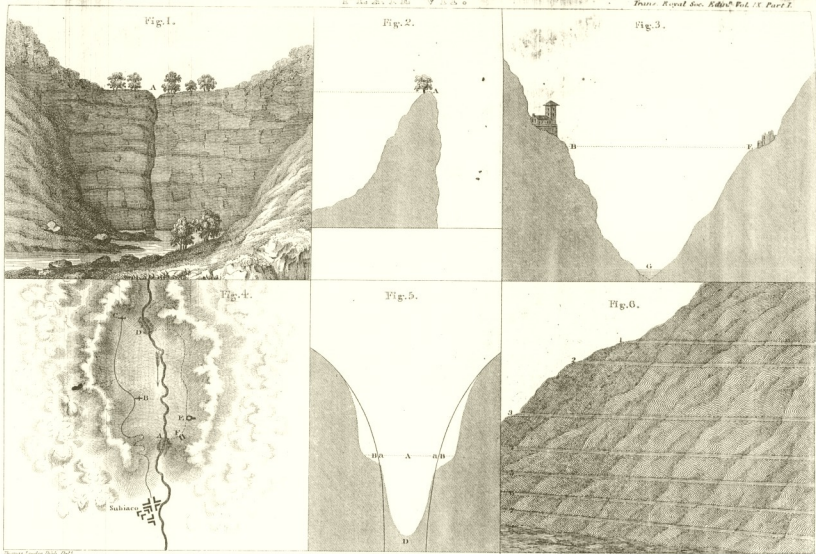
a Mountain of Tomblin - b isolated rock dividing upper and under Glen Roy - c ravine through which the Roy comes



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Designed by Wm. Miller, sculp.

VIEW of the Entrance to LOCH TREIG taken from the top of Tu-na-fersit in GLENSPEAN from point *g* in the map.



DIAGRAMS

Fig. 1. The barrier rock of the Valley of Sabiaz. Fig. 2. Section of the barrier rock. Fig. 3. Section of the Valley of Sabiaz. Fig. 4. Map of the Valley of Sabiaz. Fig. 5. Theory of the formation of a Strait. Fig. 6. Gen. Reg. pseudo-strait.



DIAGRAMS to illustrate the theory of the four different states of the LAKE'S

Fig. 1. Primary state of all the lakes. Fig. 2. State of Loch Rocy after its first subsidence. Fig. 3. State of matter after the second subsidence of Loch Rocy. Fig. 4. Change produced by the opening of the Cinnarus alba.

