

II. *An Account of Two Giants Causeways, or Groups of prismatic basaltine Columns, and other curious volcanic Concretions, in the Venetian State in Italy; with some Remarks on the Characters of these and other similar Bodies, and on the physical Geography of the Countries in which they are found. Addressed to Sir John Pringle, Bart. P. R. S. by John Strange, Esq. F. R. S.*

TO SIR JOHN PRINGLE, BART. P. R. S.

Naturalem causam quærimus et assiduam, non raram et fortuitam.

SEN. Nat Quæst. L. ii. C. 55.

Redde, Nov. 24,
1774.

HAVING had some satisfaction in the discovery of two groups of prismatic basaltine columns in the Venetian State in Italy, I thought, that an account of them might possibly prove acceptable to you, SIR, and to the other learned members of the Royal Society. I therefore take the liberty of transmitting to you the present, together with accurate drawings of these causeways, requesting of you to communicate them to the gentlemen of the society, should you think they merit their attention. I shall, first, briefly explain
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the two drawings; and then add such observations as have occurred to me, upon considering more particularly the curious originals which they represent.

N. 1. Is a topographical view of a part of the south-east side of a hill, called MONTE ROSSO, about seven miles distant, nearly south, from Padua, in the Venetian State in Italy, and a mile to the west of ABANO, a village well known, from the celebrated hot baths of that name, and which are situated at half a mile's distance to the south of it. This view particularly represents a natural range of prismatic columns, of different shapes and sizes, which are placed in a direction nearly perpendicular to the horizon, and parallel to each other, much resembling that part of the famous Giant's Causeway in Ireland, called THE ORGANS, as may be seen at Fig. 2. in the west prospect of that Causeway, engraved by Vivares, after one of Mrs. S. Drury's excellent designs. N. 2. Is a similar representation of the west side of another basaltine hill, called IL MONTE DEL DIAVOLO, or the DEVIL'S HILL, near San Giovanni Illarione, also in the Venetian state, and Veronese district, about ten miles nearly north-west of Vicenza. The prismatic columns appear to be ranged in an oblique position, along the side of the hill, not unlike the group represented under the rock, marked Fig. 9. in Mrs. DRURY's west prospect of the Giants Causeway. This drawing, however, represents only a part of the Causeway of San Giovanni, which continues along the side of a valley, nearly in the same manner, to a considerable distance.





Tab.I. *pl.* 6.

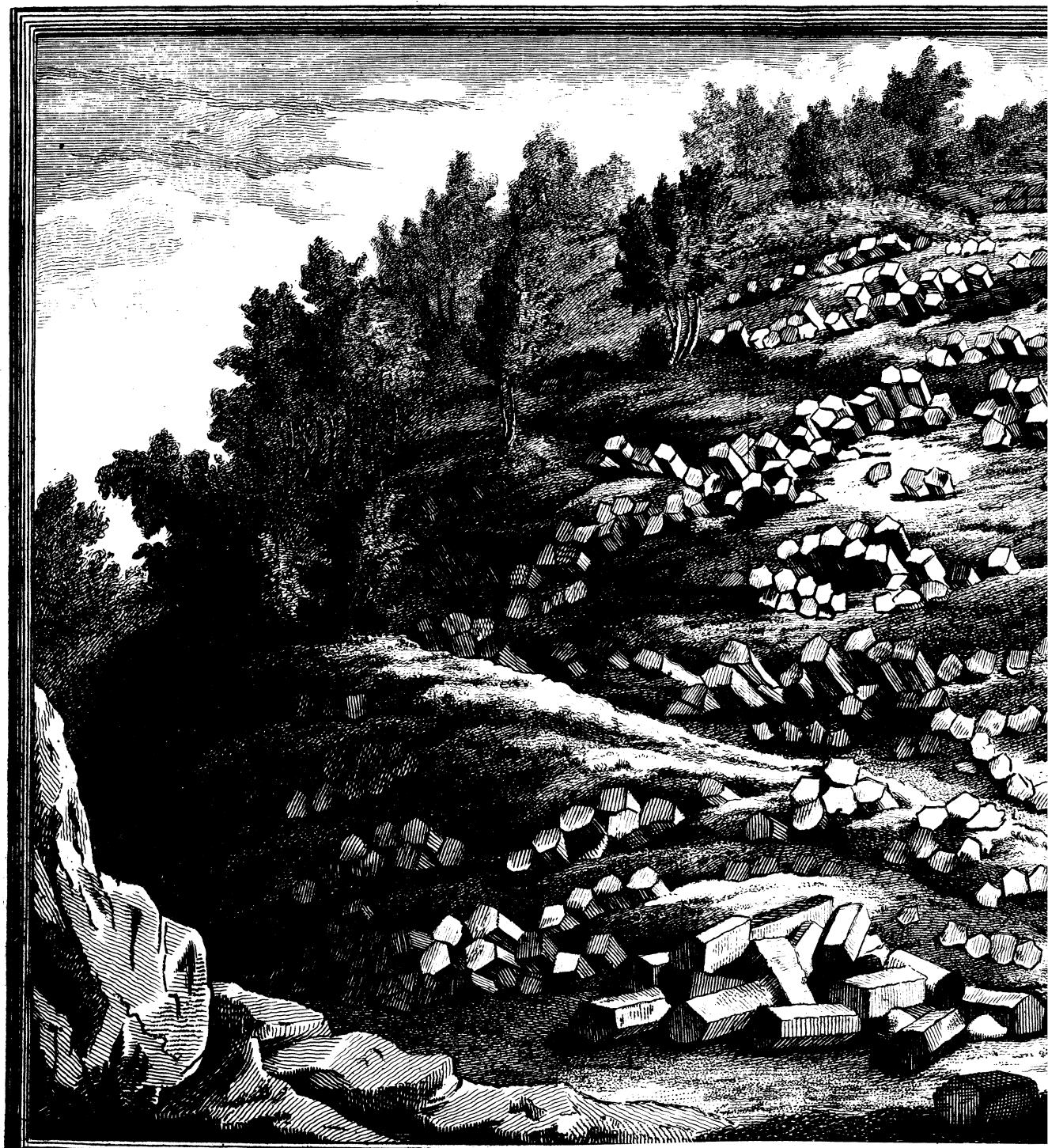


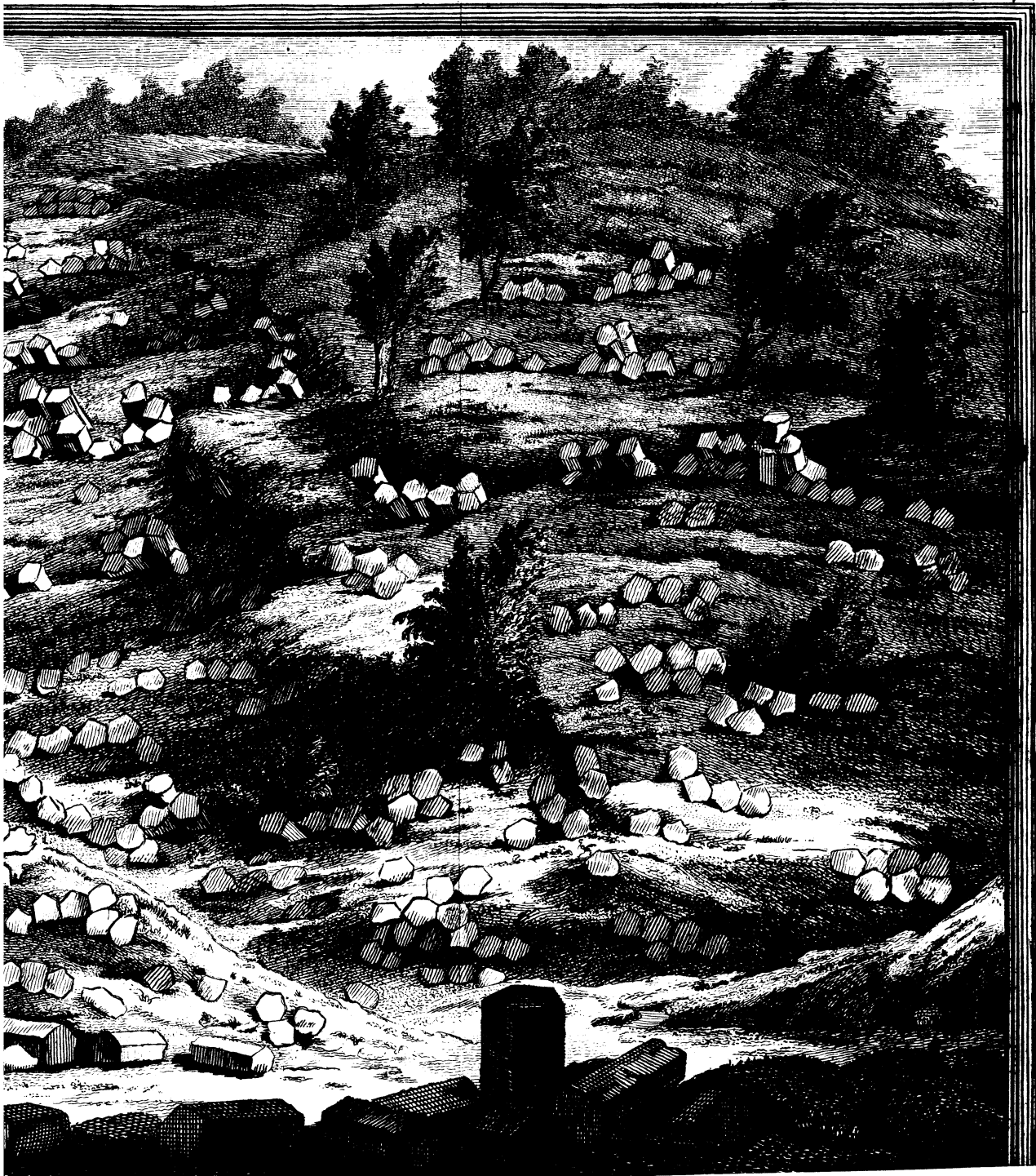
distance. Though the columns of both these hills are of the simple, or unjointed species, *Corneus crystallifatus prismaticus lateribus inordinatis*, WALLERII, yet they differ very remarkably from each other in many respects; but principally in their forms, and the texture and quality of their parts. Those of San Giovanni commonly approach a circular form, as nearly as their angles will permit; which is also observable in the columns of the Giants Causeway, and of most other basaltine groups. On the contrary, those of Monte Rosso rather affect an oblong or oval figure, as may be more particularly observed in the annexed representation of one of them^(a). The columns of San Giovanni measure, one with the other, near a foot in diameter; nor do they vary much in their size; though this is often the case in similar groups, and is particularly observable in that of Monte Rosso, whose columns sometimes equal nearly a foot in diameter, while others scarcely exceed three inches: the common width of them is about six or eight inches. They differ, therefore, very considerably in size from those of the Giants Causeway; some of which, as is well known, measure two feet in width. I can say nothing certain concerning the length of the columns of San Giovanni, since they present only their tops to view; the remaining parts of them being deeply buried in the hill, and in some places intirely covered, as may be seen in the drawing. The columns of Monte Rosso, as far as they are visible, measure only from six to eight or ten feet in height;

(a) Fig. 1.

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which is also a small size, when compared with the height of those of the Giants Causeway, some of which measure near forty feet. The columns of the Venetian groups manifest, however, all the varieties of prismatic forms, that are observable in those of the Giants Causeway, and other similar groups. But they are commonly either of five, six, or seven sides; and the hexagonal form seems mostly to prevail, which, if I mistake not, is also remarkable in the Giants Causeway, and, as I believe, in most others. Nor is there less difference in the texture and qualities of these columns, than in their forms. Those of San Giovanni present a smooth surface, and, when broken, appear within of a dark iron grey colour, manifesting also a very solid and uniform texture; in which characters they correspond with the columns of the Giants Causeway, and those of most other basaltine groups. But the columns of Monte Rosso are very different in all these respects. For they have not only a very rough, and sometimes knotty surface; but, when broken, manifest a variegated colour and unequal texture of parts. I have broken several, and have constantly found them of this heterogeneous character, and conclude, that the rest are, as usual, of the same; nor do I apprehend, that, among the whole, there is a single column of an uniform colour and texture, like those of most other groups. They are commonly speckled, as it were, more or less distinctly, and resemble an inferior sort of granite, of which Monte Rosso itself is formed, and which serves as a base to the range of columns in question. It is, in general, not quite
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so hard as the Alpine and Oriental granites, and is sometimes even friable, like the *Saxum granites particulis parum adhaerentibus*. ANON. Min. 270. n. 1.; or, *Saxum micaceum quartzosum spatiosumque subfriabile*. LINN. Syft. Nat. tom. iii. p. 76. edit. Holmiæ 1768. LINNÆUS justly observes, that this species of granite abounds in France; for I have lately seen large tracts of it in the neighbouring provinces of Auvergne, Velay, and Lionnois; and apprehend, that it likewise abounds in the Vivarey, Gevaudan, and Sevens mountains; from the affinity observable in the physical geography of those countries. But it is equally common in Italy; for besides Monte Rosso, the bulk of the Euganean hills in general, of which that is a part, principally consists of it; and these hills occupy a considerable tract in the plains of Lombardy. It is also common in the Tuscan and Roman States; the mountain close to Viterbo, on the road to Rome, is entirely composed of it. The Italians call it *Granitello*, and it much resembles the *Lapis variolatus* described by ALDROVANDUS in his *Museum Metallicum*. Though partial spots of this granite are often friable, especially about the surface, yet in general it is very hard; inso-much, that M. GUETTARD, compares the granites of France with those of Egypt^(b). The columns of Monte Rosso appear therefore of a different character from any hitherto described by mineralogists, who only mention those of an uniform colour and texture. It has been

(b) Mémoires de l'Acad. pour 1751.

observed, that the mass of stone in the hill above the Giants Causeway, portions of which are represented at Fig. 9. in Mrs. DRURY'S west prospect, is of the same quality and texture with the columns themselves; which affinity I have constantly observed between other similar basaltine groups, and the masses to which they belong. It is not therefore extraordinary, that the same should also be observable, between the columns of Monte Rosso, and the sort of granite rock on which they stand, and with which they seem, in a manner, intimately connected. For it is further remarkable, that the masses, or strata, of this granite, though irregular, are yet ranged nearly in the same direction with the columns above them, as may be observed, if I mistake not, even in the drawing. But the great singularity here is, that such a range of prismatic columns should be found bedded, as it were, in a mass of granite, and composed nearly of the same substance; of which I never yet saw or heard any other instance. This circumstance seems therefore to render the causeway of Monte Rosso more curious and singular than the famous one in Ireland is known to be, from the regular articulation of its columns; the same phenomenon having lately been discovered at Staffa, one of the Western Islands of Scotland. Different groups of articulated basaltine columns have likewise been observed in the province of Auvergne in France; particularly by M. BEOST DE VARENNES^(c), at Blaud near Langeac; and

(c) Sage *Elémens de Minéralogie Docimastique*, Paris, 1772, 8vo.

by M. DESMARESTS, near *le Mont d'Or*^(d). M. SAGE also mentions another near St. Alcon, in the same province. The Monte Rosso group is, however, not only curious in itself, but very interesting, on account of the great light it seems to throw upon the origin of granites in general, as I shall have occasion to observe more particularly hereafter. It is remarkable that the columns, in the two different groups of Monte Rosso and San Giovanni, preserve respectively the same position, nearly parallel one with the other; which is not commonly the case in other basaltine groups. For though the principal aggregate, which forms the Giants Causeway, stands in a direction perpendicular to the horizon; yet other small detached groups of columns also appear in the hill above, that affect, by their position, different degrees of obliquity. Among the numerous basaltine hills of Auvergne and Velay, in France, many of which I have lately visited, and which seem to abound in those provinces more than in any other part of Europe, and perhaps of the known globe, nothing is more common, than to see the columns of the same group lying in all possible directions, as irregularly almost, as the prisms in a mass of common crystal. Nor is this variety of position so observable in single columns, as in whole masses, or ranges of them, which often present themselves, in the same hill, disposed in different *strata*, or stages, as it were, one above the other, many of which affect very different, and even opposite, directions.

(d) De Romè Delisle Essai de Cristallographie. Paris, 8vo, 1772.

Thus, for instance, I have often seen a range of horizontal columns placed against another, in which all have appeared perpendicular; while a third mass, adherent to one or other of the former, and perhaps to both, has presented itself, with its columns obliquely disposed. It appears then, that a perpendicular position, with respect to the horizon, is by no means a characteristic peculiar to basaltine crystallizations, as hath been commonly pretended. On the contrary, whole groups frequently occur, that exclusively affect particular degrees of obliquity; as is evident in those of Monte Rosso, San Giovanni, and many others. Nor is even the horizontal position, though less common, to be excluded, as I have just observed; though I have never yet seen an entire group of columns so disposed. Such a group may, however, possibly be found, among the great variety of similar phenomena, which those curious and most interesting provinces of Auvergne and Velay present to our notice. The columns of San Giovanni seem bedded in a kind of volcanic sand, which, in many parts of the hill, entirely covers them; nor do I recollect whether any other solid masses appear, besides the columns: these, however, probably rest at bottom upon a base of basaltine rock of the same nature. Nothing is more common, in the provinces of France just mentioned, than to see isolated basaltine hills almost exclusively composed of different layers of columns, which present themselves in stages, one above the other, often without any other stratum between them, resembling, in some measure, *si magna licet componere*

componere parvis, a huge pile or stack of cleft wood. Though I do not mean to engross this Paper with my observations on the Auvergne and Velay basaltes, which I shall refer to a future occasion, yet I cannot quit the subject without adding a few particular remarks, that immediately concern the present inquiry. Though the columnar crystallization of Monte Rosso is the only one I have yet seen, or heard of, in a mass of granite; yet other groups of columns have occurred to me in other parts, that are equally of a heterogeneous substance or texture, though different from those of Monte Rosso, as well as from the common basaltes. But I shall mention only one instance, as the most pertinent to my present subject, in the basaltine hill, called *Les Rameaux*, near Isenchaux in Velay. By their form, surface, internal colour and texture, the columns of this hill partake of the characters both of the common basaltine columns, and of those of Monte Rosso before described. They approach nearer to the sub-oval than the circular form; their surface is rough, though not knotty; and though they rather incline towards the dark colour, and hard uniform substance, as usual; yet, on breaking several, I found them unequal, both in colour and texture, and sometimes interspersed with irregular pieces or patches, as it were, of a heterogeneous hard substance, which, by its *micæ*, and small rhomboidal crystallizations, much resembles a sort of granite I have frequently seen. The mass, on which these columns stand, is of the same mixed character; and towards the base of the hill,

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a granite predominates of the same nature with that observed in the columns. It is also remarkable, that granite in general, throughout Velay and the neighbouring province of Auvergne, is frequently intermixed with the basaltine, and other common vulcanic hills. I have observed the same in Italy, particularly in the Euganean hills near Padua, and on the confines of the Roman with the Tuscan State, about Viterbo, Bolsano, &c.; which tracts are also mostly vulcanic. The mountain of Radicofani, and its environs, with those of Aquapendente, are chiefly of the same character; and near the lake of Bolsano, by the road side leading to Viterbo, is the group of prismatic basaltine columns described by KIRCHER in his *Mundus Subterraneus* ⁽¹⁾, and which is the only one in Italy known to me, besides those of the Venetian State. But the profusion of basaltine phænomena in the provinces of Auvergne and Velay is really surprizing. In a morning's ride, of about a dozen or fifteen miles, round Isenchaux, which is the center of the Velay basaltes, I counted twelve distinct groups of columns, in so many different hills, detached, and at a distance from each other; and as these presented themselves to my view accidentally, without going out of the way in search of them, it is to be presumed, that many others, in the same neighbourhood, probably escaped me. They also abound about Puy, the capital of Velay, and still more so throughout all Auvergne. Nor is it merely a church, a castle, or perhaps a village, as in other countries, that sometimes crowns

(1) Lib. viii. sect. 1. c. 9. &c.

the basaltine hills of Auvergne and Velay. Whole cities are built upon them; a remarkable instance of which, among others, occurs in the episcopal city of St. Flour in Upper Auvergne, which covers the summit of a basaltine hill, and boasts a Giants Causeway for its foundation. This is more particularly seen at the south-east corner of the hill, above the bridge, and on the outside, under the wall of the town; which circumstances I mention, in case the same curiosity should ever lead any other traveller into those parts. As St. Flour is confined to the isolated summit of a hill, and is very closely built, the circumference of the walls scarcely exceeds much above a mile; but the same causeway continues from under the town, on the north side, to a considerable distance through the remaining lower part of the same hill, upon which the hospital of the town is built. Under this hospital to the west, and by the side of a road leading down into the valley from the town, the causeway is quite open to view, for a great extent, presenting the most considerable suit, or continued range, of high columns, that I saw throughout the whole tour. Including the continuation of this causeway, under the town, and the remaining part of the hill, it forms an aggregate of columns, which, for extent and importance, may almost be compared with the famous Giants Causeway in Ireland; with this signal advantage in favour of the Auvergne group, that it affords the foundation to a considerable city. The columns of St. Flour differ also from any I have yet seen. Among other singularities, which I shall not consider at present,

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I observed, that their shafts, though of the usual prismatic form, are nevertheless sometimes wreathed, or twisted, like the artificial, round, and spiral columns, that are often, though barbarously, introduced in buildings. The substance of these columns is, however, of the common sort, like that of the columns of San Giovanni, and the Giants Causeway. The town of Chillac, a few miles above old Brioude, on the river Allier, in Upper Auvergne, is also built on a Giants Causeway, consisting of high, straight, but unjointed columns, which are open to view towards the river. But I shall give no further instances of this kind at present; only must beg leave to observe, before I quit the subject of prismatic columns, that although no group of them has hitherto been discovered in our island, yet I am persuaded, that the mountains of Wales contain one; having, in my tour of that country, observed several large pieces of such columns at Townen, on the sea coast of Merionethshire, not far from Dolgelthy: particularly about Townen church-yard, where they are used as posts. I could not learn from whence they came, but should suspect, from the character of the adjacent country, that they are found in the mountains towards Dolgelthy, and probably somewhere about the famous Cader Idris. For I afterwards observed, in my ascent of that mountain from Dolgelthy, that its predominant mass appeared to be a sort of vitrifiable stone, seemingly of igneous origin, and which I shall here take occasion to observe greatly prevails in North Wales, particularly in the three Alpine Counties of Merioneth, Montgomery, and Carnarvon.

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taneously, in a manner, upon the consolidation of the whole mass of matter, in which they lie, and with which they constantly bear the greatest analogy, as I have before observed. It is further remarkable, that common crystals are parasitical bodies; whereas basaltine crystallizations, notwithstanding the peculiarities of their figures, rather seem to form integral parts of the masses to which they adhere; and seem to acknowledge, with them, one common and simultaneous origin; like the rhomboidal and other crystallizations in granites, and other similar vitrifiable compound stones. Nor does the common slow and limited principle of crystallization seem at all adequate to so great an effect, which seems exclusively attributable to an igneous fluid, on the general concretion of which, the organic principle may be supposed to have operated simultaneously in a large mass, and produced these bodies in the same manner as a linget of metal concretes at once in the mould. No other mode of generation seems reconcileable with the phenomena of basaltine aggregates, as I shall more fully prove in the account of those of Auvergne and Velay. Nor do I pretend to determine how strictly this simultaneous concretion of parts may be applied to the organization of such bodies, having used that expression rather in opposition to the slow and interrupted succession, that, to all appearance, takes place in the formation of common crystals. It seems also further evident to me from the phenomena, that prismatic basaltine crystallizations, and other regularly figured volcanic groups (for others have

have lately occurred to me in Auvergne and Velay, which have never yet been considered, and of which I shall hereafter give an account) it seems, I say, evident to me, that such regular bodies have been generated locally, and not in the midst of those violent convulsions of Nature, which are commonly assigned for the origin of vulcanic mountains in general. That the principle of organization, whatever it be, operates locally, in the formation of these bodies, appears, I think, sufficiently evident from the regular disposition and other particular characters of their groups. For notwithstanding the various directions of the columns, and masses composed of them, in the different groups, as I have before observed; yet, in other respects, the greatest regularity of disposition is commonly observable. They form *strata*, which are uniformly organized, disposed in particular directions, and often constant in the same to a great extent. These *strata* not only manifest a parallelism between their regularly figured parts, but in their whole aggregates; which often form extensive horizontal beds, and of an equal thickness throughout. This parallelism is also equally remarkable in groups that are composed of many *strata*; as I have particularly observed in those of Murat, and the Castle Hill of Achon, in Upper Auvergne; in which the columnar *strata* are not only parallel in themselves, but preserve, in their position, a parallelism with the other *strata* of the respective groups, which lie in regular stages, one above the other: and since these groups commonly form, in a manner, integral parts of the masses, or mountains,

tains, in which they are found, and these manifest also some affinity in their structure; it seems most reasonable to assign to both one common origin. The received notions, concerning the mode of origin of vulcanic hills, do not therefore seem intirely to correspond with the phænomena of Nature; since naturalists generally suppose, that they have all been thrown up, from the bowels of the earth, by subterraneous explosions, like the Monte di Cenere, near Puzzuoli, in the kingdom of Naples, the island of Santorino in the Archipelago, or the ejected entrails of Vefuvius and Ætna. But surely this must appear a mistaken notion to any one who compares these tumultuary and inordinate aggregates, with the regular vulcanic organizations before described. For in fact, what does Vefuvius, Ætna, the Monte di Cenere, and such like erupted piles, present to us but a heap of ruins, which evidently manifest the casual and extraordinary cause, to which they avowedly owe their origin? But this origin seems irreconcilable with the regular structures before mentioned, as may perhaps satisfactorily appear, from my considerations on the particular phænomena, that characterize them. And though it is very possible, that such organizations may sometimes take place upon the concretion of liquified matter thrown up in vulcanic eruptions; yet, however similar they may be, from the nature of their origin, I can hardly imagine they can form other than imperfect and irregular masses. For however wonderful the rivers of *lava* of Vefuvius or Ætna may appear to us; they, in reality, are but partial and

tumultuary efforts of nature, that by no means seem adequate to the production of a Giants Causeway, or the basaltine organizations of Auvergne and Velay, several of which continue, almost uninterruptedly, for many miles. This I have more particularly observed in the solitary and horizontal basaltine *strata* that cap the high, though flat, volcanic hills in Auvergne, and the adjacent part of Velay; as may be more particularly seen at the brows of those hills in the respective vallies. The celebrated M. DE BUFFON, speaking of these hills, styles them *Des plaines en montagnes, qui forment des pays au dessus des autres pays* (*f*). They also prove the mistake of some naturalists, who falsely ascribing to volcanic hills in general the same origin, as to Vesuvius and Ætna, exclusively assign to them also the same conical or orbicular forms. But, if I mistake not, the particular and relative characters of basaltine, and other regular volcanic organizations of the like kind, contradict a casual and tumultuary cause, and evince the necessity of their local origin upon a more steady and uniform principle. I shall also further observe, that I never saw any certain vestige of a regular *crater* in any spot characterized by similar organizations; which, as I before remarked, form, in general, integral parts of the masses to which they adhere, and which also frequently manifest an analogous structure, however irregular. And so far are they from representing the ruinous scenes of Vesuvius or Ætna, that they often afford no loose or isolated masses, except fragments of the columns

(f) Histoire Naturelle, tom. ii. p. 11.

of such groups, which have given way through time. This I have more particularly observed in the vulcanic and columnar hills of Isenchaux in Velay; in which the groups of columns are often so united with the body of *lava*, that they form, in a manner, but one solid, though figured mass. Monte Rosso is precisely of this character; nor did I observe a single column, or fragment even, loose; those in the drawing being merely introduced to show the forms of the columns. Neither are there here, or in the basaltine hills near Isenchaux, any signs of a *crater*: on the contrary, these hills, as well as Monte Rosso, are mostly terminated by regular convex summits, that form a solid mass. And that fused masses should frequently concrete in such a form we need not wonder, if we reflect on the effervescent and expansive property of fire. The phenomenon of horizontal vulcanic hills is accountable upon another principle, and seems chiefly to depend on the state of those hills before their ignition; as I shall endeavour to prove in my account of those of Auvergne; and of which the vulcanic hills of the Veronese and Vicentine districts afford also singular instances, which I shall now consider. It is difficult to say in what state vulcanic hills of a particular and regular structure, like the basaltine hills, for instance, may have pre-existed, before their alterations by fire, since they afford evident proofs, not only of a liquefaction, but of an entire new organization; by which means all marks of their former characters are totally effaced. Notwithstanding which, since these organizations are generated locally,

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some light is often to be had, even in this difficult question, and merely from the physical geography of the country, independent of the particular structure of the hills themselves. For countries have their external characters, according to the nature of the hills that compose them; though these characters seldom form a part of the geographer's inquiries; geography having never yet been formally considered, but as subservient to civil history. I shall not enter particularly into this question at present; only I shall observe, that the difference, in the external characters of mountains, according to their internal structure, is easily seen, on comparing, for instance, the outward forms of mountains of granite, or other similar vitrifiable compound stones, which are of an irregular structure, with those of limestone, which are commonly formed in regular *strata*. Signal examples of this are observable in the chain of mount Jura, which is exclusively calcareous, and of a horizontal summit, and that of the Alps, whose highest mountains are mostly of granite, and terminate in pics, pyramids, and other irregularly pointed forms, according to the nature of such mountains. When therefore a remarkable similitude is observable, between the forms and disposition of the hills and vallies of a volcanic district, and those of other countries of a certain character, that have not suffered by fire, it is reasonable enough, upon the principles before adopted, to suppose the same similitude even in the primary structure and qualities of the former, however they may have been obliterated by the intervention of fire. The
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vulcanic districts of Auvergne and Velay, as well as those of the Venetian state, afford proofs enough of the truth of this opinion; but I shall confine myself at present to the latter, and particularly to the phænomena of this kind, which I observed in the Vicentine and Veronese mountains, and which, if I mistake not, will appear decisive in the question before us.

These mountains occupy the lower skirts of the Alps, on the north side of Lombardy, and are partly volcanic, and partly of limestone. They form sub-divisions, or lateral branches of the great chain of the Alps, from which they diverge, nearly at right angles, and extend in a southern direction, and parallel with each other, towards the plain. Some of these branches are intirely of limestone, without any *lava*; others are composed of a mixture of both; and others again are exclusively volcanic. I have rode from the point of one of them near Montebello, in the Veronese territory, to Bolca, always upon *lava*, for the distance of near twenty miles. It is along this branch, by the side of the valley leading to Bolca, and about four or five miles short of it, that the causeway of San Giovanni Illarione before described is situated. The whole solid mass of this branch, as far as I could observe, is almost intirely composed of *lava*, which, about the skirts and surface particularly, is of various kinds. Among others very curious, I remarked some, at the foot of the castle hill near Montebello, concreted in different masses, which, by their extreme hardness, heterogeneous texture and colour, very much resemble an ordinary sort of porphyry. But I saw

no granite mixed with the *lava*, in these lower limestone skirts of the Alps, though it abounds so much in the neighbouring Euganean hills, as well as in Auvergne and Velay, as I before observed. Notwithstanding the general volcanic character of this branch of Montebello, its original structure and characters are still very evident, and perfectly correspond with those of the neighbouring branches, that have never suffered fire. For though some new igneous modifications have accidentally and partially taken place about the skirts and surface of this branch; yet in other more internal parts, not only the original horizontal position and parallelism of the *strata* are manifest, but small, though integral parts of those *strata*, here and there, remain unburnt, and show their calcareous qualities, structure, and extraneous contents, perfectly similar to those of the other neighbouring mountains, that have never suffered by fire. This I particularly observed along the brows, or upper lateral *strata* of the volcanic branch just mentioned, above the valley between Sorio and Montebello. The famous fossil fish quarry at Bolca, so well known to all the curious in Europe, is only an unburnt, calcareous, and flaty point, or side promontory, as it were, of the highest part of the same volcanic branch, that descends into the valley, from the church and village of Bolca, which are built upon it. This point within unites immediately with the *lava*, forming, in a manner, an integral part of the same hill. In other parts again; and particularly at Ronca, also in the Veronese territory, a few miles to the north-west of

VOL. LXV. E Montebello,

Montebello, though the mass is converted intirely to *lava*, and has evidently concreted from a fusion, yet the marine fossil bodies, originally contained in the *strata*, are distinguishable, and even distinct in the *lava*, though variously disfigured. Another observation I made, and which appears to me very interesting, is, that most of these branches, in the Veronese and Vicentine territories, whether marine, vulcanic, or mixed, still preserve nearly the same external characters, directions and parallelism, exclusive of the trifling alterations produced at the surface of the latter, as I before observed. It seems, therefore, sufficiently evident, that fire not only operates locally on lapideous solids, but often also in such a manner as not intirely to destroy all marks of their primary organization and qualities, much less to alter their dispositions, and the external characters of the masses or mountains, they form. And though all traces of the primary organization of these masses may be effaced by new modifications, yet often sufficient proofs remain of their former characters, in the forms, direction, and disposition of the mountains they compose, as appears from the instance I have just considered, and is still more strongly confirmed by the phænomena of Auvergne and Velay, which I shall consider upon a future occasion. It does not, therefore, seem impossible, nor even difficult, to trace the leading original character of a country, though it has suffered by fire a new modification of the *strata* that compose it. And the vulcanic mountains before described not only afford evident marks of their having pre-existed

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in another state, but manifest also plainly their primary qualities and structure, and equally prove, by their particular directions, that they never can have been thrown up fortuitously, from the bowels of the earth, like the Monte di Cenere, &c.; but have suffered fire *in statu quo*, or locally, without the least appearance of subversion, or change of place. The same seems also very probable of many other mountains, that are purely vulcanic, from the necessity of the local origin of their particular organizations, which I have before considered; and supposing even that such mountains manifest no internal nor external signs of their primitive structures or qualities. From the preceding observations it appears, I think, evident, that subterraneous explosions and eruptions are merely accidental phænomena, that are by no means essential to the production of all vulcanic mountains, as has been commonly imagined. This notion seems to have proceeded from the affinity often observable in the qualities and external forms of many such mountains, and those of real volcanos. But I have already observed, that there are many vulcanic mountains of a totally different form from the common volcanos; and though their *lava* may sometimes be similar in its qualities, yet the regular organization of it, in the former, frequently makes a most essential difference. For, as I before said, what does Vesuvius or Ætna present to us but a heap of ruins, which give us not the least idea of the structures to which they belonged? And though they may lead and enlighten the chymist, yet they afford but little instruc-

tion to the physical geographer, a constant sameness of phenomena occurring every where. Nor have we any foundation, from the external appearance of such mountains, to conclude, that all others, that have suffered fire, are of the same character. We see nothing but a heap of ruins, cast up from their bowels, and we are apt to imagine, that such inordinate materials compose the intire mass; and analogy, too often seductive in similar matters, leads us to conclude the same of other volcanic mountains in general. But I am much inclined to think, that the materials thrown up by burning mountains, are only lodged superficially, as it were, on their sides; and though they may considerably increase their bulk, as well as alter their form, yet they do not seem to constitute the intire mass of those mountains, as might be reasonably imagined from their external appearance. For it has been observed, both by PADRE DE LA TORRE, M. DE LA LANDE^(g), and others, that the inner sides even of the funnel of mount Vesuvius preserve manifest vestiges of its primary organization, in regular, parallel, and nearly horizontal *strata*, like those of other common mountains. And does it not appear more than probable from hence, that an original mountain lies under the *lava* of Vesuvius, serving in a manner, as its base, and which, whatever local alteration it may have received intrinsically, from the subtle element, that wastes its bowels, still maintains its primary undisturbed structure, like the volcanic mountains of the Veronese territory be-

(g) Voyages d'Italie, tom. VII. p. 169, 176.

fore described. It is not therefore likely, that the whole of mount Vefuvius should have been made at several times, by the earth and cinders flung up out of the mouth, that lies in the midst of them, the ashes falling down the sides of it, like the sand in an hour-glass, as Mr. ADDISON^(b) particularly observes, and as most people are naturally enough apt to think. And however considerably the bulk of this mountain may have been increased, by the loads of *lava* thrown out at the several eruptions; yet no great addition seems to have acceded to its height, if the observation just mentioned be true; which, though I have never had it in my power to verify, yet I readily believe; not only on account of the respectable authorities above quoted, but also from its consistency with other similar and indisputable phænomena, of which the vulcanic branch of Montebello before described affords, if I mistake not, no inconsiderable proof. Nor does it indeed appear agreeable to reason, that mountains of great height, where volcanos exist, should be entirely vomited up in this manner; such volcanos seeming to require a solid and permanent channel for the violence and frequency of the effects they produce. It seems therefore, that a way or channel only has been opened, by an original effort or explosion, through mount Vefuvius, which has since been deeply buried by the materials successively thrown up, from its bowels, in the several eruptions. And I am inclined to think the same of mount *Ætna*, from its superior height, though I am uncertain

(b) Travels, p. 184.

whether

whether BORELLI, or any other of its historiographers, takes notice of any fact, by which this conjecture is proved. The same seems also probable, for similar reasons, of mount Hecla, the Pic of Tenerif, &c. And if this be true of single or isolated volcanos, like Vesuvius and Ætna, that carry such strong external marks of having been exclusively produced by the accumulated *lava* of eruptions, much more is it likely to be so of others, that are not only considerably higher, but form parts of a continued chain, like the volcanos of the Andes, as I imagine. Is it not, moreover, highly improbable, that Chimborazo, which is one of those volcanos, and the highest mountains in the known globe, measuring, according to the French academicians, 3220 toises, which exceed four Italian miles, allowing 764 toises to a mile; is it not, I say, highly improbable, that such a mountain should exclusively owe its origin and formation to the accumulated materials of eruptions only? May not the same be said of the mountains Antisana, Kotopacsi, Pichincha, and the other volcanos of the Andes, of which some are little inferior in height to Chimborazo, and constitute in general the highest parts of that vast chain? And though the summits of these mountains, in all probability, form isolated points, yet, I presume, they unite in an uninterrupted mass below, like other chains of mountains. And if this be true, it is hardly credible, that the masses where these volcanos respectively exist, can have been indebted solely to them for their origin, or that they can have been fortuitously cast up from the

bowels of the earth like the Monte di Cenere, the island of Santorino, &c. If they form integral parts of a continued chain, as it is natural to suppose, is it not even absurd to imagine, that they can have had such an origin? Is it not, on the contrary, rather to be presumed, that channels only have been opened along this chain, by different explosions, where these volcanos respectively exist; and that the sides of these channels form integral parts of its original structure, as in the case of mount Vesuvius before remarked, and which here seems to receive the strongest confirmation. For however the eruptions of the volcanos of the Andes may have loaded their sides and summits in particular parts; yet surely inferior masses exist of a much prior origin, and whose continuity sufficiently seems to prove, that such eruptions are, relatively, only accidental phenomena. This reasoning is, however, grounded upon the supposition, that the Andes form a continued chain, like that of other similar mountains; and, as I presume, they do. From the preceding observations it seems therefore evident, that whether volcanic mountains preserve, or not, vestiges of their ancient and primitive state, or in whatsoever manner they appear to have been newly organized; few of them seem to have been intirely thrown up from the bowels of the earth, like the Monte di Cenere, &c. On the contrary, they mostly appear to have pre-existed in another state; and to have suffered by fire only locally, and more or less partially, of which I have given sufficient proofs; or, having afforded only passages to explosions and eruptions,

are

are partly in an original state within, and partly increased by new and adventitious materials superadded to their surface by successive eruptions; as seems to be the case of the volcanic mountains of the Andes, mount Vesuvius, and probably of most other volcanos of any great height; more especially where they form parts of continued chains. And if so few of the extinct volcanic mountains appear to have been thrown up, from below the common surface of the earth, like the Monte di Genere, &c. nor even those intirely which manifest actual volcanos; it seems highly improbable, that other common mountains should have had such an origin; as many respectable writers ⁽ⁱ⁾ have been inclined to think; and still more so, that such should have been the sole origin of all mountains; as a late Italian writer ^(k) on the theory of the earth has very unsuccessfully endeavoured to prove. It also plainly appears, if I mistake not, from what has been before said, that the phænomena of recent volcanos are very little calculated to give us much instruction about the more curious igneous concretions, and the origin of volcanic mountains in general; and that a few days tour in such countries as Auvergne, Velay, and the Venetian state are worth a seven years apprenticeship at the foot of mount Vesuvius or Ætna; where nothing but a heap of un-instructive ruins, and a sameness of phænomena appear. And since our ideas, concerning volcanic effects, have

(i) HOOKE's Philosophical Discourse on Earthquakes in his posthumous Works. RAY's Physiological Discourse. RASPE Specimen Globi Terraquei.

(k) MORO de Crostacei che su i Monti si trovano.

been almost exclusively drawn from recent volcanos, we cannot much wonder if they yet remain so imperfect.

Having dwelt a little, in the course of this paper, on the physical geography, and particular vulcanic phenomena of Auvergne, Velay, and the Veronese and Vicentine territories; I shall beg leave to add a few observations of the like nature relating to the Euganean hills; more especially as they produce other vulcanic concretions equally curious, and of a very different character from any observed in the provinces before mentioned. The Euganean hills form an irregular group in the plain of Lombardy, about seven miles nearly south by west from Padua, and extend from north to south as far as Este. The most considerable part of them composes an irregular sort of chain, which extends in the above direction; while other parts are severally detached, and form isolated mountains about the skirts of this chain, particularly on the north-east side, towards Abano. The outer skirt of the intire group may measure perhaps from thirty to forty English miles. The external characters of this group exactly correspond with the forms commonly ascribed by naturalists to vulcanic mountains in general; since the points of the chain before mentioned, as well as the isolated members of it, are of various conical, orbicular, and elliptical shapes. As this group, therefore, rests upon a perfect plain, it makes a very singular appearance, and exactly answers to the following lines of Ovid⁽¹⁾, which, I hope, I may therefore be permitted to insert, though in a philosophical paper.

(1) Met. lib. XV.

*Extentam tumefecit humum, ceu spiritus oris
Tendere vesicam solet, aut direpta bicornis
Terga capri; tumor ille loci permanfit, et alti
Collis habet speciem, longoque induruit ævo.*

The vulcanic hills immediately round Isenchaux in Velay affect also the same forms; but as they are mixed with other hills of a different form, and the country about them is broken and irregular, they do not produce so singular an effect as the Euganean hills, which suddenly rise from a perfect level. I am informed, that there is a similar, though smaller group of isolated vulcanic hills in a plain of Dalmatia, near Cossovo; and another group of hills, nearly of the same forms, in the county of Down, in Ireland, and called the Mourn Hills; which, like those near Padua, consist, as I am informed, mostly of granite and *lava*. The Euganean hills have, moreover, a superficial and partial covering of stony and calcareous *strata*, of posterior origin, and that manifest no marks of having suffered by fire. Such *strata* slightly capmount Venda, which is the highest among these hills; though of no very considerable elevation, measuring only about 252 French toises above the Venetian Lagoons, according to abbé Toaldo, professor of astronomy at Padua, who lately, at my request, obligingly took its elevation from the observatory at Padua. From the *lava* and granite mixed together in the Euganean hills, they bear an affinity with those of Auvergne and Velay; but differ from them by the superincumbent unburnt *strata* of Lime-stone. This they call Scaglia, or Scagliola, from its

its being composed of thin slaty *strata*, which are of a yellowish colour, and contain a few vestiges of fossil marine bodies, but no regular bed of them. Sometimes an irregular mass of marble is found among the Scaglia, and near Arqua particularly, of a most beautiful kind, much resembling the noted Florentine figured marble; with this further addition, that, besides the ruins it represents, it is also variegated by frequent dendrites, which, if I mistake not, are very uncommon in the former. Part of the tabernacle of the great altar in the church at Arqua is of this marble, which also takes a most beautiful polish. If Vaucluse, near Avignon in France, is become celebrated from the memory of the plaintive and eloquent PETRARCH, Arqua ought still to be more so; since not only his remains lie there, in a large *sarcophagus*, of red Veronese marble, in the church-yard; but his villa at Arqua is still in being, and preserves some pastoral and historical fresco paintings, of himself and his LAURA, of no inconsiderable merit. His great armed chair, and the skeleton of his favourite cat, are also still in being. This villa was his retreat, during his residence at Padua, where he was a canon of the cathedral. The common *lava* is not so frequent among the Euganean hills as in the provinces of Auvergne and Velay, and seldom forms intire hills, which are mostly of granite, on the surface of which, where there is no lime-stone, the *lava* is partially and superficially scattered, and sometimes mixed even with the mass of granite. I have already observed, that the prismatic group of Monte Rosso is nearly of the same sort of

granite with the hill, and is the only one in those parts; the common vulcanic tracts affording nothing similar. Having dwelt sufficiently on this group, in the beginning of my paper, I shall briefly add a few observations on the physical topography of Monte Rosso itself, with an account of some other of its vulcanic productions, not less curious than the group of columns before described.

Monte Rosso is isolated from the principal chain of the Euganean hills, of an orbicular form, and measures about a mile and a half in circumference at the base. It consists principally of gray granite, which is disposed in blocks, and irregularly perpendicular *strata*. I have already mentioned the quality of this granite, and its resemblance with that of Auvergne and Velay. Towards the surface of Monte Rosso, it appears sometimes rotten, or friable, and porous, as it were, like a motley kind of *lava*, which I have frequently seen. But I was surprised, on examining the granite masses of Monte Rosso, to find in them pieces of common porous brown *lava*, which did not appear to be casually lodged there, and of extraneous origin (like the rounded pebbles in pudding stone, and other aqueous *strata*) but manifestly seemed to form integral parts of the mass itself, and to have concreted with it at the same time. I observed a similar sort of porous *lava*, but of a black colour, in the granite of the castle hill at Moncelese, near Este, at the south east skirt of the Euganean hills; and I doubt not but the same is common to others. This fact, added to many others, which I shall not insist upon at present, seems strongly
to

to confirm an opinion, which I have long entertained of the igneous origin of granites in general; some further proofs of which I shall hereafter consider. A dingy red ochrous earth covers partly the surface of Monte Rosso, from whence probably proceeds the name given to the hill; *rosso*, in Italian, signifying *red*. Much iron sand also abounds here, as it commonly does about other volcanic and granite mountains or tracts in general. Among the figured concretions of Monte Rosso, I observed a small open perpendicular bank, at the east end of the hill, which presented a group of a very peculiar structure. It is formed by an aggregate of angular bodies, laterally ranged together, like balustrine columns, but in a horizontal direction, with their tops in front, and prominent, as they are represented in the figure^(m). These prominencies are of a globose form, and made rough by a number of small crystallizations, of a parallelepiped figure, that are concreted in the mass, which is of a yellowish colour, and rather friable sort of volcanic substance, inasmuch that I could not separate, or isolate the bodies so far as precisely to determine their particular form, though a correspondent continuation of the external angles appears within, and they seem to contract a little, pyramidically, like the isolated body figured⁽ⁿ⁾, and which seems to be somewhat of the same kind, but of a much harder substance. This is also from a part of Monte Rosso near the prismatic columns. Though, as I before said, there are very few of the Euganean hills that intirely

(m) Fig. 2.

(n) Fig. 3.

consist

consist of common basaltine, or other *lava*, like those of Auvergne, Velay, and the Vicentine and Veronese territories; yet some there are, and very curious, which I shall briefly describe. Monte Nuovo, or the New Mountain, about a league to the south of Abano, and near Battaglia, is one of them. Though connected with the principal chain of the Euganean hills, by a depressed neck, or isthmus, yet it contains no granite, or lime-stone, like the rest of that chain, but is formed exclusively of *lava*, of various kinds, and different from any *lava* I observed about these hills. Great part of its surface, especially about the top, is very rough, knotty, and sinuous, and manifestly appears to have concreted from a fusion by fire. The skirts and bottoms of it equally prove the same, consisting mostly of another sort of mixed and congealed *lava*, which the Italians call *lava brecciata*, from its resemblance to the Breccia marbles. It is formed by many broken and irregular fragments, that have been accidentally licked up, as it were, or collected by the *lava*, while melted and running, and concreted with it, without however suffering fusion. Large broken masses of this *lava* are seen about the foot of the hill, very much resembling fragments of ancient Roman buildings ruined; inasmuch, that I mistook for such the first mass I saw, under a part of the hill, called Il Monte della Croce, from the church built upon it. The manner in which the Romans were accustomed to fill up the inner parts of their thick walls, within the facings, exactly resembles this kind of Breccia *lava*; since they used irregular bits

bits of stone, confusedly thrown into, and cemented with a large body of mortar. This kind of *lava* is common enough about Vesuvius, and other recent volcanos; and also occupies large tracts in Upper Auvergne, especially between Murat and Aurillac; where it covers the skirts of the hills, by the side of a valley, for many miles; forming the most grotesque figures imaginable. I have also observed it, in plenty, in the environs of Puy, in Velay. The famous St. Michael's church at Puy is built on the summit of a high, isolated, and almost pointed rock of this *lava*, and makes a very extraordinary appearance. Monte Nuovo seems to have suffered a more recent conflagration than any other of the Euganean hills, as its name rather implies. But though its skirts and surface appear, almost every where, to have suffered a fusion; yet parts of the internal structure of the mountain, manifest, however, the primary horizontal direction and parallelism of the *strata*, as I before remarked of the Veronese volcanic hills. This I particularly observed within the park of Cataio palace, which is situated at the north-east extremity of Monte Nuovo, and has parts of its under apartments cut out of the solid rock of *lava*. Supposing Monte Nuovo isolated from the low narrow isthmus before mentioned, it would measure about six miles in circumference at the base. I shall further observe, that it forms a sort of half moon, on the west side of the plain near Battaglia, and stands in the centre of several hot springs; as those of St. Elena, and San Bartolomeo, to the south and west; those of Abano and Monte Ortone to the north,

north, and many others. The neighbourhood of Monte Nuovo is also rendered interesting to naturalists by its fossil glass, *vitrum obsidianum* PLINII, *pumex vitreus fossilus* LINNÆI, which is found in plenty under the west side of it, in a small valley, called Val San Zibio, near the baths of San Bartolomeo. It exactly answers to the characters given of it by LINNÆUS and others; as may be seen by some specimens of it, which I have sent, and which were broken from a very large mass. It abounds about the volcanos of the Andes particularly; but I found none of it in Auvergne, Velay, or the Veronese or Vicentine volcanic hills. Monte Castello, or the Castle Hill, near Baon, at the south-east skirt of the Euganean hills, and about half a league from Este, affords another volcanic concretion of a very remarkable structure. This hill is mostly formed of huge oval and laminated masses^(a), of various sizes, confusedly concreted together, like a pudding stone, but in a volcanic matrix, consisting of a sort of dark-brown stone, with angular *lapilli* in it of a dingy-whitish colour, and visibly manifesting an affinity with the ordinary granite of the other neighbouring hills; and perfectly similar to the figured masses concreted with it. In other parts, and particularly at Monte Galda, a small isolated elevation in the plain of Padua, between the Euganean and Vicentine hills, I have found these laminated masses of a spherical figure. In a broken cavity of a mixed volcanic and marine hill of Monte Galda, I saw a group of these laminated round balls regularly placed one above the other, and

(a) Fig. 4.

perpen-

Fig. 1

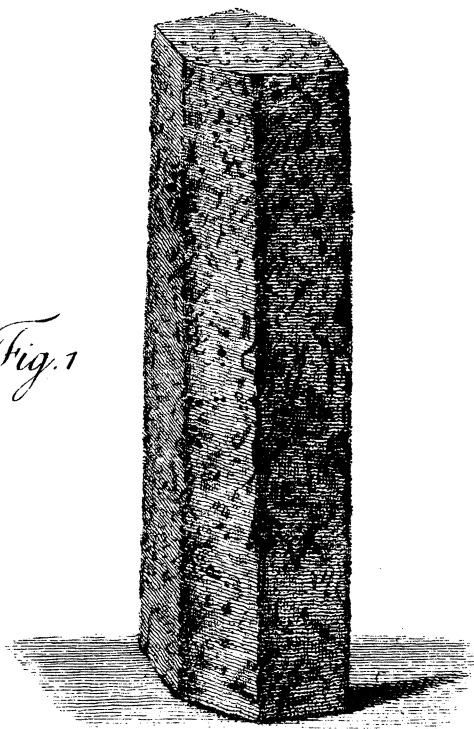


Fig. 3.

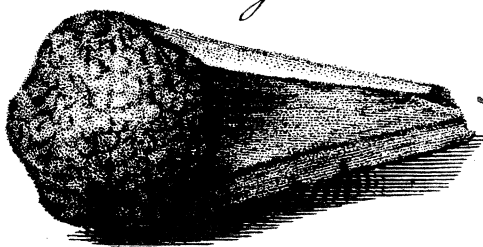


Fig. 2.

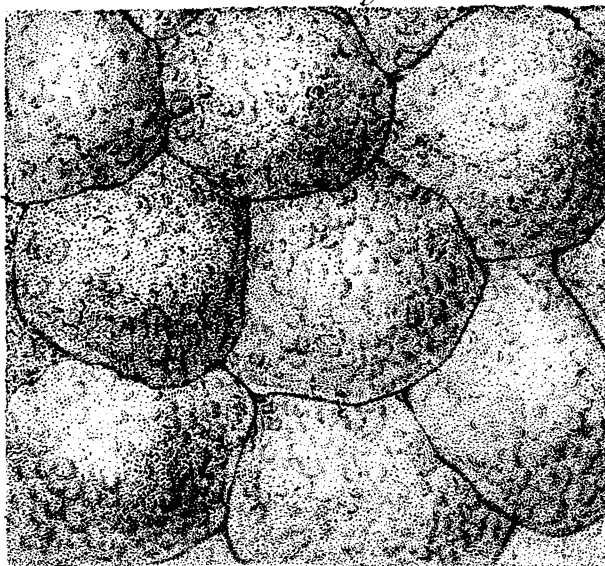
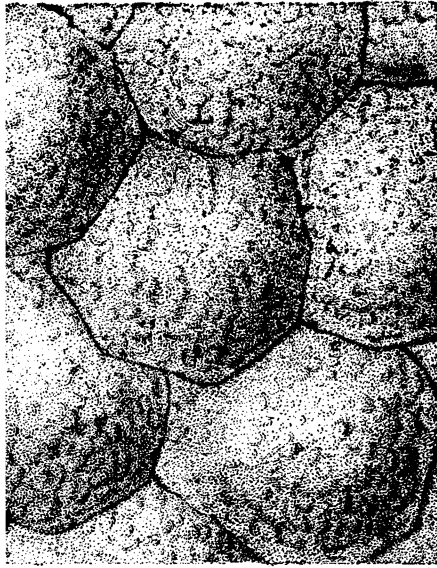


Fig. 4.





J. Basire Sc.

perpendicularly, in columns, as it were. The annexed figure (p), though sketched chiefly from memory, may serve to give some idea of this phænomenon. I have often observed the granite, of the Euganean hills particularly, affecting such orbicular and laminated forms; as may be seen in the figure (q) representing a perpendicular section of a simular bank in these hills. Indeed, from this and other facts, which I have occasionally mentioned in the course of my paper, there seems to be a strong analogy between granites and many particular volcanic concretions. Another of the Euganean hills, called Monte Uliveto, or the Mount of Olive Trees, near Teolo, is chiefly composed of a confused aggregate of smaller globular volcanic balls, which are rather solid than laminated, and of a hard ferruginous substance, of a dark-brown colour, much resembling some common ferruginous *geodes* I have seen. The annexed figure (r) represents a group of them. This may suffice for a specimen of the more curious volcanic productions of the Euganean hills, and united to the observations before made, may perhaps show, how little we are acquainted with the structure and relative phænomena of volcanic bodies in general. I shall not enter into any account of other more common productions of this kind; and shall only mention, that, during my summer's residence at the baths of Abano, I made a collection of the Euganean *lava*, which is now in the public museum at Padua. Since such productions are rather calculated to illustrate the physical topography of the coun-

(p) Fig. 5.

(q) Fig. 6.

(r) Fig. 7.

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ry to which they belong, than to adorn a cabinet, they must be more useful upon the spot, than they possibly can be elsewhere; which consideration will, I hope, serve as my apology for not having transmitted them to the Society with the other specimens. It seems rather extraordinary, that so curious a tract as that of the Euganean hills, which differs from all others in Italy, should have remained so long unknown, especially being in the neighbourhood of frequented baths, and a celebrated university. For though BACCIUS, in his book *De Thermis*, supposes subterraneous fire, to account for the heat of the waters of Abano, and also mentions pumice stones about the baths there; yet he means only the porous and calcareous concretions formed by deposition from those waters; nor does he seem to have been at all acquainted with the indisputable volcanic phænomena, which the adjacent hills in plenty afford. Nor does VANDELLI enter into any observations of this kind, in his more modern and express treatise *De Thermis Patavinis*; if we except the mention of the fossil glass of Val San Zibio, which he seems to have first observed. I therefore hope, that the foregoing observations will be the more acceptable. It appears also from hence, if I mistake not, that the Venetian territory in general abounds full as much with volcanic phænomena, as any other part of Italy. For, besides my observations in the Paduan, Veronese, and Vicentine territories, I have seen *lava*, in the public museum at Padua, from the Brescian hills; and have observed *lava* pebbles in quantity in the beds of the rivers
flowing

flowing from the mountains of Friuli. I therefore doubt not but these provinces also abound with vulcanic phenomena, though I have never had an opportunity to visit them. I mention these circumstances more willingly, since it has been generally imagined, that the northern parts of Italy contained few, if any, such productions. They are, however, not only full as common, but, if I mistake not, more instructive than those of any other province of that country. For, besides the phenomenon of Monte Rosso, on the importance of which I have already insisted, and the other curious vulcanic productions of the Euganean hills, I must observe, that, from the inordinate course of the Appenines in general, the vulcanic hills of that chain afford no observation so interesting to physical geography and the theory of such phenomena, as that before remarked of the correspondent direction and parallelism of the vulcanic and other branches of the Veronese and Vicentine districts. My observations also, on the vulcanic branches of these districts, do not seem to agree with the celebrated Mons. GUETTARD's principle, who supposes⁽¹⁾, that all vulcanic materials observable in calcareous countries are adventitious; the contrary of this being indeed demonstrated by the facts I have advanced. Nor have I entered particularly into an account of my vulcanic tour in the Venetian state, that I might not abuse myself of the sufferance of so respectable a Society by an uninteresting detail of

(1) Memoire sur la Mineralogie d'Italie, in the first volume of his Memoires sur les Sciences et les Arts.

facts, however justifiable I might have been, by the importance of some of them. For another imperfect basaltine columnar group, of which I have also a drawing, exists near Gambellara, in the Veronese territory, a few miles from Montebello; and, according to the informations I have received, they are equally prevalent in the adjacent district of Vicenza. Doctor FESTARI, an ingenious physician of Valdagno, whose curiosity I have fortunately excited in these matters, lately informs me, that he has discovered a similar group of prismatic columns, in the mountains of that neighbourhood; and I had before been apprized of another near Maso, not far from Bassano, by Mr. ARDUINI, a celebrated naturalist of Venice. I have observed fragments of prismatic columns about Maso, but did not see the group. When I was at San Giovanni Illarione, I was also informed, that, at some distance, by the side of the torrent below, another similar group existed. Nor have I the least doubt of the frequency of such phænomena, especially in the Vicentine hills, where volcanic effects are more common even than in the neighbouring territory of Verona. For of all the numerous lines, or branches, of mountains, that diverge from the chain of the Alps, and intersect, nearly in parallel directions, the Vicentine district, there is not one, I believe, but what contains more or less *lava*, and in quantity; whereas many of the said branches, in the Veronese territory, are exclusively marine and calcareous; especially in the immediate neighbourhood of Verona, about the Val Pantena, the Val Policella, and towards the

the Adige; and the Veronese mountains, that mostly abound with *lava*, are those of the east and north-east quarter, about the confines of the Vicentine territory, in the common road from Verona to Vicenza. I first perceived vulcanic effects in the environs of Caldiero, where the hot springs rise. The immediate hills about them, which are isolated in the plain, though of little elevation, are almost exclusively vulcanic; as are likewise the neighbouring points of the Alpine branches before mentioned. None of the writers on the baths of Caldiero take any notice of these facts, though they seem almost inseparable from the consideration of the origin and properties of those waters. The same defect is observable also in the writers on the hot springs near Viterbo, which are in the centre of vulcanic hills, and on the other *Thermæ* near Radicofani, in the confining part of the Tuscan state, where, as I before observed, vulcanic effects also abound. This neglect indeed is but too common to other writers on *Thermæ* and mineral waters in general; physical topography seldom forming a part of their inquiries, however pertinent and even necessary in itself.

Having often had occasion to speak of Abano in the course of this paper, I cannot conclude it without mentioning an extraordinary phænomenon in the animal kingdom, which is observable there. Notwithstanding the heat of those waters, in which FAHRENHEIT's thermometer rises to eighty-eight degrees, a particular species of *buccinum* breeds and lives in them, and is found in great plenty. It is of the fluviatile kind, and seems to be peculiar

cular to these waters, having never seen nor heard of them in any others. They are remarkably small, scarcely exceeding a line or two in length, and are perhaps the smallest univalve or testaceous animal of any such kind hitherto discovered. It is mentioned and figured by VANDELLI in his treatise *De Thermis Patavinis*; but the figures are not good, and much too large; as may be seen by the original specimens herewith sent.

Such are the observations, which I have the honour to present to you, SIR, and to the other learned members of the Royal Society upon the present occasion. I shall think myself very happy if they afford any satisfaction; and more particularly so, should they be found conducive to the advancement of so interesting a province of Science as that of Physical Geography, which being grounded upon facts, that require observation, seems hitherto to have suffered for the want of it. If, contrary to the common opinion, I have insisted on the local origin of most vulcanic tracts, it may further be considered, that this seems full as consistent with the principle of their origin, as it is agreeable to the phænomena themselves. For fire not only penetrates, pervades, destroys, and new modifies the texture of the most solid bodies; but is also often generated in these bodies, without the previous intervention of other fire; which consideration alone might lead us to the opinion I have advanced, were there not such evident proofs in support of it. These will, I hope, receive a stronger confirmation from a more particular account of the vulcanic phænomena of Auvergne and Velay,

Fig. 5.

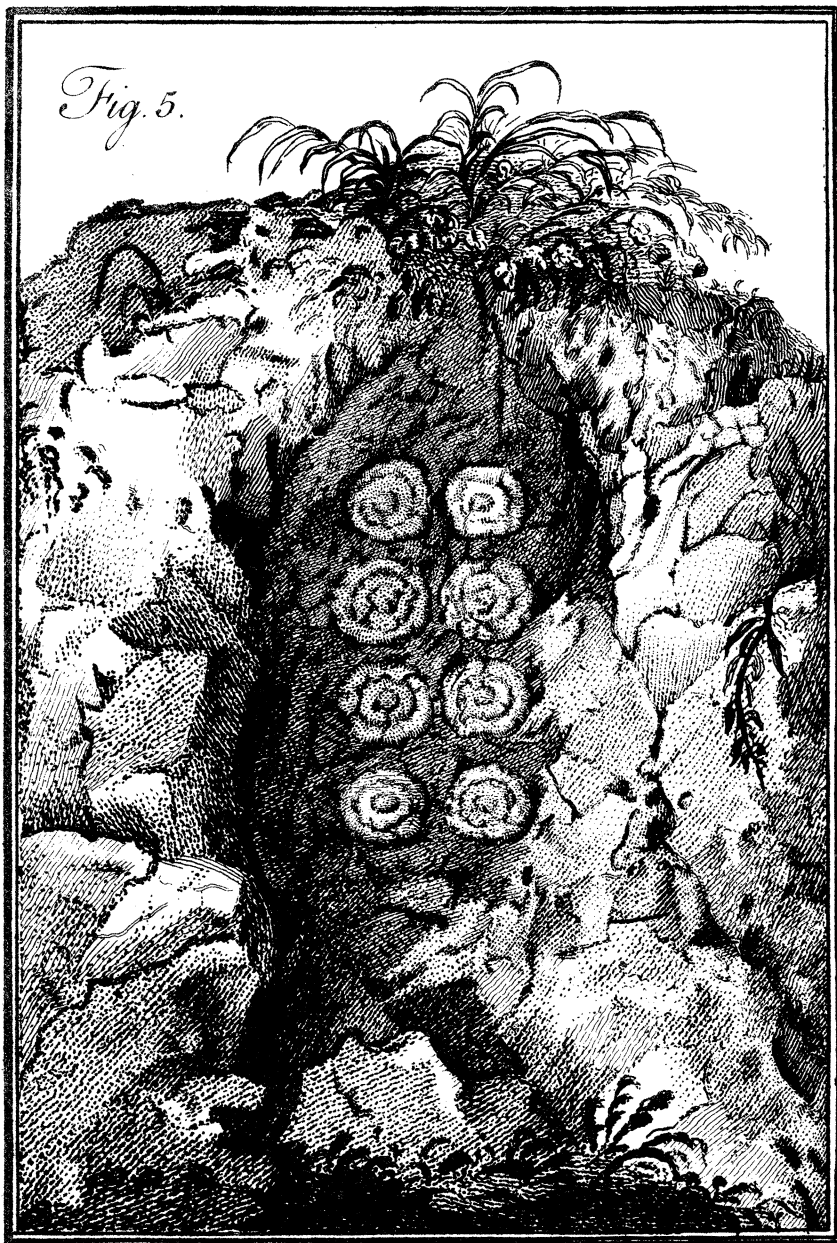


Fig 6



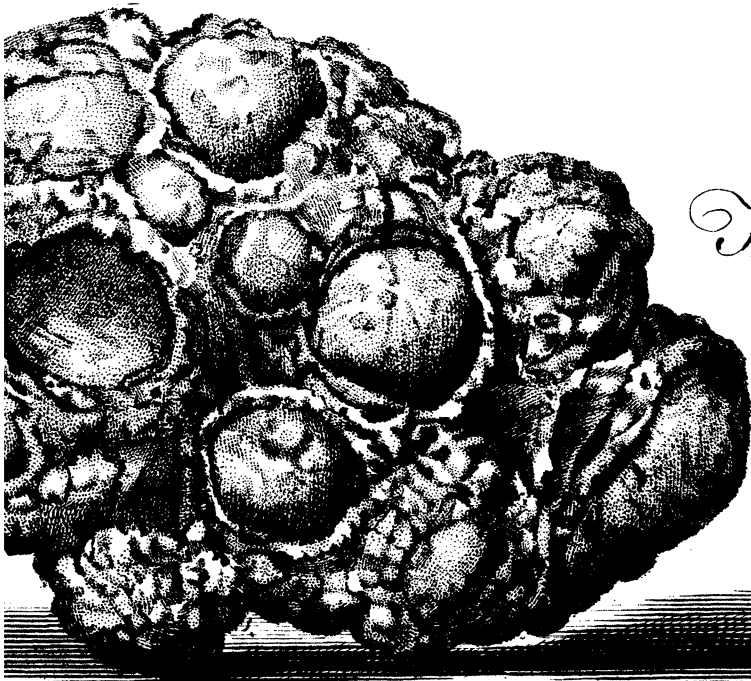
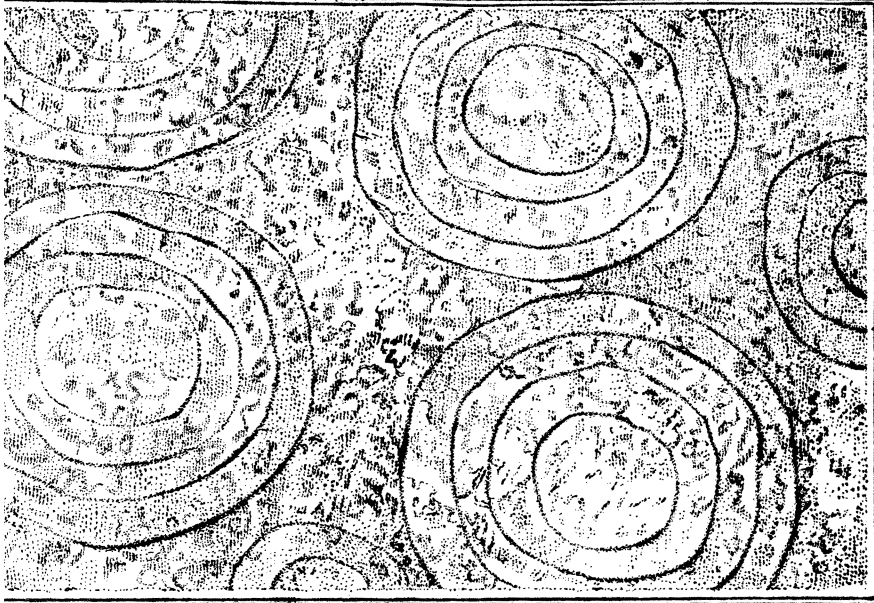


Fig 7

Velay, which I propose myself the honour of presenting to the Society upon a future occasion. In the mean time I am, with great respect and esteem, SIR,

Your most obedient

and very humble servant,

JOHN STRANGE.

P. S. Since the termination of the foregoing paper, I am informed by Mr. CHARLES HAY, of Brecknock, in South Wales, that the prismatic basaltine columns of Tŵen before mentioned were actually brought from Cader Idris, at the top of which mountain there are prodigious quantities of them, which are totally different from the rocks around them. This information Mr. HAY has lately received from a person informed; having obligingly made the inquiry at my request. I may, perhaps, be enabled hereafter, through the same channel, to transmit to the Society a more particular account of the phænomenon; presuming, that, in some part or other of Cader Idris, these columns form a regular group, as they commonly do in other places.





Fig. 1.



Fig. 2.

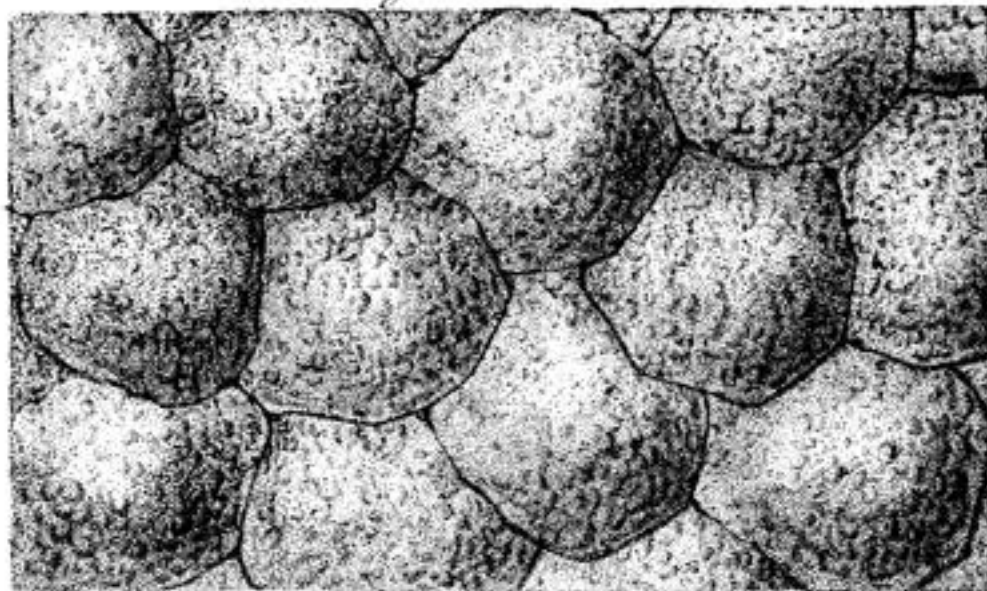


Fig. 3.

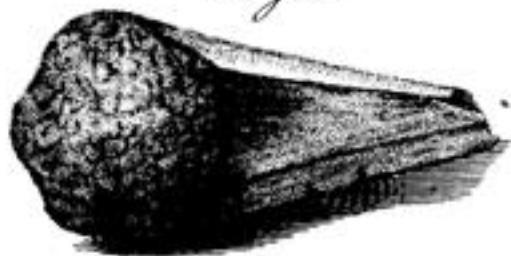


Fig. 4.

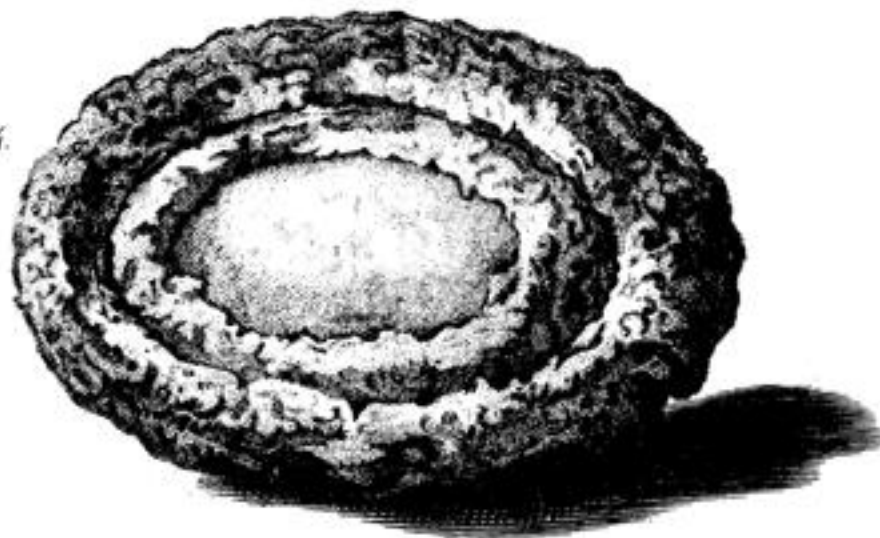


Fig. 5.

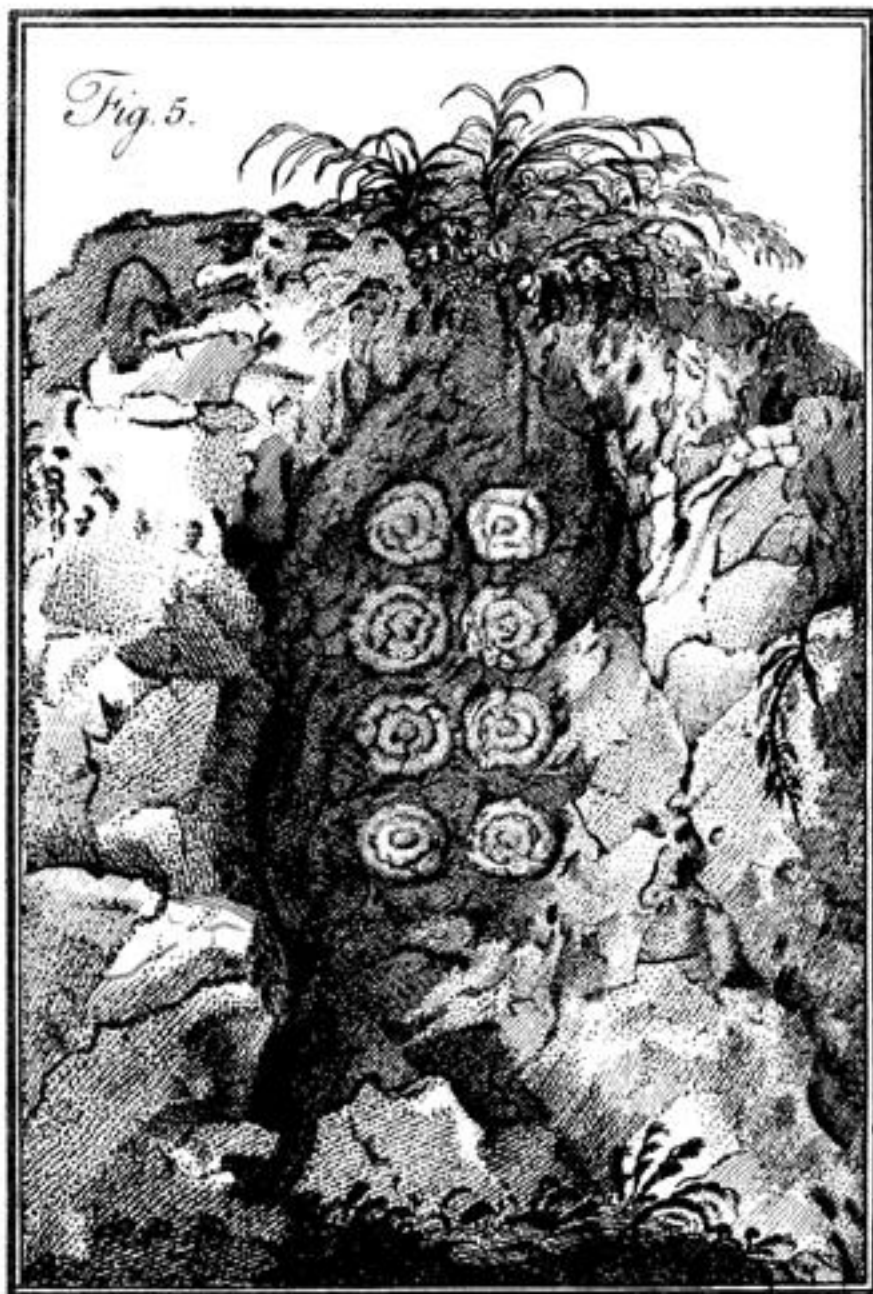


Fig 6

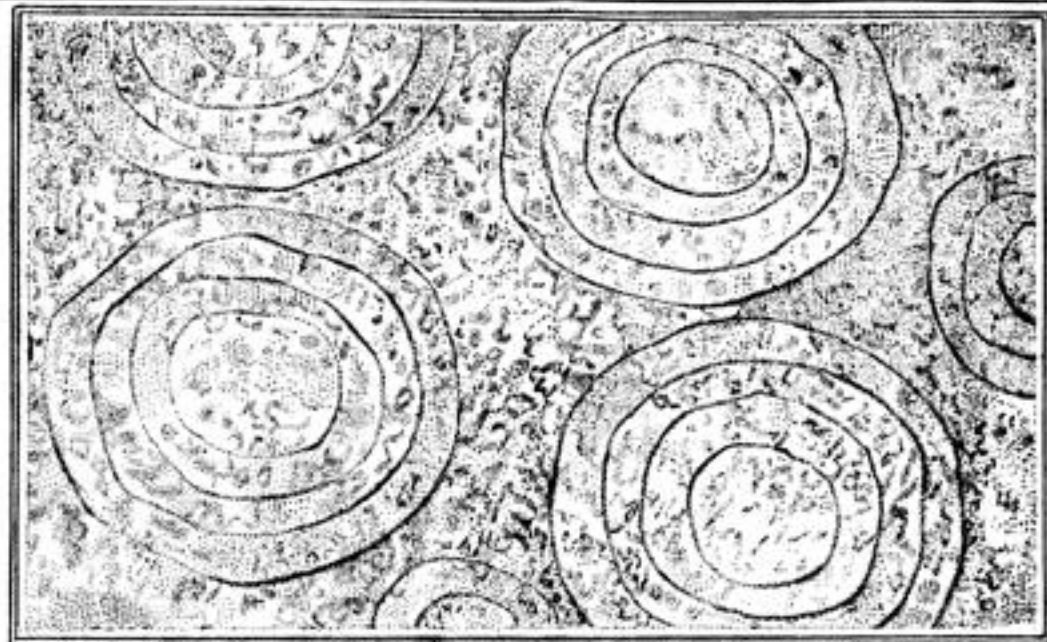


Fig 7

