II. *An Account of Two Giants Cauſeways, or Groups of priſmatic baſaltine Columns, and other curious vulcanic 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.*

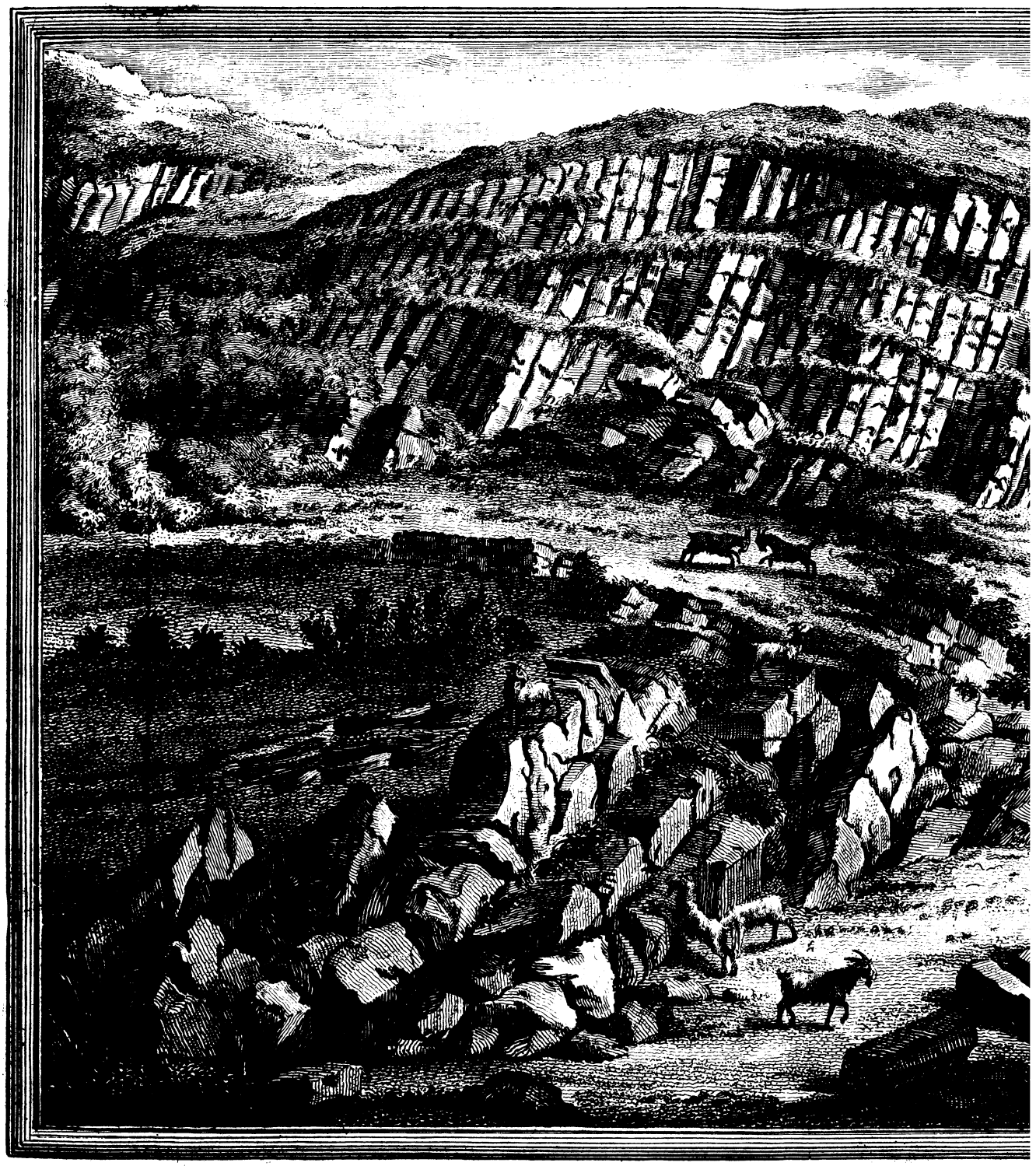
TO SIR JOHN PRINGLE, BART. P. R. S.

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

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. p. 6.

diſtance. Though the columns of both theſe hills are of the ſimple, or unjointed ſpecies, *Corneus cryſtalliſatus 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.

which

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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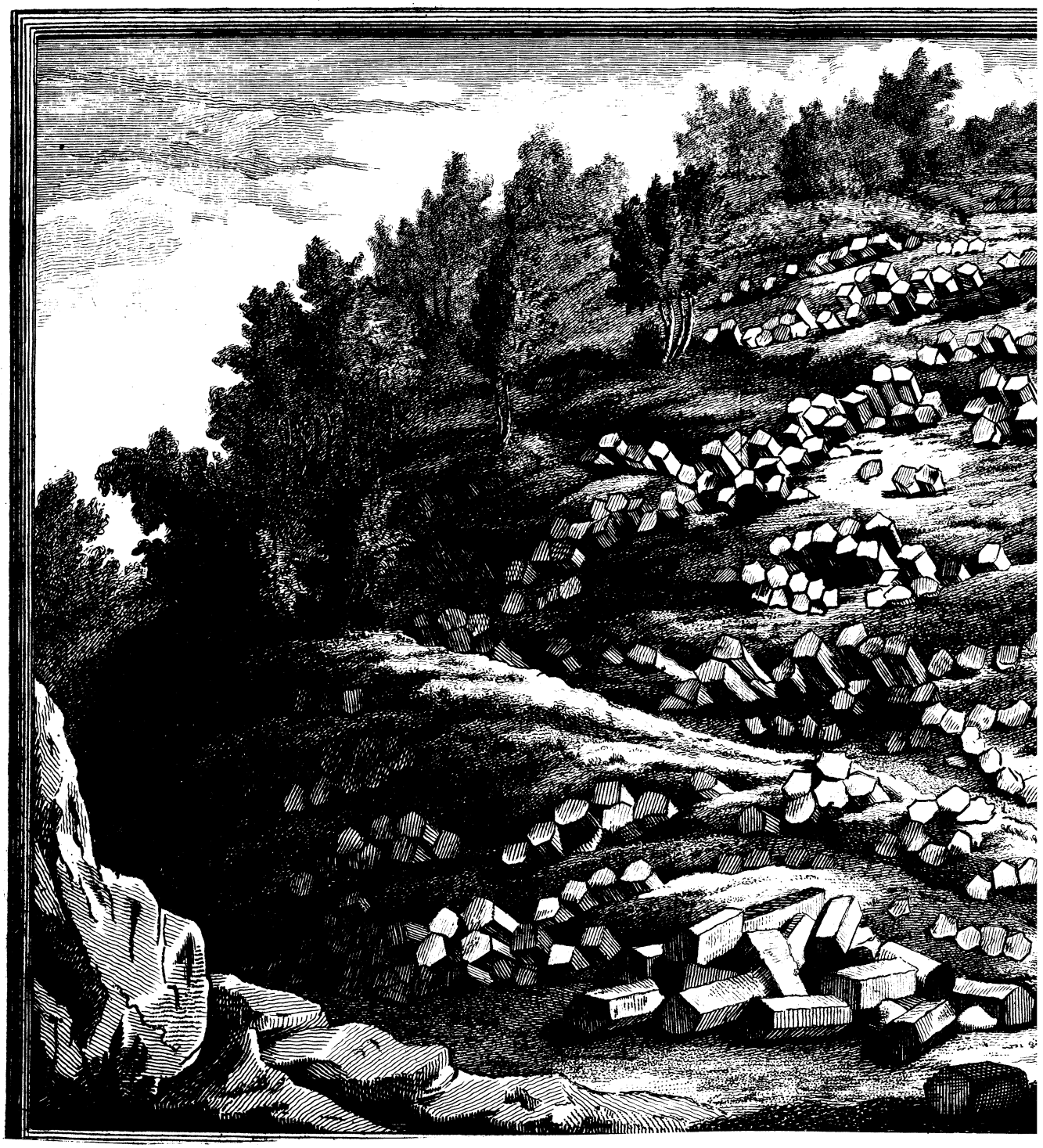

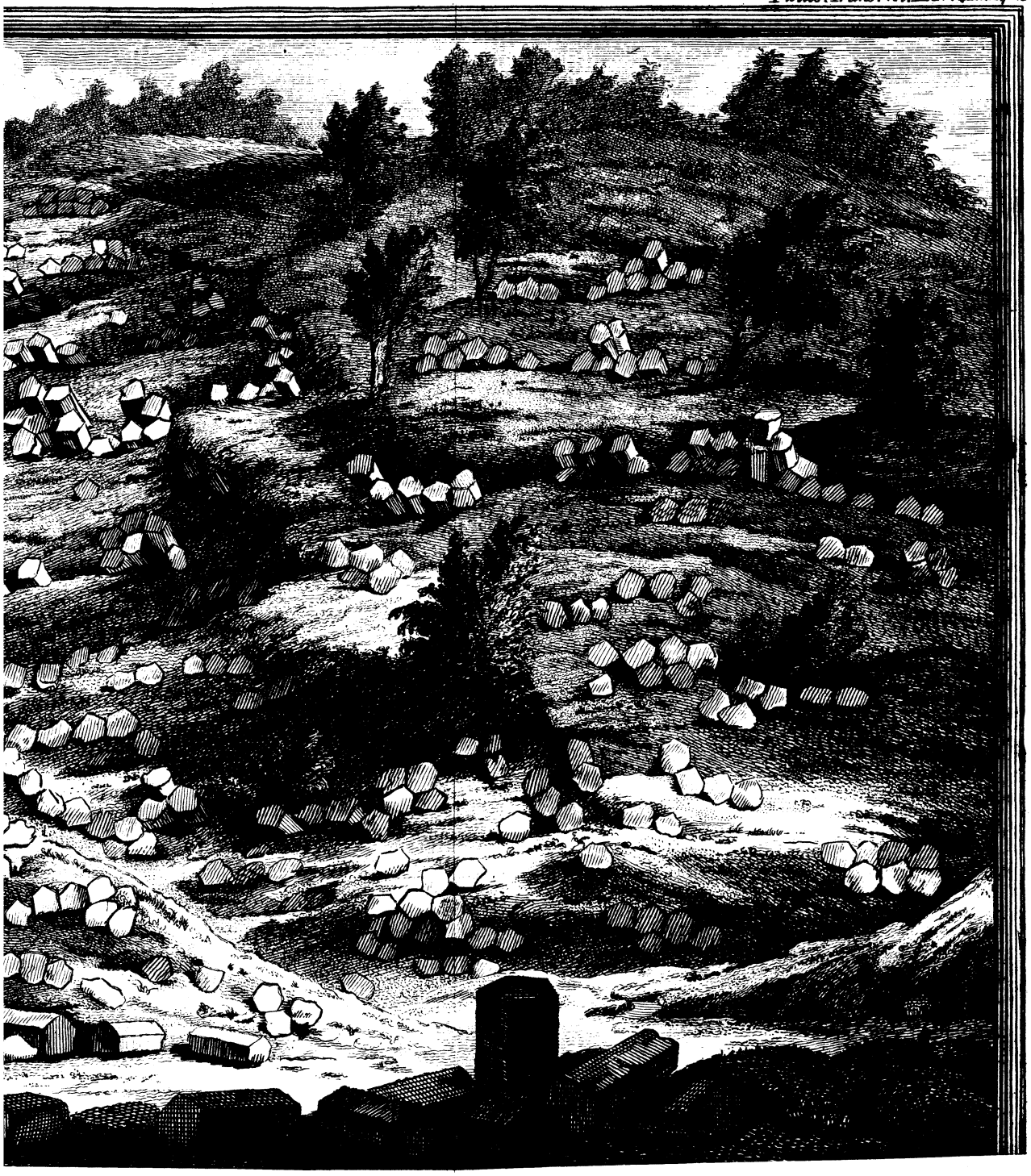

ſo hard as the Alpine and Oriental granites, and is ſometimes even friable, like the *Saxum granites particulis parum adhærentibus.* ANON. Min. 270. n. 1.; or, *Saxum micaceum quartzoſum ſpatoſumque ſubfriabile.* LINN. Syſt. Nat. tom. iii. p. 76. edit. Holmiæ 1768. LINNÆUS juſtly obſerves, that this 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 Sevennes 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 intirely 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; inſomuch, 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*) Memoires 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 phænomenon 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 Elemens de Mineralogie Docimaſtique, Paris, 1772, 8vo.

by

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 phænomena, 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 vulcanic ſand, which, in many parts of the hill, intirely 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,

a granite

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* (e), 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

(e) Lib. viii. ſect. 1. c. 9. &c.

the

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, I obſerved,

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, ſtrait, 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 Towen, on the ſea coaſt of Merionethſhire, not far from Dolgelthy: particularly about Towen 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. Having

Having dwelt a little upon the ſubject of baſaltine organization, I ſhall beg leave to add a few remarks concerning the origin of theſe bodies. The ſyſtematical mineralogiſts, in general, aſſign the ſame common origin to moſt lapideous ſolids, which they ſuppoſe to be generated by depoſition from an aqueous fluid. In whatever manner, therefore, the priſmatic bodies in queſtion are claſſed upon ſuch a principle, no adequate idea can thence be aſcertained concerning their origin, which ſeems manifeſtly different. For ſurely the ſtructure and other phænomena of theſe bodies ſufficiently prove them to be cryſtallizations or concretions of a particular kind, and generated immediately from an igneous fluid: for they are not only peculiar to vulcanic tracts of country; but differ, in every reſpect, from common cryſtals produced from an aqueous fluid. Every one knows, that the latter are formed *ſtratum ſuper ſtratum*, by a ſlow and ſucceſſive depoſition and *juxta*-poſition of parts, as hath been proved ſatisfactorily by CAPPELER, LINNÆUS, and other writers on this ſubject. The ſame mode of generation is more particularly explained by STENO, in his excellent treatiſe *De ſolido intra ſolidum naturaliter contento*. But this mode does not ſeem at all reconcileable with the baſaltine cryſtallizations in queſtion. For however theſe bodies may vary in their texture, none of them, notwithſtanding, afford the leaſt indication of an origin common to other cryſtals; but ſeem rather the effects of ſome intrinſic principle of organization, by which they appear to have been produced ſimul-

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 phænomena 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 phænomena, that priſmatic baſaltine cryſtallizations, and other regularly figured vulcanic 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 moun-

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 Veſuvius 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 Veſuvius, Ætna, the Monte di Cenere, and ſuch like eructed 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 irreconcileable 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 Veſuvius 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, vulcanic 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 païs* (f). They alſo prove the miſtake of ſome naturaliſts, who falſely aſcribing to vulcanic 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 vulcanic 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

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 phænomenon 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 preexiſted, before their alterations by fire, ſince they afford evident proofs, not only of a liquefaction, but of an intire 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 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 vulcanic 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 vulcanic, 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 vulcanic. 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

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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 vulcanic 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 vulcanic 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 vulcanic 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

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 phænomena 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 ſeducive in ſimilar matters, leads us to conclude the ſame of other vulcanic 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 vulcanic mountains of the Veroneſe territory be-

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

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fore deſcribed. It is not therefore likely, that the whole of mount Veſuvius 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 Veſuvius, 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 Chimboroſo, 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 Chimboroſo, 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 phænomena. 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 vulcanic 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,

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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 vulcanic 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 vulcanic mountains appear to have been thrown up, from below the common ſurface of the earth, like the Monte di Cenere, &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 vulcanic 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 uninſtructive ruins, and a ſameneſs of phænomena appear. And ſince our ideas, concerning vulcanic 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

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 phænomena 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[l], which, I hope, I may therefore be permitted to inſert, though in a philoſophical paper.

(*l*) Met. lib. XV.

Extentam tumefecit humum, ceu ſpiritus oris
Tendere veſicam ſolet, aut direpta bicornis
Terga capri; tumor ille loci permanſit, 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 ſlaty and calcareous *ſtrata*, of poſterior origin, and that manifeſt no marks of having ſuffered by fire. Such *ſtrata* ſlightly cap mount Venda, which is the higheſt among theſe hills; though of no very conſiderable elevation, meaſuring only about 252 French toiſes above the Venetian Lagunes, 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 vulcanic 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 balſantine 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 parallelipepid figure, that are concreted in the maſs, which is of a yellowiſh colour, and rather friable ſort of vulcanic ſubſtance, inſomuch 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; inſomuch, 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 vulcanic 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 ſolidus* 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 vulcanic 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 vulcanic concretion of a very remarkable ſtructure. This hill is moſtly formed of huge oval and laminated maſſes (o), of various ſizes, confuſedly concreted together, like a pudding ſtone, but in a vulcanic 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 vulcanic and marine hill of Monte Galda, I ſaw a group of theſe laminated round balls regularly placed one above the other, and

(o) Fig. 4.

perpen-

Fig. 1

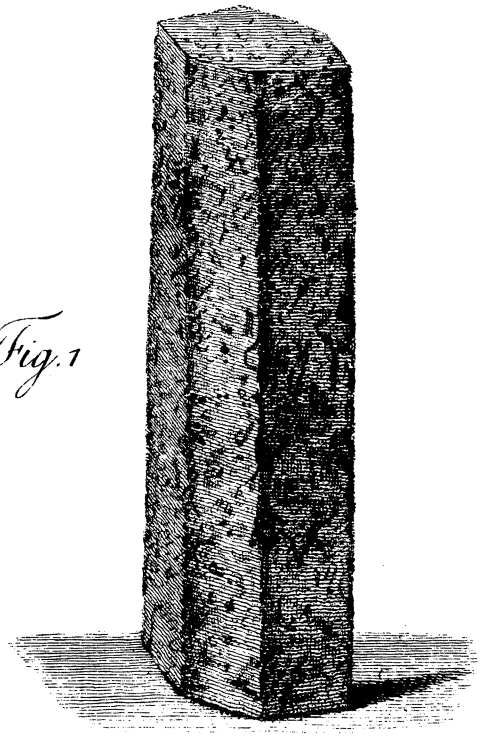


Fig. 2.

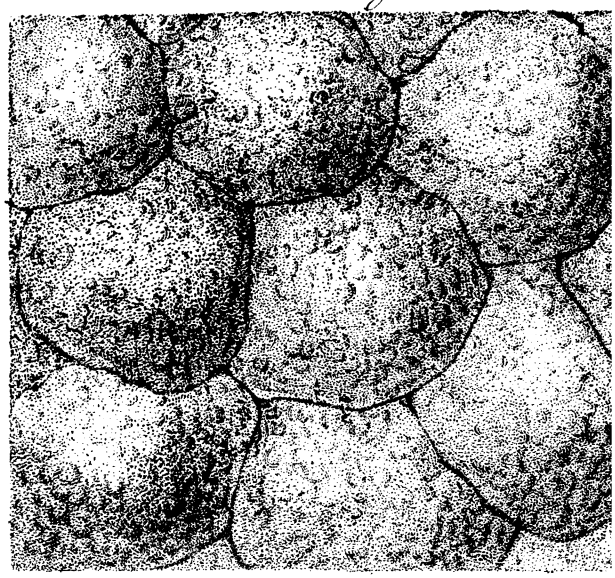


Fig. 3.

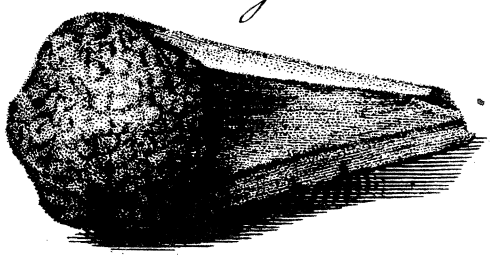
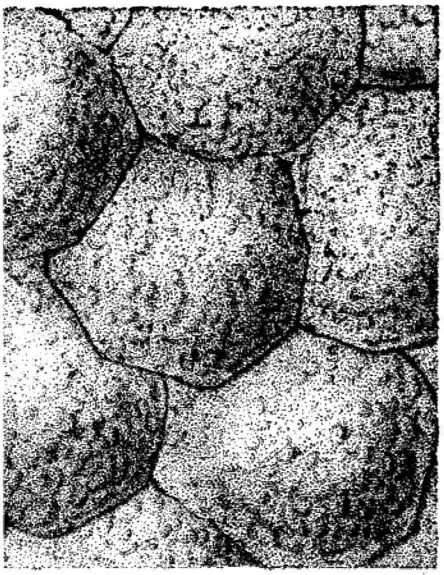


Fig. 4.



J.e 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 ſimilar 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 vulcanic 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 vulcanic 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 vulcanic 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 vulcanic 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.

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 vulcanic 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 Pativinis*; 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 vulcanic 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 phænomena, 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 phænomenon 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 phænomena, 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 (s), 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

(s) 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 Maſon, not far from Baſſano, by Mr. ARDUINI, a celebrated naturaliſt of Venice. I have obſerved fragments of priſmatic columns about Maſon, 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 vulcanic 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

culiar 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,

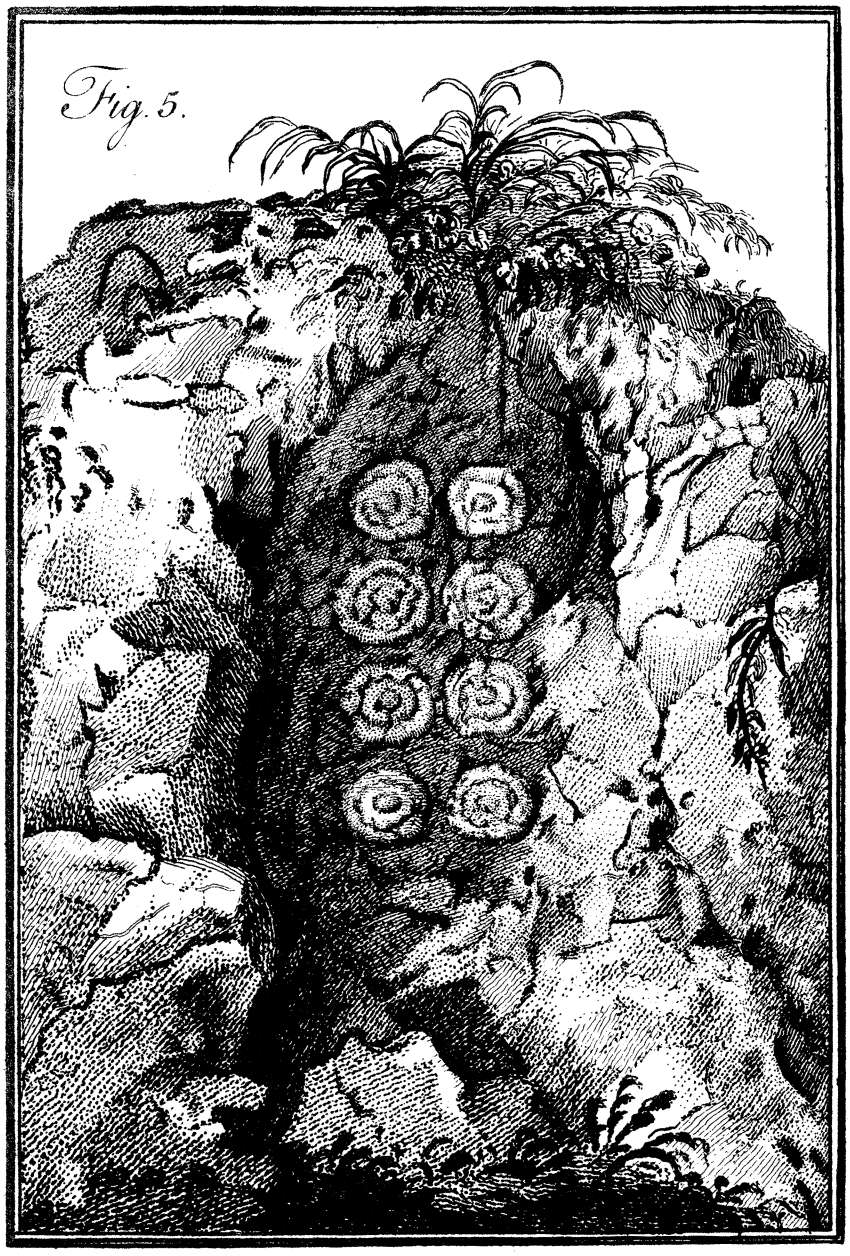


Fig. 5.

Fig 6

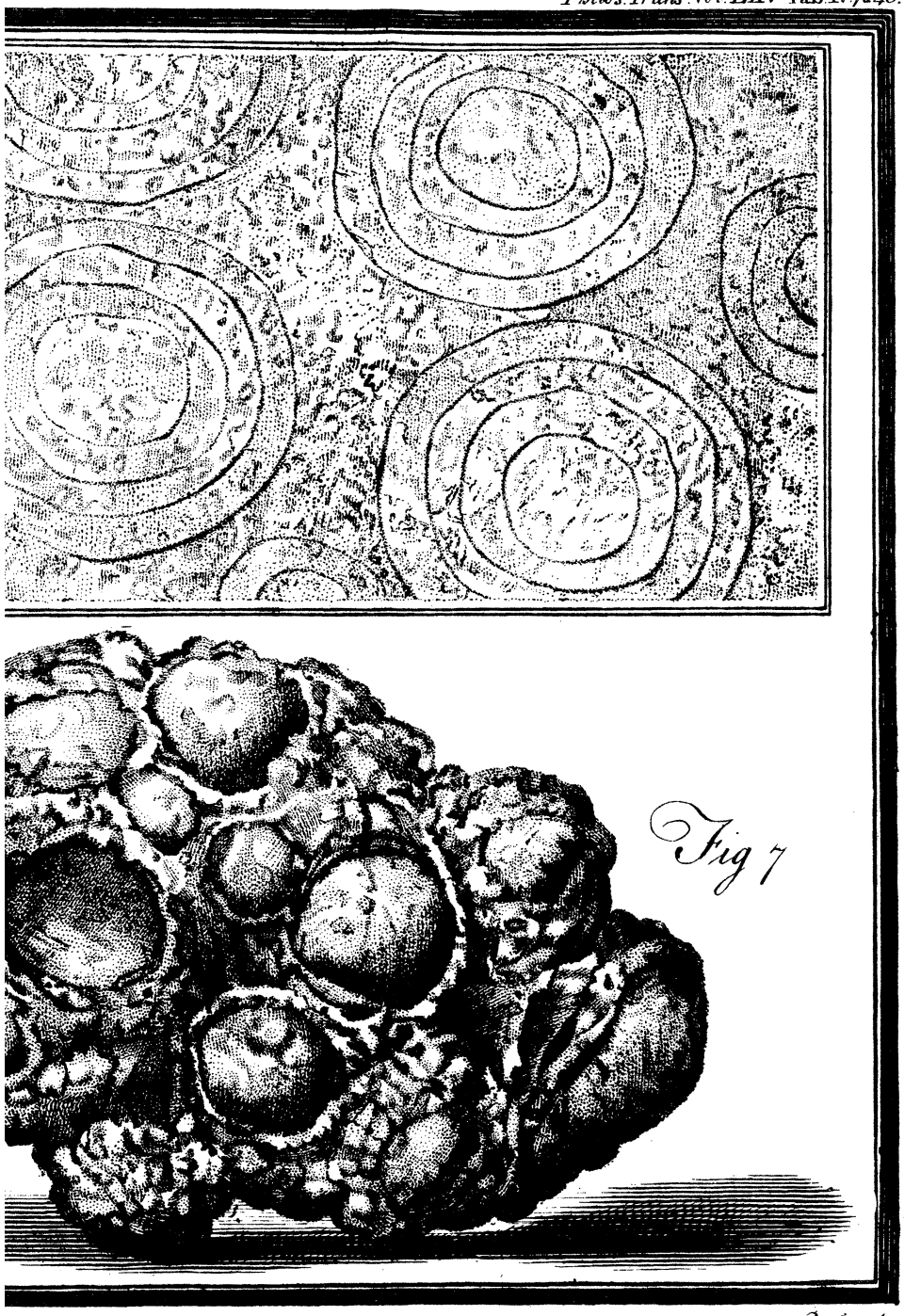


Fig 7

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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 Towen 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.

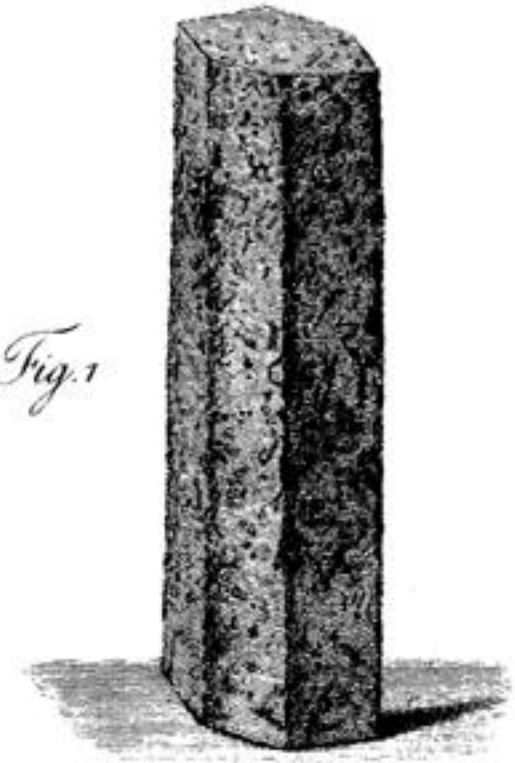

Fig. 2.

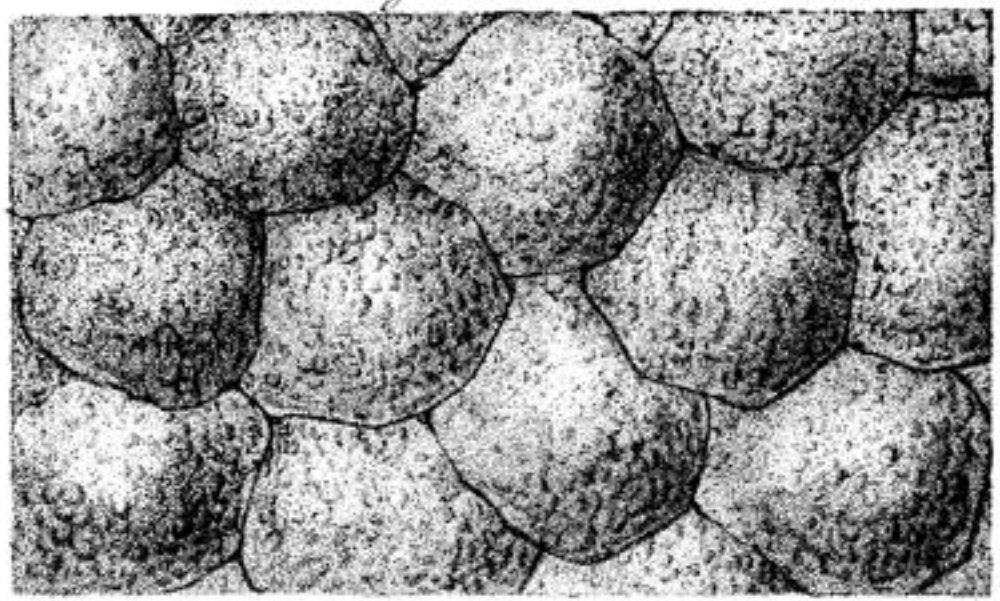

Fig. 3.

Fig. 4.

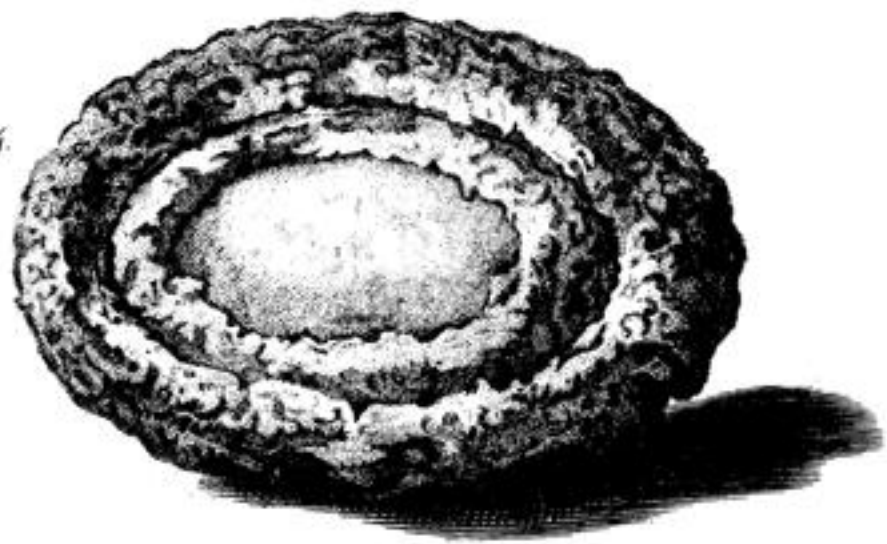

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Fig. 5.

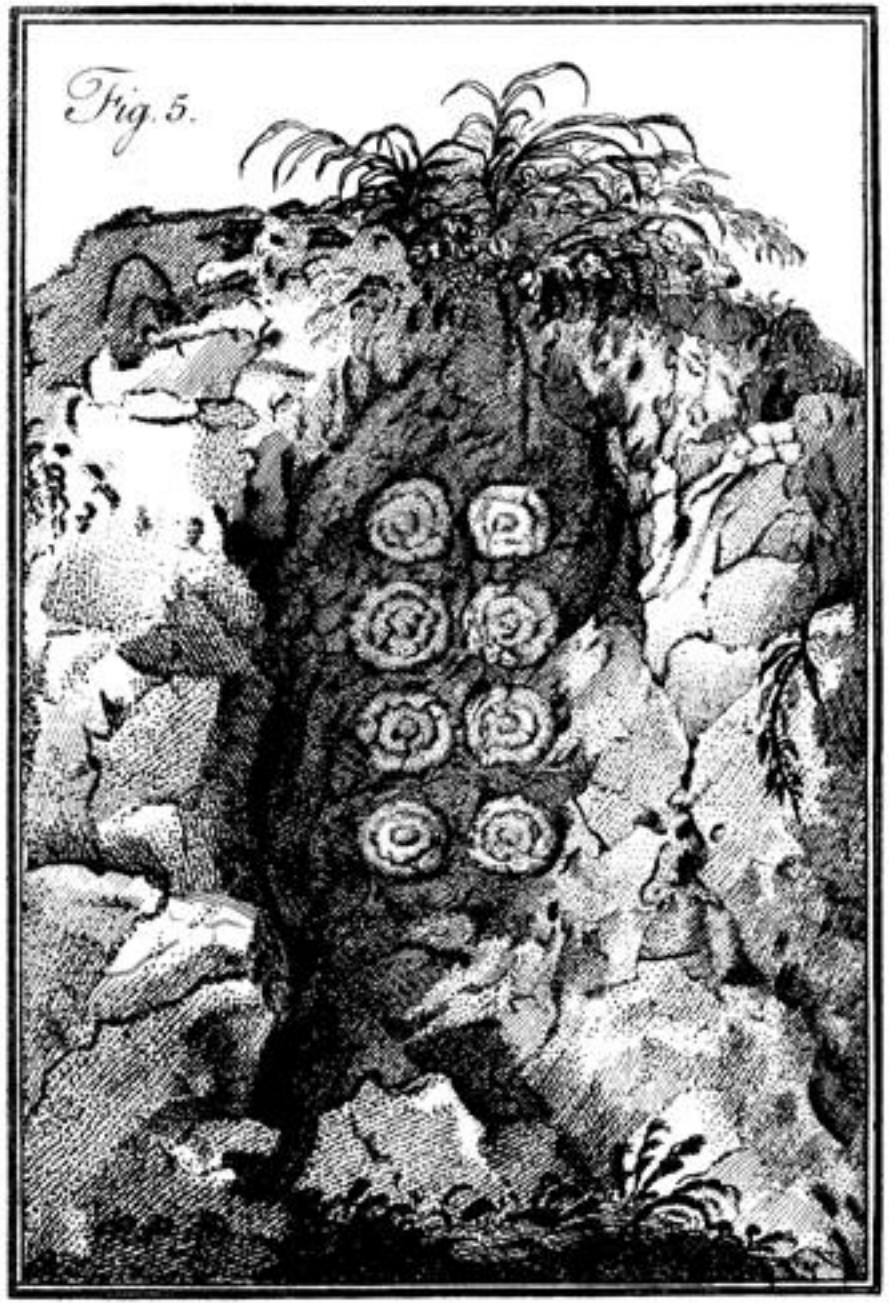
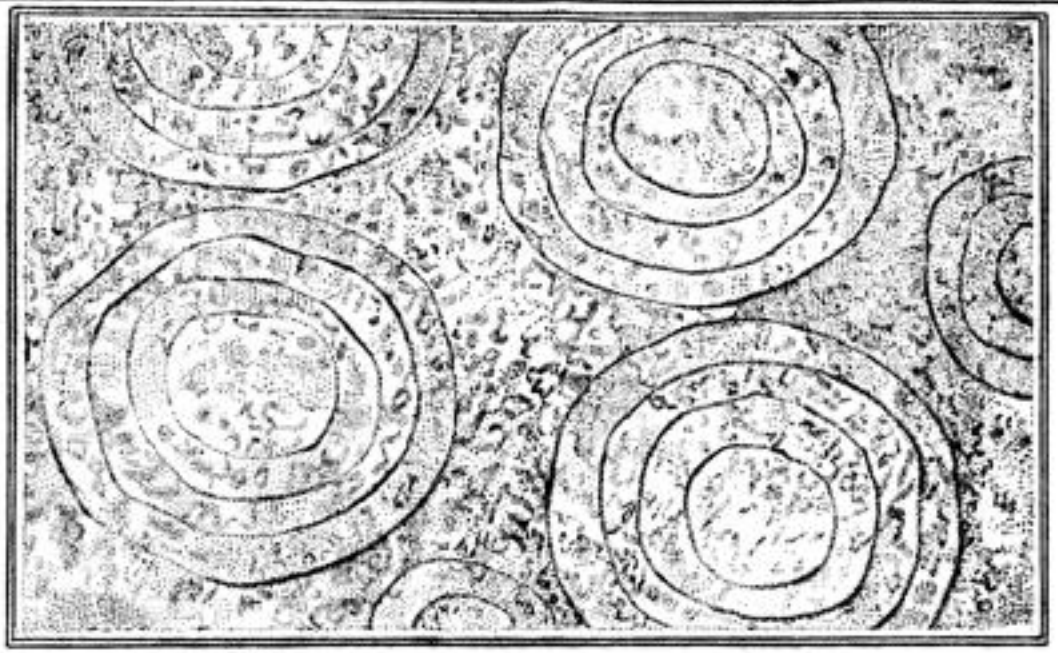


Fig 6



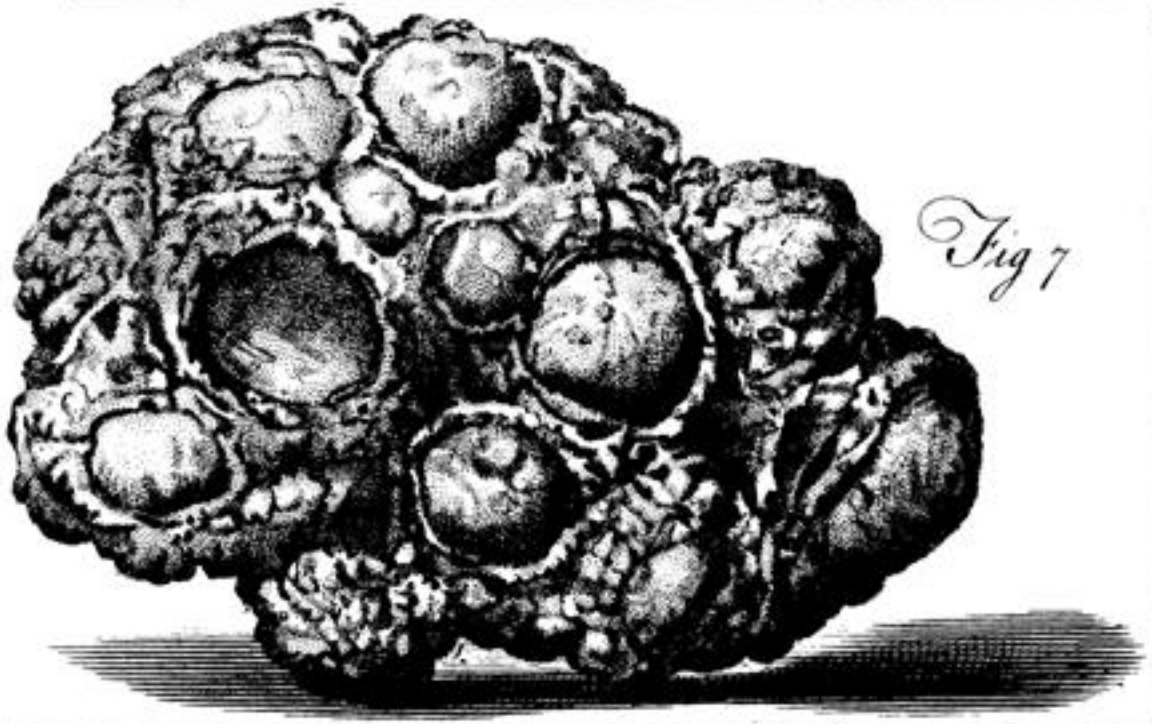


Fig 7