

XIV. *An Enquiry into the original State and Properties of Spar, and Sparry Productions, particularly, the Spars, or Cryftals found in the Cornish Mines, called Cornish Diamonds. In a Letter to Emanuel Mendez da Costa, Esq; F. R. S. from the Rev. Mr. Wm. Borlace.*

S I R,

Read Dec. 14, 1749.
May 3, 1750.

S I N C E among your Searches into Natural History, you think it worth your while to be particularly inquisitive after our crystallized Spars, commonly called *Cornish Diamonds*; I will give you the best Information I can concerning them, assuring myself, that you will make proper Allowances for the want of such Assistances as are not to be had in my present Situation.

I shall consider Spar here as the Genus, at the Head not only of all the Species of common Spar, and In crustations of what Colour soever, but of Cryftals and Gems, which are here understood only as finer and purer Substances of the Spar Kind (1).

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(1) The Properties of Crystal assigned by a late Treatise (*Mr. Hill's Nat. Hist. of Fossils*), such as keeping itself unaffected by Acid Menstrua, remaining unaltered in a moderate Fire, and giving forth Sparks of Fire by Collision (whereby that Author distinguishes it from Spar), are here reckoned, rather to be accidental and casual Differences, owing to a purer stony Juice, less friable and

There are several Sorts of these sparry Productions, which are carefully to be distinguish'd from each other; but they may all be considered, first, with regard to their original State, or what they have been; and, in the next Place, as to what they now are, that is, as to Form, Size, Colour, Hardness, Texture of Parts, and Direction of their Shoots in the Mines or Quarries. These Particulars, separately discussed, may possibly lead us to several probable Conjectures concerning the Original and most distinguishing Properties of these Bodies, such as may afford some Light to this perplexed and intricate Subject.

S E C T. I.

That all Spar has been, at one time or other, in a State of Fluidity, may be maintained, I think, with great Reason, as well as supported by the Authority of some of the most eminent Naturalists (2). In some Spars are found Straws, and other light Bodies; and we may therefore as justly conclude them to have been once fluid, as the Amber that incloses the Bee. In some Stones, whereon were sparry Concretions,

and terrene than that of the common Spar, than to any essential and radical Difference in the Principia of these Bodies. [“ There is in “ all Spar more or less of Crystal.” *Woodward's Nat. Hist. Fossils*, 158.] For many Spars there are, which are opaque, and yet in the same hexagonal Form as Crystals; whence it appears, that Spar and Crystal do not differ in Substance and Nature, but in Transparency, Colour, and different Degrees of Purity. “ Spars much the same with Crystals, says Dr. Plot, *Oxf. p. 98. §. 52.*” And *Boetius* doubts not, but they (*viz.* Spars) are of the same Matter with Gems, *ib. §. 53.*

(2) *Woodward's Catal. of Foss. Vol. 1. p. 151, and 157. No. 78. alibique passim.*

Dr. *Woodward* found Fragments of Shells, and Pellicles of the Ova of Fishes; a certain Evidence, that this sparry Production was not anterior to the Deluge; for the Stone must have coalesced and hardened upon the Shell, before the sparry Concretion could have fixed upon the Surface of the Stone; and as I apprehend, the Learned are now very well satisfy'd, that such extraneous Fossils as are mentioned above, are not the *Lusus Naturæ*; but the Exuviae of Animals brought where we find them by the Waters of the Deluge.—Where-ever any Number of the shotten Spars occur, there may be seen successive Incrustations and Crystals fixing on other Crystals, some Incrustations broken off, and shewing their concave Base, shaped by the Cuspis or Apex of the Diamonds on which they were once fastened; which shews, that there has been a Succession of separate and distinct Indurations. — In several Places we find wavy Processes* formed in thin Plates, on the perpendicular Sides of the Rocks, by the Spars flowing down in the same Manner, as one Wave succeeds another on the Sea-Shore; to which we may add, the frequent Formation of sparry Efflorescencies, Accretions on Walls, and Stalactites hanging down from the Vaults and Caverns of deserted Mines, Evidences sufficient of the modern Date of such Productions. That we may the easier apprehend this Truth of Spars having been once a Fluid (upon which much depends), it may here be observed, that something very like this Process, (I mean Liquors hardening into Stone) is commonly seen in the Effects of petrifying Waters; where as soon as the stony Juice

* See *Tab. V. Fig. 22.*

meets a proper Nidus of Wood, Reed, Grass, or the like, it will forsake its State of Fluidity, and become a solid Stone: Why then should it seem more unaccountable or difficult, to conceive that the same Alteration should happen in the Bowels of the Earth, and in larger Masses of Matter? For as the same Cause will in like and equal Circumstances produce the same Effect, so to produce a greater Effect (*viz.* an Alteration of Form or Motion in a greater Quantity of Materials), there is need only of a proportionably greater Force in the Cause; it being as easy for a powerful Effort to produce a Rock, or a Mountain, as for a smaller Force to congeal a Pebble, or form the smallest Gem. If it were possible, therefore, for us to be as attentive Witnesses of the Changes which happen under the Surface, as we are of those which appear on the Banks of every petrifying Spring, we should discover many new Stones produced every now-and-then, which by their Firmness appear now to have been as old as the World (3). It is indeed a vulgar Mistake to imagine, that Time has added, or shall add, to the Firmness of a Spar; or because it is so hard and compact a Body, that it cannot therefore but be as old as the first Formation of Things; for Spar becomes as hard at the first Time of its consolidating, as it will be ever after, as we find by the exact

(3) Since the Writing of the following Treatise, Mr. Hill (*Nat. Hist. of Fossils*, p. 157.), by a curious chemical Investigation of the lapideous Contents of Water, says, "That Stones and Minerals, formed of Crystal and Spar, need not be supposed all of them as old as the Creation or Deluge; but may be, and unquestionably are, formed to this Day."

Shape, and the smooth Sides which *Cornish Diamonds* make in Incrustations, and all after and secondary Concretions. This sparry Liquor is stiff and sluggish, and apt to harden; but it is a Liquor however, before it becomes a Stone. — Nor is this Opinion singular, but adopted by many of the Moderns as well as Antients. *Pliny* (4), from the Resemblance that Crystals have to Water, carried this Hypothesis much too far, and thought them to be nothing more than Water congealed by excessive Cold; and *Diodorus* esteems them no better than a Concretion of pure Water, assigning however a different Cause, concluding them harden'd by a divine Heat. *Agricola* makes the *Succus lapidescens* the original Matter of which Stones are formed, some by the Heat, others by the Cold (5) they meet with, during the State of Fluidity (6). Mr. *Geoffroy's* Hypothesis supposes Crystal to be formed of thin equable Plates, that Water is the Vehicle of crystalline Parts; and when those Parts meet together in any Quantities, the Water easily evaporating leaves the Crystals to form themselves into hard, pellucid Bodies. Mr. *Boyle's* Opinion was, that these Bodies were originally in a fluid State (7).

(4) *Lib. 37. t. 2.*

(5) “*Utroque enim modo effici potest Lapis.*” *Ag. de Ort. Subt. Lib. 4. Basil. Edit. p. 57.*

(6) *Ib. p. 56.*

(7) See *Boerhaave's Theory of Chemistry, by Shaw, Not. 120.*

SECT. 2.

Whence this Fluidity.

'Tis Water that first occasions, and afterwards maintains, this Fluidity; and the Reason why we find none of this sparry Mass in its fluid State, nor ever see this lapideous Juice, is, because that whilst it remains incorporated with the Water, it is not to be distinguish'd from the Liquor in which it swims; and as soon as ever it is deserted by the Water that circulated it in the Bowels of the Earth, and other necessary Circumstances concur to produce that Change, it becomes Stone: By Water it is that the sparry Atoms are washed forth out of their Repositories (8), collected into a thick, transparent, or opaque Juice (the stony Particles attracting each other as much as the intermediate Water will give leave); and as soon as the redundant Water is drained off, or evaporated, the lapideous Parts (now more at Liberty) accede to a closer Union, and are assisted greatly therein, as well by the condensing Nature of Cold, which compresses the Parts, and forces them nearer one to the other, as by sudden evaporating Heats; and thus the Stone forms itself, so much Water resting in the Pores and Interstices of the Parts (in proportion to the Number and Magnitude of those Pores), as is neces-

(8) *Woodward's Nat. Hist. of the Earth*, 2d Edit. p. 189.

"Water is the only Agent that educes the Matter, of which they (viz. Spar and Crystal) consist, out of the Strata, and compiles and forms it in the perpendicular Fissures." *Woodward's N. Hist. of Foss.* Vol. I. p. 150.

fary to fix it into a Consistency; for, as I apprehend, there is no compound Body, but by means of the Chemist's Fire will yield some Water; but as soon as all the Water is thrown off, the Body loses its Hardness and Continuity, and turns to a Calx and Powder.

Here, Sir, I beg Leave to propose a few Queries to you.

1st Query, Whether Spar is not the universal Gluten of Stones, distinguished from each other by the various Mixtures of earthy, mineral, or metallic Particles, but all united by the sparry Liquor? Of this I should be glad to have your Opinion; for it seems to me, that there is scarce any Sand, Nodule, Stone, or Ore, which either by the naked Eye, or Glasses, may not be discerned to have a certain Portion of Spar, clear, or opaque, in its Composition.

2d Query. Whether it is not reasonable to believe, that Stones in all Ages have been, and are still forming in the Earth, in some such Manner as is here mentioned, whenever the necessary Materials and Cause concur with proper Incidents?

3d Query. Whether this Hypothesis is not better adapted to account for testaceous, and other extraneous Bodies, found inclosed so often in Masses of Stone, than Dr. *Woodward's* Supposition, that all Stones were reduced into a fluid Mass by the Waters of the Deluge; which Waters being those of the Ocean, we cannot allow to have any such dissolving Power

Power inherent in them, and therefore they could produce no such Effect?

4th Query. Whether there are not Quarries of Stone, which when left idle, or unwrought for some Time, yield a fresh Supply of Stone in the Channels and Hollows of the said Quarries, which had been before thoroughly cleared by the Workmen (9); and whether this will not confirm the Supposition, that Stones formed since the Deluge, in Places where Shells, Teeth, and the like Bodies, were deposited by the Waters, inclosed them in their Substance?

You will excuse this Digression.

SECT. 3.

Different Appearances of Spar.

Our *Cornish* Spars are either plain, simple, and unfigured, or figured into various and rectilinear Shapes.

All sparry Liquor is in itself stiff and sluggish, and covets no Shape; but, being intimately mixed with Water, which is the restless Agent, to disperse, collect, and renew all subterraneous Nature, it moves as a Fluid by the Rules of Gravitation, that is, from an higher to a lower Position, till meeting with a retentive Bed, the Water no sooner retires, and leaves it exposed to a drier or colder Air, than it dries, and hardens into Stone, in Shape and Size, as the Attraction and Quantity of its own Parts determine, or

(9) See *Addison's Travels into Italy*, and *Bp. Burnet*.

the circumambient Bodies will give it Leave to fix and extend itself.

Plain Spars.

Sometimes we find the sparry Liquor spread into thin Plates on the horizontal or oblique Planes of Rocks; sometimes we trace it in Sheets down the Sides of Fissures; and where it meets with Impediments of Gravel, or Stone, it will resemble branched Limbs, Clay, Boughs, and Stumps of Shrubs; sometimes it drops from Vaults, and Roofs of Caves, whence it has the Name of *Stalactites* (10). In all these Cases it is plain, that the Juice had no other Motion, whilst a Juice, nor appears in any other Shape now a Stone, than what its own Weight or Gravitation, during its State of Fluidity, inclin'd it to. In these uninform'd rude Productions, it is very plain, I think, that the Juice wanted those active Principles (whatever they be), which enable it at other Times to shoot into regular Forms.

Fig. 1. TAB. IV. (11). is a Spar Pebble, its Surface about the Roughness of the Peach-skin, inclosed in Part of its Socket, which is also of Spar, angular, and puculated (which latter Property is rarely met with): The Coat or Socket is mixed with solid white Mundic, and Cockle; which last (or the same Principle, which throws Cockle (12) into this oval Figure) seems to have determin'd this Spar to its singular, *viz.* orbicular Shape; for it is observed,
that

(10) It also veins or granulates, or both, every Kind of Stone; and is oftentimes found to compose whole Loads or Veins, without any metallic or mineral Mixture, or any particular Shape, more than the Fissure in which it rested compressed it into.

(11) *N. B.* The following Figures, referred to, are intermixed in *TABB. IV. and V.*

that where Cockle is plenty, Spar-Nodules round as Musket Balls, and black, in Sockets of the same Colour and Substance, are frequently found.—But as this Pebble was not black, as Cockle always is; it may therefore be questioned, whether the Shape of it may not be owing to some metallic (*viz.* Iron or Copper) Principle, rather than to Cockle, and whether Cockle itself be not more probably indebted to other Powers for its orbicular Nodules, in such Sheaths, than derive them from any inherent Activity of its own.—The Exterior of the Shell or Socket has a thin Incrustation of gritty cinerous Mundic.--- It came out of *Wheal Royal Mine*, in the Parish of *Cambron, Cornwall*.

Of Incrustations.

The next Appearance of Spar Bodies, which I shall here take Notice of, is that of Incrustations; these sometimes make one continued Sheath, Lump, or Mass, and inclosed in them we find *Cornish Diamonds*, Grains of Tin, and other adventitious Bodies, plainly of a different Texture and Colour from the Crufts which surround them; so that Incrustations must be cautiously distinguished from the entire Sheaths, or Laminæ, which compose the Column of hexagonal Crystals, and which are really form'd at the same time with that Column (13); whereas Incrustations are additional, and after Concretions made on the before settled original Grains and Columns, (14) sometimes these Incrustations, are but Sprink-

(12) Cockle is a black, shining, light Stone, free of all Metal, different from Mock-Lead, common in the Tin Mines of *Cornwall*.

(13) See p. 274. Note 26.

ings of the crystal Drops, without any Continuity, or mutual Contact; and in this Case, when the pearly Drops are themselves bright and transparent, and the Stone they fix on, of an Agate Colour, or any lively Opposition, the Incrustation is exceedingly beautiful. On one shotten blister'd Spar, I find the Incrustation white, not pellucid, flowing in parallel Threads by each other (*Fig. 2. TAB. V.*), in several Places passing from one Tubercle to another, without touching the interspers'd Hollows; by which I conclude, that this Spar was fixed on the perpendicular Side of a Fissure; that the Juice of this Incrustation was of the *Stalactites* Kind, and, proceeding from the same Cause, descended in a similar Direction.

Fig. 3. TAB. V. Is a Bunch of semi-pellucid Spar, shot into reclined Cones, making an Angle of 30 Degrees, with the Surface of the Stone; the Sides of these Cones are a very curious Fretwork of little Spires or Bristles, many of them sharp as the smallest Needle, and pointing nearly in the same Direction, as the Cone on which they rise. The Surface of these Shoots is of a ferrugineous Tint, but their inner Substance pellucid, very little short of that Spar, which for its Clearness is called Crystal, and

(14) Incrustations are so many evident Proofs of Stones not being formed all at the same Time; for many *Cornish Diamonds*, and columnar Shoots of Tin, Cubes of Mundic, and Grains of Lead are often broke off from these their Inclosures; but the angular Cavities, with their strait Edges and smooth Sides, still appear in the Incrustation; which plainly shews, that the Diamonds and Tin Shoots, &c. were first form'd and harden'd, and then furrounded and united into one Lump, by a successive Induration of these Crystal or Spar Crusts.

and more transparent than many hexagonal Shoots ; 'tis the only one I have seen of its Kind.

Fig. 4. TAB. V. Is an Asterisk of the clearest Spar; its Shoots or Rays are hexagonal, swelling, or gibbous, in the Middle; their Sides not plain, or of one level Surface, as our *Cornish Diamonds* generally are, but ridg'd near the Edges, and somewhat hollow, but not uniformly, in the Middle; the Points or Terminations were entire and sharp, but not to that Degree aculeated as the former conic Spar; but it is very plain, that these Spires never had any hexagonal Apices: The undermost Shoots spread horizontally; but the other rise gradually, making a greater Angle, till the middle ones make nearly a right Angle with the Base, which has a ferruginous circular Spot in the Middle, from whence the Rays regularly proceed on every Side. *Fig. 5.* TAB. V.

These are some of the most singular Spars which have reach'd my Observation; but the general Shape of our figur'd Spars is hexagonal; and these Hexagons either consist of a Shaft or Column, and a Point with the same Number of Sides correspondent to the Column (*Fig. 6.* TAB. IV.) or are only Points, that is, pyramidal Hexagons stuck on at their Base, upon the Surface of their stony Beds. *Fig. 7.* TAB. IV.

In a thin Cake or Lump in my Possession, one Half of the Spar shoots from one Side, the other Half from the other; and so incrusts the Planes of both Sides with hexagonal *Apices*. *Fig. 8.* TAB. IV.

Here the Spar (as appears by the Tendency of its Fibres, when the interior Texture is examin'd) struggled to form Stems or Stalks to these *Cuspides*; but either the Effort was not vigorous enough, or, through the Impurities of the Juice, the sparry or crystalline

crystalline Principles had no room to extend or protrude themselves into the Shape they seem inclinable unto; so they lie blended, and their Lincaments scarcely to be distinguish'd from the general Mass.

Some Spars rise out of the general Surface, into large orbicular Blisters, thick set with hexagonal Points diverging, as Rays from a Center. *Fig. 9.* TAB. IV.

These Blisters or Protuberances are in other Spars subdivided into Numbers of other small, orbicular Excrescencies, and the *Cuspides* very small, but, like the pointed Shoots of most *Cornish* Spars, hexagonal. *Fig. 10.* TAB. IV.

At the Root, or where they join to the Rock, these globular Masses shew in what Direction the Juice exerted itself, springing commonly, as from one general Center, and extending itself equably on every Side. When the Juice is simple, and of one Sort only, the Rays are continued from the Center to the Extremities; as *Fig. 11.* TAB. IV. But when the Juice is of two or more different Mixtures and Impregnations (which will generally appear from the different Colours and Degrees of Transparency), then the Effort is various and successive, protruding the Juice according, and in proportion to the different Activity of the *Stamina*, of which it consists; and in both these Cases I find the coarsest and most terrene Part of the sparry Lump next the Center, and the most transparent and purest shot forth, to form the pyramidal *Cuspides* of the Circumference. Though the Effort is various and multiple, the several Juices preserve a Parallelism to each other, and to the Ex-

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own Impregnation would carry it; and therefore settling in parallel Lifts or Lines behind each other, and their Angles less and less perfect, that is, becoming more obtuse, till you come to the Rock, or lifeless Lump of Spar, which the Effort had no Power to move, and thro' which the impregnated and purer Juices escaped, according to their Degree of Mobility: The Base of one of these orbicular Lumps, which has seven distinct Lifts or Fillets one within the other, besides lesser Lifts, mark'd (*b*), will explain what is here suggested. *Fig. 12. TAB. IV. ‡*

These hexagonal Points do not always sit close to the Body of the Rock, but are as often found mounted upon columnar Shoots of the same Number of Sides; and these are what are commonly called *Cornish Diamonds*: They are generally found larger somewhat at the Base, where they fasten on the Rock, than at the Top, where they support the *Cuspis*. *Fig. 13. TAB. IV.*

Some of these Shoots have also hexagonal Points at each End, as *Fig. 14. TAB. IV.* and are sometimes found single, that is, detach'd, and without a Root, as the Naturalists say; but I have them also in Lumps fixed Side by Side, but in no parallel Direction. *Fig. 15. TAB. IV. (15).*

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| ‡ <i>a.</i> The clearest Crystal. | <i>f.</i> Small Fillet of purpled Spar. |
| <i>b.</i> Sup-pellucid, inclining to purple. | <i>g.</i> Flock-white. |
| <i>c.</i> Flock-white, not pellucid. | <i>h.</i> Lifts of Spar less distinct. |
| <i>d.</i> Large Fillet of purpled Spar. | <i>i.</i> That Side on which the Effort was faint, and the Shoots scarce perceivable. |
| <i>e.</i> Flock-white. | |

(15) These Shoots are not always straight, but are found sometimes bent or crooked; but as this Deformity is owing to some accidental inter-

This is the general and most common Appearance of our *Cornish* figur'd Spars and Crystals, *viz.* either hexagonal Points on the Rock, or common Spar, or fixed on Shoots or Columns of the same Figure; but we must not imagine, that Spar assumes no other Shape, but what has been here mentioned. There are also trigonal and cubical Spars; but of these Sorts I have not yet seen any in *Cornwall*; however, as our Observations in this inquisitive Age are daily growing more extensive, it is very probable, that new and undescribed Shapes of Spars may often fall under our Notice: What I have here mentioned seem most worth notice; but to pretend to number them all, would be very extravagant; for they are varying every Day upon our Hands, and new Mines throw forth new Forms, according to the different Combinations of their Solids, and the Impregnation of their Waters.

SECT. 4.

Whence the hexagonal Shape of Spars.

It has been observed before, (*p.* 257.) that Water and the sparry Juice, considered simply, without any other Aid, will produce only the irregular, shapeless Masses of Spar, incapable of any Activity, or Struggle towards Shape and Figure, and determined only by the common Principle of Gravitation, to that Position in which we find it: We must call

interposing Force or Obstruction, during the Time of forcing, it will not, I apprehend, make the Body of a different Species, as long as all the other common Properties are continued.

call in therefore the Assistance of some other Principle, to account for the rectilineal regular Phænomena of these sparry Productions.

As the general Appearance of our *Cornish* Spars is hexagonal and uniform, there must be some one general Principle to which this great Uniformity is to be referred. If these Spars owed their Form to any metallic Principle, that Metal would be found, when the Fluor was thrown off by Fire: But the contrary is apparent, the clearest Spars yielding no Metal. And, indeed, it may here be observed, that when the stony Juice meets and coalesces with any metallic Particles, that Juice shoots not into its natural Form, but by Tin is forced into Prisms, and various *Speculums*; by Lead, into Cubes; and by other Metals into other Forms: So that it never retains its hexagonal Shape, but when free of Metals. As therefore there is no Metal in our regularly-figur'd Spars, we must have recourse to another Origination; and Salt, as I take it, is most likely to be that active Principle, by whose Force the Fluid in which it is mix'd, be it pure Water, or lapideous Juice, is made to shoot forth into regular rectilineal Masses, agreeable to the original Shape and Figuration in which these Salts were first created. 'Tis by the Force of Salts that liquid Bodies are thrown into all the geometrical Planes, Angles, and more compounded Shapes, the Variety of which is no less surprizing, than the Constancy and Uniformity of each particular Species; the same Salt shooting still into the same Figure (as is plain from all artificial Crystallizations), when not streightened in Room, or otherwise determined by heterogeneous Mixtures. To produce Salt

from any liquid Body, two things are requisite: First, that the redundant Liquor, in which the saline Particles are kept too dispersed and remote to attract each other, be discharged (which is usually performed by Evaporation), and that the Remainder be exposed to a colder Air. This simple plain Process will produce all the Varieties of Crystallization; the Salts contained will shoot into their peculiar Forms, pointing forth their Darts, regular Planes, or Spires, into such Figures as are proper either to their native or compounded Salts. From this easy and incontestable Procedure of Liquids into figur'd and solid Bodies (to which nothing more is required than Heat and Cold), may it not appear probable, that something like this has happened, and does still happen, among our Spar-Loads in the Mine? For Instance: When the Juice of Spar, impregnated strongly with Salts, which have been from time to time imbibed, is sufficiently drained from the Water (which not only collected the sparry Mass, but kept it in a fluid State), either by natural Heat, so common in Mines, or by the Water's running off into Crevices, where the stiffer Stone-juice cannot follow it; in other Words, when the Water deserts the Spar; the Spar, as soon as a colder Air succeeds (16), shoots, and is protruded into Figures by the Salt which it contains (17); and thus

(16) "*CrySTALLUS EST SUCCUS, QUEM FRIGUS INTRA TERRAM CONGLUTINAVIT.*"
Agric. p. 282.

(17) Mr. Boyle's Opinion is, that such Stones (*viz.* Spars and Crystals) were originally in a fluid State; that the Figure of them is determinate and geometrical, like the Crystals produced by Alum, Nitre, Vitriol, in Water; and their Texture like the Congelations of Salt produced in Crystallization by Cold.

thus it happens that we have such figur'd Bodies from the Spar, which, without those Salts, would shew us no such Shoots as we call *Cornish* Diamonds, but fix quietly into Sheets, and even Plates, or drop down where-ever its own Weight would carry it.

What sort of Salt it is, which inclines Spar to this hexagonal Form, is the next thing to be inquired into; and most probably will appear to be that of Nitre, if we consider that the Resemblance betwixt the Figure of what we call *Cornish* Diamonds, and that of the pure unmix'd Nitre, is so great, that no two things can be more exactly alike. "The known Figure of Nitre, says *Grew* (*Cosmol. p. 15.*) is a sexangular Prism." "Particulas nitri *Listerus* deprehendit sexangulas, tenues, longas, lateribus paralleogrammis, & ex altera parte in pyramidale acumen desinentes." *Phys. Cler. 8vo, tert. Edit. p. 150.* This exact Resemblance is sufficient to make us conjecture, that these sparry Productions may owe their general Figure to a nitrous Salt, which exerted itself at the time when the Juice of Spar became Stone; and I shall endeavour to support this Conjecture only by one Authority, which is that of the curious, and, in the Studies of Natural History, indefatigable *Linnaeus*, which he favoured me with in Answer to some Queries, jointly with the Opinion of the present Dr. *John Frederick Gronovius* of *Leyden*. "The Origine of those Crystals (18) is a most intricate thing; but you may conclude----*quod omnis crystallizatio a*
L 1 2 "sale,

Grew (*Cosmol. p. 14.*) after talking of the Regularity of Forms, and the Salts of Bodies, proceeds thus: "Arguing (says he) that the Atoms of the lapidific, as well as of the saline Principle, being regular, do therefore concur in producing regular Stones."

(18) *Cornish* Diamonds, sent to Dr. *Gronovius* from *Cornwall*.

“ *sale, quod crystalli gaudent figura nitri, quodque omnes generentur in cavo: Hi (viz. crystalli) quo magis simplices, eo magis puri & pellucidi: Hinc nitro originem debent, quemadmodum gemmæ istæ, quæ prismaticam nitri figuram exhibent.*”

As Nitre may be reasonably conjectured to give the ordinary and general hexagonal Figure to Crystals, it may be as justly inferred, that when they depart from this Uniformity, it is owing to some mineral, earthy, or metallic Mixture, some heterogeneous Salt, which impedes the Nitre in its shooting, and turns it into trigonal, cubical, conic, or other unusual Figures.

SECT. 5.

Of their SIZE.

The next thing to be considered, is the Cause to which the different Size in which these Bodies do appear may be owing, Some Crystals are said to be a Cubit high: *Livia Augusta* dedicated one in the *Capitol* of fifty Pounds Weight (19); and Dr. *Isaac Lawson*, late Physician to the Army in *Flanders*, informed me, that he saw a Crystal in a foreign Mine, with its Edges well preserved, which he believed might weigh about 200 Pounds. Dr. *Woodward* reckons, among his *Cornish* Diamonds, a single Column or Shoot very large, if it be three Inches in Length, and one Inch and half in Diameter near the Base. The largest I have yet seen in *Cornwall* weighs somewhat more than three Pounds, is about ten Inches
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(19) *Pliny, lib. 37. c. 2.* Sir *Hans Sloane* has one Block of Crystal which weighs between 40 and 50 Pounds, and another about 20, quite clear and regular. C. M.

(20) *Catal. 158. f. 98.*

in Girt at the largest End, and more than seven high; from which Size there are of all Degrees, down to the Bigness of a small Pin. As the Size of this last-mentioned is very unusual, I have given a Drawing of it, *Fig. 16. TAB. V.*

The largest proceed out of a large Course or Load of Spar; but the smallest of all from small Bits or Lumps of Spar; and the small pyramidal *Apices* are generally stuck on upon the Side of the large ones, sometimes in distant Spangles, other times in thin and broken Incrustations. Now the Cause of these different Sizes seems to be this: Where-ever great Masses of the sparry Juice have happened at the same time to be in a State of Fluidity, the exuberant Water drained off suddenly, and consequently left Cavity sufficient for the Salts to extend themselves, there the great Quantities of nitrous Salts mixed with the lapideous Juice incline it to shoot vigorously, and form large Crystallizations; and from proportionably lesser Masses, whilst they are indurating, proceed lesser Diamonds. If the whole Mass be impregnated with nitrous Salts, the whole Surface of the Rock shall rise into Points or Spires (21), according as the Mass is more free or more stubborn to comply with the Agitation. If the nitrous Salts are not intimately mixed, but swim in Clouds and Bunches, those Lumps only, where the Nitre is, shall be shot, and the rest be plain. This is the Case when the sparry Juice gets into its proper *Nidus*, or rests in its Fissure. But where small scatter'd Quantities of this stony Juice circulate in the
subter-

(21) See *Fig. 4. and Fig. 3. TAB. V. and Fig. 8. and 11. TAB. IV.*

subterraneous Waters, some trickle down the Sides of Stones and Fiffures, and already-formed Diamonds, and, sticking in *little* Globules, form a Crust by Juxtaposition, whose Points are sexangular, their Columns short, sometimes crooked and unfinish'd. At other times Water, charged with these sparry Juices, falling from higher into lower Parts of the Mine, cannot but be dashed and dispersed about the Cavity in all Directions; and thus it is, perhaps, that the distant Spangles, like the Dew or Mist that rises from a Cascade sprinkled on the Surfaces of all Bodies in their Reach, are there congealed, and shot by their Salts.

SECT. 6.

Of their COLOUR.

Spars are of different Colours, and different Degrees of Transparency; some yellow, some reddish, brown, green, purple, black, some of a cloudy fleecy white, some freckled with little Specks of various Colours and Magnitudes, and others of a Water not inferior to the purest Crystals. The Yellow is supposed to be indebted for its Tinge to Sulphur and Iron, or Lead, or both; the Red to Iron, and perhaps *Gossan*, that general Companion of Copper; Green, to the Solutions or Rust of Copper; Copper will also probably impart its Purple (for of that Colour we find some of our most beautiful Copper Ores) to the Juices near it: Black may possibly be indebted to Copper also of like Colour, to Tin, or the Particles of Coal; but the most transparent owe that Advantage to the Purity and Simplicity of the Juices of which they are formed. What this Purity is owing

to, cannot be so easily determined. Some think to Percolation, or straining through the Pores of other Bodies, the lapidaceous Juice depositing the Sediment and Impurities, which it may have contracted in its Passage. Now, it is not impossible but that the Water, and that liquid Spar, of which these Bodies are principally formed, passing by their own Weight thro' a soft, porous, sandy Stone in the *Oxford, Bath*, and other-like Quarries, may undergo a Change for the better, and acquire a greater Degree of Transparency; but it cannot be so with our Spar, on which we find the Crystals above-mentioned: For, besides that these Crystals are found on both Sides the Stone (22) (which, in the Procedure of Percolation, could never happen), and in very large Shoots, our Spar will no more transpire or exude than Glass, it is of such Consistency and Hardness: So that whatever Filtration has happened to these Crystals, must have befallen them during a former Percolation, before they rested in their present Beds, not from any sweating thro' that Bed in which we find them, as Dr. *Plot* imagines (23).

Crystals therefore, it is certain, owe their Transparency and Purity to the simple State of the Juices that form them; but to what that State and Condition is owing is uncertain. Whether it may be to some purifying Menstruum or Spirit, that precipitates every kind of Sediment, I do not presume to say: I shall only observe, that in *Cornwall* the clearest Diamonds are for the most part found in a dry, lax, sandy Soil, where

(22) See Fig. 8. TAB. IV.

(23) *Oxfordjb.* p. 98. and *Ramundus in Alonzo Barba.* p. 36.

where no dirty or dark-colour'd Loam, Mineral, or opaque Stones prevail: So we may conclude in general, that if, during the Fluidity of these Bodies, no metallic or mineral Fume, no Dust, Clay, or Sand, was imbibed, the Water and lapideous Juice make up a clear pellucid Mass. If the Case was otherwise, whatever Impurities the Waters contracted, and had not at the time of forming discharged, are still to be seen in the Stone.

S E C T. 7.

Of their HARDNESS.

As to the Hardness of our *Cornish* Crystals, all I have to observe is, that they cut well into Seals, when they have no Flaws: Their natural Points also will cut Glass; but not freely or deep; in which Particular they fall much short of the true Diamond.

Conjectures relating to the Properties of the true Diamond.

Of this I shall not pretend to assign any other Reason, than that the true Diamond seems to have more lapideous Juice included, and more intimately and congenially united under an equal Surface, than any other Body in the World. It has also very little Salt in it, as *Dr. Grew* observes (*Cosmol. p. 14.*); and his Opinion is confirmed by its being found in such small Masses; and by its great Weight it can have little Water; both which Observations are supported by its great Resistance, and almost Immutability in Fire: So that the true Diamond has little Salt, and little Water, consisting almost intirely of stony Juice con-
creted;

creted; to which Properties its great Hardness may therefore be attributed: Whereas in our Diamonds there is much Salt, and much Water (comparatively speaking); which two Ingredients, mix'd with the lapideous Juice, may incline those Bodies to be more friable and tender, and deprive them of that Hardness, which a less-reduced lapidific Juice would certainly have had. This seems to me the real Cause of the true Diamond's Hardness, and of our false ones falling as much short of it in this Particular, as in Lustre: But I must acknowledge, that, for want of sufficient Experiments relating to both, I cannot decide peremptorily. However, by weighing the *Cornish* Diamonds in Water, I find they are generally to the Weight of our common Water, at a Medium, as $10\frac{1}{2}$ is to 4; and I apprehend, that if they had more lapideous Particles, they would weigh more, as they find the true Diamond really does*. I find also the clearest and brightest *Cornish* Diamonds weigh much heavier than the other which are more shady and opaque. That they have much Salt also, may be concluded from their being projected sometimes into such large, regular, hexagonal Columns.

SECT. 8.

Of the TEXTURE of Cornish Diamonds.

There are some little Varieties in the Texture of our *Cornish* Diamonds, which are sometimes to be observed in their broken Sides and Edges; but always, and more distinctly, in their Base. Some are uniform, of one Colour and Transparency throughout;

M m some

* The Weight of *Crystals* to Water is as $2\frac{1}{2}$ to 1. of *Diamonds* as $3\frac{1}{2}$ to 1. See these Transactions, No. 488. p. 451. C. M.

some have hexagonal Sheaths described one within another, as in *Fig. 17. TAB. V.* In the first Case, the thotten Juice was of one and the same Nature and Consistency, equally impregnated, and the Production of one Effort; in the latter Case, where the Sheaths are one within another, 'tis also the Product of one Effort or Shoot, the Concretion of one and the same time, as the tremulous Undulations upon the Surface of Water, on throwing in a Stone, are all the Offspring of one Force, tho' the first be strongest, and the rest gradually fainter and less distinct: But the Juices being differently mix'd, gave way to the Effort in proportion to their Sensibility of the Impregnation, the most agile flying off to the greatest Distance from the Center, and the most mix'd, coarsest, and most opaque, remaining nearest the Center (24). That this is the true Process, and that those different Sheaths are the Produce of one Effort or Birth, and not formed at different times, and in Succession, as *Steno* and *Aldrovandus*, and some others, say (25), is plain, I think, from the two following Observations (26). If the Juice which forms these Sheaths was impregnated and shot at different times, it would not form in Sheaths round what appears to be the Central or Master-shoot, but would project itself into its natural hexaedral Figure. If it were not impregnated, but mere Spar only, without Nitre, or any other active Principle, it would form itself, as the Stalactites, in a pendulous undulating Direction, Drop or Wave upon Wave; and in this Case these Sheaths could never surround, in that neat and exact manner, the central Shoot; but

(24) See *Fig. 12. TAB. IV.* and its Description, p. 263.

(25) See *Plot's Oxf.* p. 98.

(26) See p. 259. Note (13)

but would be found only on the under Part of that Shoot, where its own Gravity would inevitably carry it: For it would be observed immediately, that these Diamonds in the Mine point forth in all Directions; which must consequently prevent every unimpregnated Juice from hardening into a regular uniform Sheath.

It is also to be noted, that these Sheaths are often found broke and interrupted: But this cannot be owing to their being *Gemma inchoata & non perfecta* (27), for the above-mentioned Reasons, but to the Insufficiency and Want of Juice, or to some accidental Impediments of Stone, Earth, or Sand, which make those Breaks, and prevent it from forming a complete Sheath.

S E C T. 9.

Of their DIRECTION in the Mine.

Not long since I went with a Friend or two into a Mine called *Pillion Erth*, in the Parish of *St. Just*, on purpose to survey the *Cornish* Crystals in their natural Situation. The Cave, to which we were introduced, was not much larger than a common Baker's Oven, and much of that Figure. We had two Candles with us, by means of which we saw the Roof, which might, in the Middle, be about five Feet high from the Floor; in the other Parts not so much. The Roof was the most surprising Piece of Fretwork imaginable, and consisted intirely of Spar shot into *Cornish* Diamonds, of which the large one (*Fig. 16. TAB. V.*) was a Part. I could not discern any coveting a Position

M m 2

exactly

(27) *As Plot, ibid. ut supra.*

exactly perpendicular to the Horizon; but in every indifferent Direction they pointed forth very plentifully of several Sizes; sometimes in Groupes and Clusters, sometimes single, now crossing each other, and now standing by each other with parallel Sides: Some were smooth, shining, and clear, others rough and opaque; some vein'd with red, like Porphyry; others speckled thick with the smallest Spots of deep Purple, and a bluish Cast: But the finest of all, were those which had innumerable little Diamonds or Sparks (of the clearest Water) stuck upon their Sides, and, by means of the Candle, had a Lustre not to be conceived. We gazed here in this incommodious; but beautiful little Cave, till we could no longer hold up our Heads; and then crept out as we came in, upon our Knees.

Now, among the great Numbers of sparry Productions which I saw in this Mine, I could not observe, but that they pointed indifferently in all manner of Directions; which I suppose owing to the great Unevenness of the Surface on which the Bases of these little Columns were fix'd; and for the same Reason I doubt not, but in all concave Beds the Points converge, as in all convex they turn the contrary Way, and diverge, as from a Center: So that the natural Cause of these different Directions is probably no other than the accidental Form of that general Mass from whence these Shoots proceed. I would say, that as the Figure and Regularity of the lapidific impregnated Matter happens to be when drained of all superfluous Moisture, and by the Cold, Heat, or Dryth, disposed to shoot, so will the Tendency of the Shoots, both Column and Point, be. If
the

the concave Part (for Instance) of the *Voluta* of the *Cornu-ammonis* be set with Crystals, their Points must tend inwards to the Center, where the Tail ends, being thereto compelled by the regular Contour of the Shell; and indeed they are so in Fact, as see *Fig. 18. TAB. V.* But if the Crystal Juice chance to fix on, or proceed from a convex Bed (to which its *Nidus*, and other Causes, may contribute), or be itself an orbicular Lump, and equally impregnated on all Sides; then will the Fibres spring as from one common Center, and at their Extremities point forth their *Cuspides* in a circular Figure, as in *Fig. 19. * TAB. V.*

If there be a thin Plate of Spar equally exposed to Cold on each Side, and having equal Room and Force to shoot, it will throw forth its Points on each Side; and the Line from whence the Fibres began to spring shall be exactly in the Middle of such Plate of Spar, and the Figures shall cut the said Line at right Angles, as in *Fig. 8. TAB. IV.* whence it seems reasonable to conclude, that the Direction in which these sparry Productions shoot forth is generally rectangular, or very near it, to the Beds or Masses from which they proceed; and that all the seeming Confusion in Pointings of the *Cornish* Diamonds in *Pillion Earth*, was owing to the great Variety of Planes and Surfaces, into which that large Body of Spar was hardening, when these Diamonds shot from its Extremities.

I am, Sir,

Ludgvan, Oct. 18.
1749.

Your most obedient Servant,

W. M. BORLASE.

* See *Fig. 5. p. 261.*

Fig. 11. p. 262.

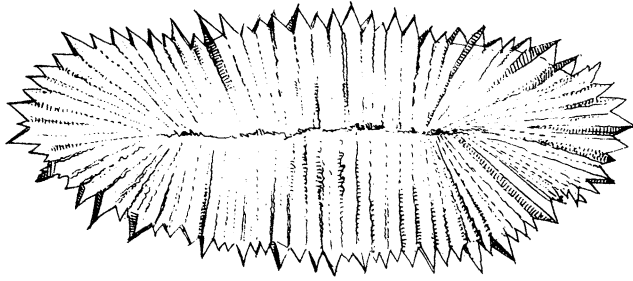


Fig. 1. p. 258.

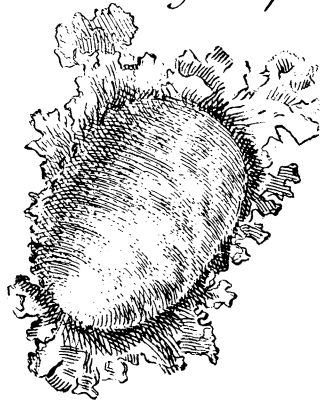


Fig. 12. p. 263.

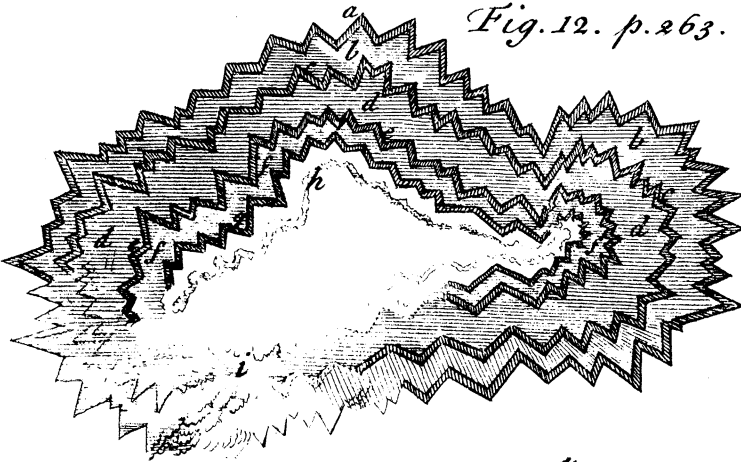


Fig. 6. p. 261.

Fig. 7. p. 261.

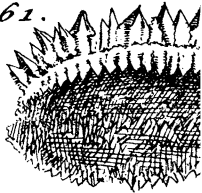


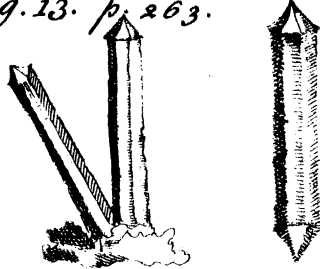
Fig. 14. p. 263.

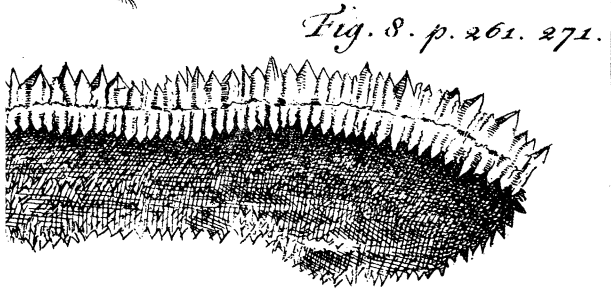
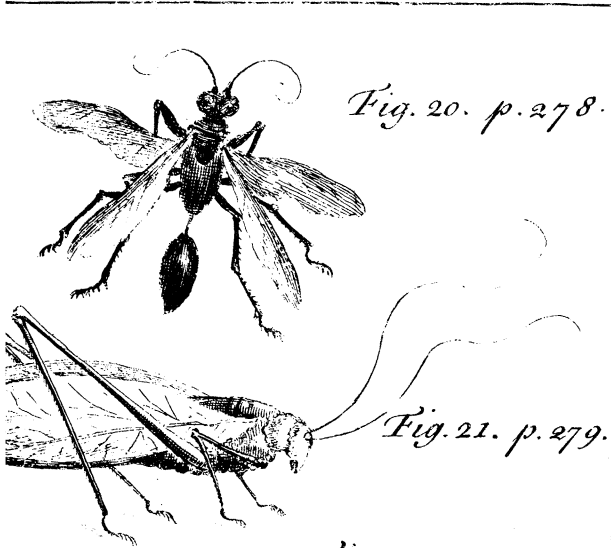


Fig. 15. p. 263.

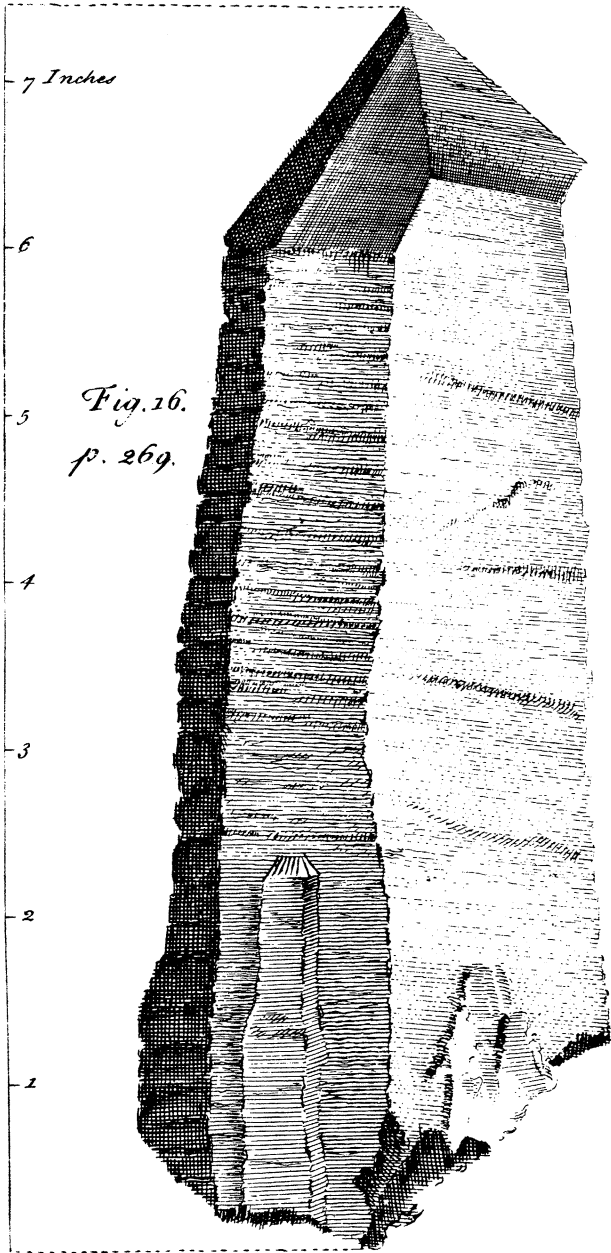


Fig. 13. p. 263.





J. Myrda sc.



*Fig. 16.
p. 269.*

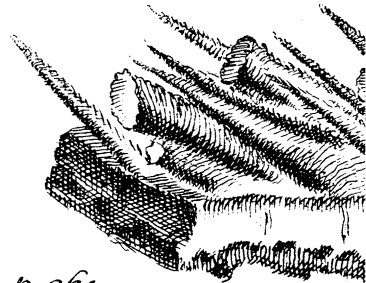
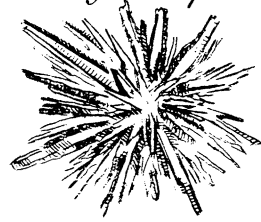


Fig. 4. p. 261.



*Fig. 5. & 1/4 Base of
Fig. 4.
p. 261.*

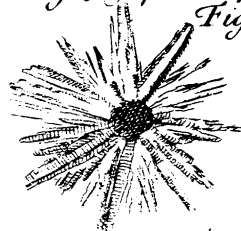


Fig. 19. p. 277.

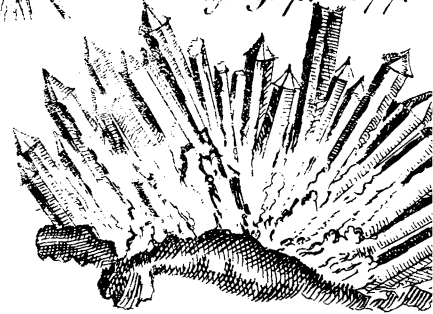
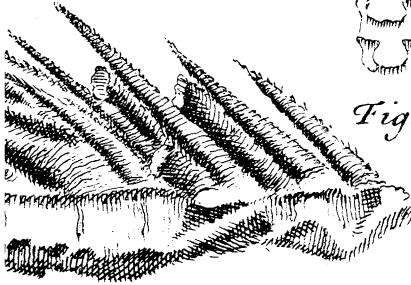
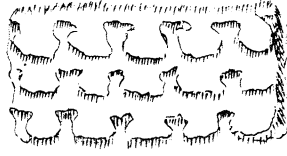
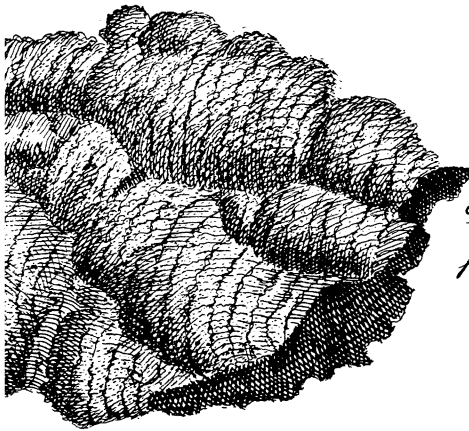


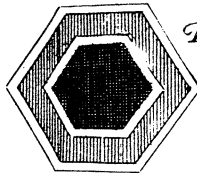
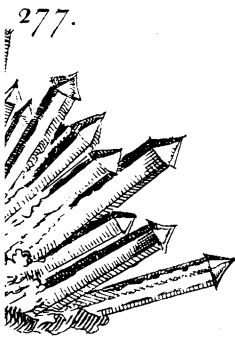
Fig. 22. p. 252.



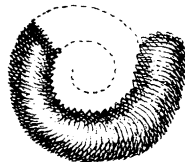
*Fig. 3.
p. 260.*



*Fig. 2.
p. 260.*



*Fig. 17.
p. 274.*



*Fig. 18.
p. 277.*

Fig. 11. p. 262.

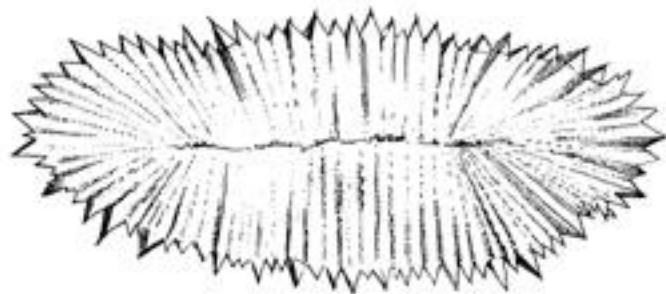


Fig. 1. p. 258.



Fig. 20. p. 278.



Fig. 21. p. 279.



Fig. 12. p. 263.

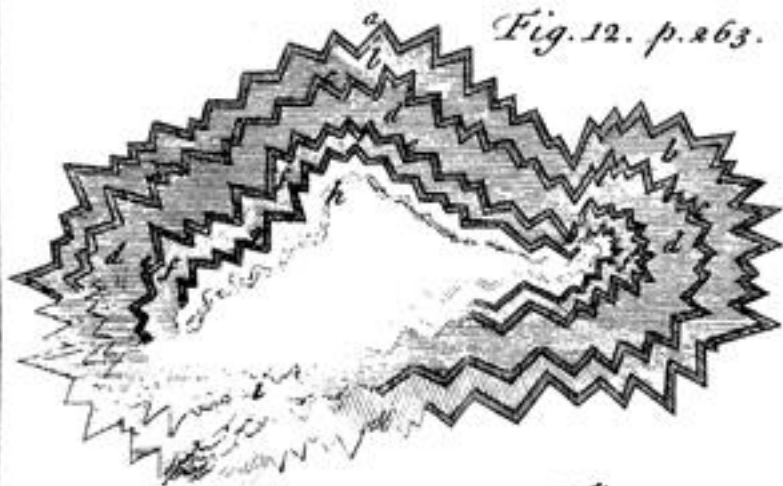


Fig. 6. p. 261.

Fig. 7. p. 261.



Fig. 8. p. 261. 271.

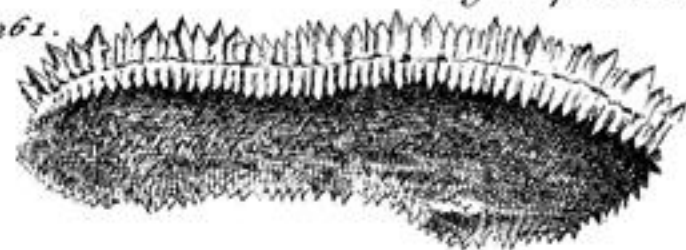


Fig. 9. p. 262.



Fig. 15. p. 263.



Fig. 13. p. 263.



Fig. 14. p. 263.



Fig. 10. p. 262.



