

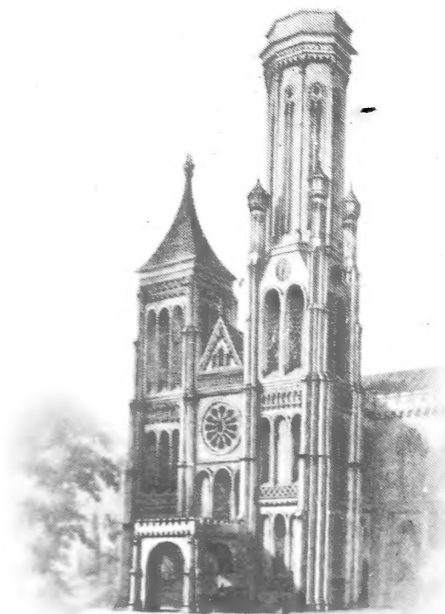




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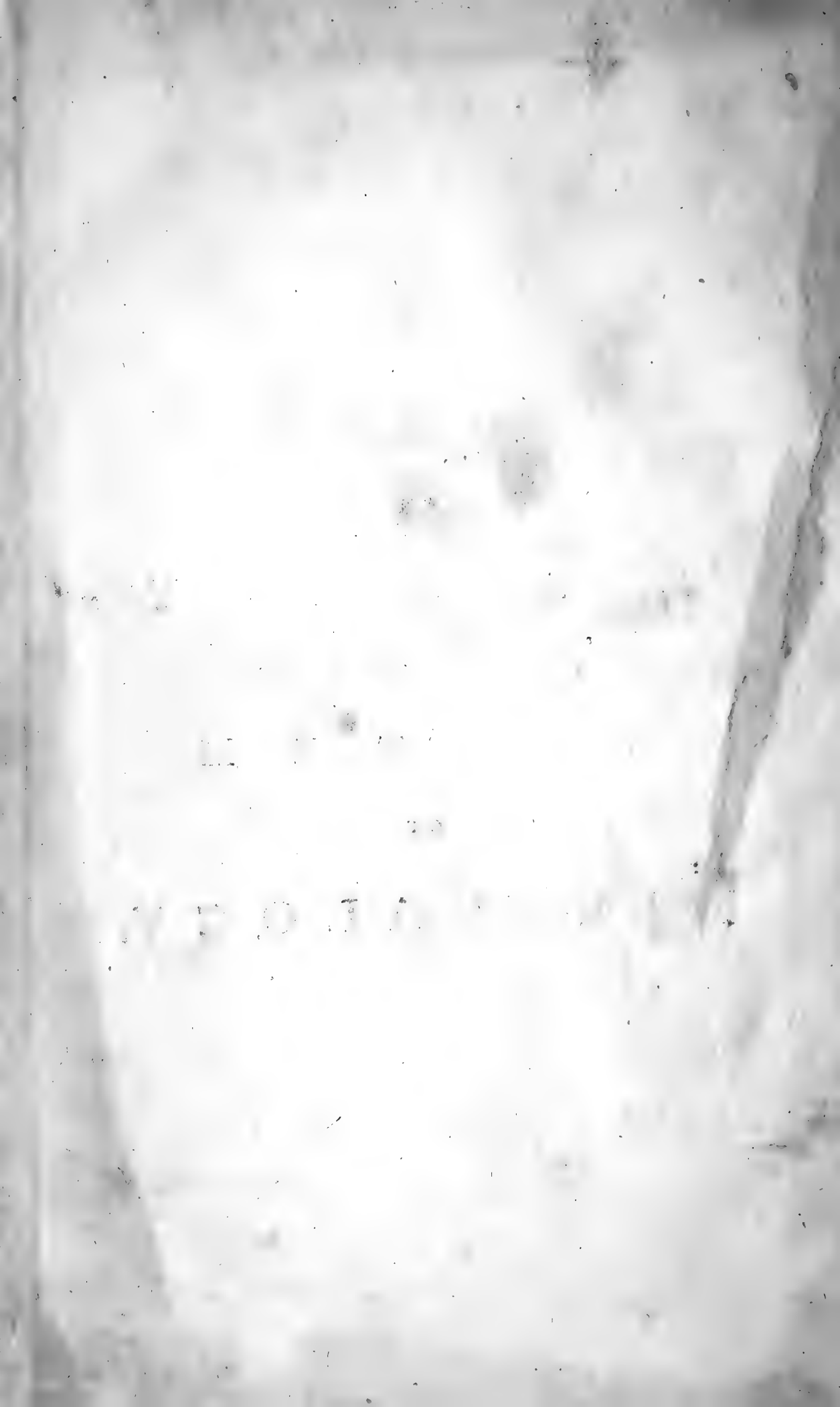


Gift of

Mrs. Grace Caley



AN
E S S A Y
TOWARDS A
S Y S T E M
OF
MINERALOGY.



A N
E S S A Y
T O W A R D S A
S Y S T E M
O F
M I N E R A L O G Y :

B Y
A X E L F R E D R I C C R O N S T E D T .

Translated from the Original Swedish, with NOTES,
By G U S T A V V O N E N G E S T R O M .

T O W H I C H I S A D D E D , A
T r e a t i s e o n t h e P o c k e t - L a b o r a t o r y ,
C O N T A I N I N G
A n E a s y M e t h o d , u s e d b y t h e A U T H O R , f o r
T r y i n g M I N E R A L B O D I E S ,
W R I T T E N B Y T H E T R A N S L A T O R .

The Whole Revised and Corrected, with some Additional Notes,
By E M A N U E L M E N D E S D A C O S T A .

L O N D O N :

Printed for EDWARD and CHARLES DILLY, in the Poultry,
M D C C L X X .



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Mr. D A C O S T A's

P R E F A C E.

I Should hardly have troubled the Reader with any Preface, had not the title page mentioned a Translation by Mr. Engestrom, revised and corrected by me; which necessarily demands some explanation, in justice to us both. It is as follows:

Mr. Engestrom, a Swedish gentleman of great merit and learning, particularly in the science of Mineralogy, amused himself with translating Mr. Cronstedt's celebrated *System of Mineralogy*.

On Mr. Engestrom's return to Sweden, this translation became the property of Messieurs Dilly, by whom I was employed to revise and correct it; as it could not be expected that Mr. Engestrom, being a foreigner, was capable of giving a correct translation in regard to language, or to a proper application of scientific names.

I have therefore carefully corrected it in those particulars, and collated it with the German edition printed at Copenhagen in 1760; and the notes which occurred to me I have marked with D. C. to distinguish them from those of Mr. Engestrom, marked E.

THE
TRANSLATOR'S
PREFACE.

THIS Essay was published in Swedish in the year 1758, by the Author, who in the beginning chose to be anonymous, for reasons he has given in his Preface: He could not, however, remain long concealed, but was soon discovered to be the learned nobleman Axel Fredric Cronstedt. I now give a translation of it, to comply with the desire of several of my friends here in England. I shall not attempt to amuse the Publick in favour of this work, since it speaks so well for itself, and has been almost generally adopted wherever known.

The universal applause, and the favourable reception it met with in Sweden, made it soon known in Norway and Denmark. In the year 1760 it was translated into German, and was
equally

equally approved in Germany; nor, indeed, has it been unknown to the learned in England; for the ingenious and celebrated Dr. Lewis has mentioned it with praise in the second part of his Philosophical Commerce of Arts lately published.

As a foreigner I should make an excuse for the translation, it not being so elegant as it ought to be; however, I flatter myself I shall not be too severely censured on that account, since it is a known truth, that originals always lose something of their beauty by being translated: I therefore think it better to prefer the true meaning of authors to the elegance of style, particularly in scientific works; and I am in this respect more able to give the Public satisfaction, as I have had the happiness to be a disciple of the author himself.

That the mineralogical terms might be more generally understood, I have added the Swedish and German names of the mineral bodies to their English and Latin names; except when to avoid tautology I have sometimes left out the German as nowise different from the Swedish names. New discoveries being daily made in this science, I have also added some notes of my own, concerning such things of which I am perfectly convinced, leaving several others to be further examined and tried.

I was in hopes to have seen a second edition of this excellent work improved and augmented by the author himself; he having,

ever since the first publication of it, been constantly employed in making further enquiries and discoveries in this science: He had even actually made some collections towards it, of which, however, the literary world is likely to be unfortunately deprived, as he lately died in the fortieth year of his age, before he had time to revise and put his new observations in due order.

THE
AUTHOR'S
P R E F A C E.

AS former ages principally encouraged philological and antiquarian enquiries; this present age, at least in Sweden, favours the study of Natural History.

Such changes must be ascribed to geniuses, who understand how to make those sciences, which they have chose for their principal study, agreeable to the Public; and which Sciences, being in general useful to the whole community, every individual thereof can reap some advantage from it, and thereby gratify that self-love implanted in the breast of all mankind in the pursuit of them.

When the pride of a nation is flattered with the vain glory of being of great antiquity, the author of such an opinion is always favoured; and every little circumstance conducive to further confirm it, is carefully recollected and noted. Thus when the subjects of the creation are re-

presented to us in a manner which assists our memory, and renders our conceptions of them easier, we aim at earnestly adopting the noble improvement, and, in order to be the more esteemed, we likewise always confer praise on the author.

As long as the author adheres to his system, and does not alter it, but only illustrates it from time to time with some additional observations, we are not only well satisfied with him, but also often become his faithful assistants. But if he, convinced of the impropriety of his method from its very principles, rejects it, and presents us with another new and entirely different; what will then be the result? Or what is likely to happen if this is attempted by a person who is unknown, and not artful enough to seize on the advantages of our passions?

For my part, I am apt to believe, that in the former case, the present general taste might be somewhat lessened without any loss to the science itself; because among the great number that love Natural History, there are always some who embrace it when free from errors, and others, who are only fond of new reasonings and conclusions, merely because they are so.

These latter are even of service, and their party will certainly increase in length of time.

From this persuasion I have ventured to publish this Essay for treating Mineralogy in a systematical manner; a study to which I have with so much pleasure applied myself. It is not done from the desire of novelty; and still
less

less from contempt of those systems, which Swedish gentlemen in particular, very deservedly, though chiefly on the same principles, have heretofore generally pursued.

I have thought proper to conceal my name *, to prevent any constraint on myself or others, and with a view to be at a greater liberty to amend the System, whenever I shall be convinced there is a necessity for so doing, either by my own experience, or by the observations of others : For I flatter myself that this work will not pass unnoticed by men of letters ; and, as it is only an Essay, it ought, according to an established law amongst authors, to be sheltered from too severe censures.

I wish that the mineralists themselves would examine and compare all that has been hitherto done in this science ; they would then find the reason which has induced me to deviate from the received systems, and to propose another founded upon my own, as well as upon the discoveries of others. But as this comparison is not in the power of every one to make, I think it necessary briefly to repeat here the changes which this science has undergone.

The first writers on Natural History found so great a number of unknown bodies before them, that their curiosity and time would not allow them to do more than to describe them by their mere external appearances, and to collect the names by which they were known to the natives of the countries where they were

* Mr. Cronstedt never put his name to this Essay. D. C.

found. But as every country had a different name for these bodies, they often gained more names than there were real species, and even sometimes the very reverse happened; this occasioned a confusion, which in the beginning was excusable, but in length of time could not fail of being an obstacle to the progress of the science, and its application in common life.

To remove and alter these inconveniences, they have in later and more enlightened times endeavoured to fix proper names to the subjects of the mineral kingdom, according to their external marks, as in regard to Figure, Colour, and Hardness; but these characters afterwards having been found not sufficient, it was necessary to discover others more solid by the result of chemical experiments, which added to the former ones would make a complete system. Hiarne and Bromell were, as far as I know, the first who founded any mineral system upon chemical principles. However, they were only the projectors of this manner of proceeding; and to them we owe the three known divisions of the most simple mineral bodies; viz. the *Calcarei*, *Vitrescentes*, et *Apyri*. This system was afterwards adopted by Dr. Linnæus, who, as a very skilful person in the other two kingdoms of nature, ought not to have omitted the third when he published his *Systema Naturæ*. Browal, bishop of Abo, a prelate of great learning, had an opportunity of altering and improving Linnæus's method in a manuscript, which Dr. Wallerius has since made public in his *Mineralogy*.

logy, with some alterations of his own; however, the principal foundation remained the same in all, or according to Bromell's method, which he had published in a small book, entitled *Indications for the searching for Minerals*: Until Mr. Pott, a chemist by profession, and consequently inclined rather to believe the effects of his experiments, than the external appearances alone, proceeded farther than was customary before his time, in the assaying of stones by fire, and afterwards published his acquired knowledge by the title of *Lithogognesia*. From this book the said author received considerable honour, because the true advantage of his researches began to appear: Miners and other manufacturers were by it able to determine the reason of certain effects, which they before either did not observe, or wilfully concealed, to avoid the censure of being ignorant, if they advanced such things as real truths, which, according to modern systems were regarded as contradictory and absurd. Mr. Wolterdorff, a disciple of Mr. Pott, then begun *immediately to form an entire mineral system*, founded upon chemical experiments; but his master did not approve of it, still insisting that materials were yet wanting for the purpose; and that *every* mineral body ought first to be examined and tried with the same care that he had tried and examined the most simple of them; to wit, the Earths and Stones.

Such was, according to the idea I had of it, the state of Mineralogy, when I, touched by
the

the difficulties which beginners laboured under, undertook to put my scattered thoughts in this order. Naturalists agreed with me, in thinking the barrier, which had a long while been defended with such ardour, was now beaten down, and that it was necessary another should be erected in its stead, as good as could be procured, until a perfect one might be in time discovered.

Such an enterprize it was thought would promote this desirable end, when on one side I reflected upon the passion which our learned have for disputing, and on the other part considered the gracious reception which the Arts and Sciences have met with at this time, from those to whom the heavy burthen of governing human societies is allotted. It is from their care we are to expect the compleat tribunal where all disputes in this matter can be accurately decided, and all things be rendered truly useful; I mean the institution of a Laboratory; where the sifting, grinding and polishing; where the air, liquid, and dry dissolvents and also fire in all its degrees, from the electrical to that of the burning-glass, may be employed as means to obtain the knowledge of these intricate and unknown bodies.

To a similar circumstance, perhaps, those chemical experiments upon vegetables were owing, which were made many years ago in a certain kingdom; and though they did not answer at that time the intended purpose, yet they may at some future time be repeated with
 advantage,

advantage, when more knowledge in that matter is obtained : But thus much we certainly know by experience, that the mineral kingdom is extremely well adapted to be examined by these means. The experiments made by the ingenious Mr. Homberg, with Tschirnhausen's burning-glass, may certainly be carried yet farther, whereby some doubts may likewise be removed, which still remain regarding some of the effects of his experiments. Thus, we should be employed in observing the phenomena and drawing conclusions from them, instead of only searching for the principles of those effects, as naturalists were formerly obliged to do.

How satisfied would every lover of systems be, if by this means he could get materials properly prepared to compose a better work, in which he could introduce the few valuable things which are to be found among the old ruins, and leave out all the vague expressions, together with the distinctions, that are of no consequence.

When I had, for the above-mentioned purpose, collected my own observations, and those of others, I heard of two new books on the same subject; they were Mr. D'Argenville's *Oryctology*, and Mr. Justi's *Mineralogy*; for which reason I laid my manuscript aside, until I had, by the perusal of those two works, convinced myself that those gentlemen had not prevented me from pursuing my plan; for, the former has, in my opinion, endeavoured to
bring

bring us back to a taste that was formerly in vogue; and which, though we do not despise, yet we neglect. The second seems to have hurried himself too much, mixing together some irresistible truths, with a greater number of opinions, not yet demonstrated, or mere conjectures; *which is running on faster with a theory than experiments will permit*; whereby nature, which is the *chief point*, will at the end be lost.

Therefore, that no fondness for novelties, in consequence of these new works, or others of the like nature, which may hereafter be published, may again divert our attention from the *only method of obtaining any knowledge of the Mineral Kingdom*, which has with so much pains at length been discovered, and has already been a little entered upon; I have, prompted either by self-love, or a more generous motive, published this Essay, even before I have had time and leisure to reduce it into a perfect system: I do not pretend that it is a compleat one, by which we can with certainty divide mineral substances, and afterwards reduce them into order. I have chiefly intended it as a bar or opposition to those, who imagine it to be an easy matter to invent a method in this science, and who, *entirely taken up with the surface of things*, think that the *Mineral Kingdom may with the same facility be reduced into classes, genera, and species*, as animals and vegetables are; they do not consider that in the two last kingdoms of nature there are but sel-

dom,

dom, and never more than two different kinds found mixed together in one body ; whereas in the mineral kingdom it is very common, though it will nevertheless always remain concealed from every one, however penetrating, *who has not employed himself in the compounding or decomposing such bodies*, as far as the present knowledge of these matters will permit.

So much may be said in general concerning this Essay ; but now I ought more particularly to inform my readers of the motives why I have now and then deviated from the orders and distinctions hitherto used.

Earths and Stones are comprehended in one class, because 1. they consist of the same principles ; 2. they are by turns converted from one into the other, insomuch that an earth may in length of time become as hard as a stone, and *vice versa* : nor can the true difference between a stone and an earth be positively pointed out by the degrees of hardness or softness ; for where is it that the common chalk finishes, and the lime-stone begins in the English strata ? and how is a clay, whether in water or not, to be distinguished from the soft and unctuous soap-rock, or Smectis.

The division of earths into *Vitrescentes* and *Apyri* is here omitted, since all of them are, in a due degree of heat, found equally apt, either *per se*, or by means of some natural or artificial mixture, to be reduced to glass equally as well as those hitherto called *Vitrescentes* ; which are nearly the most refractory in the fire, and ought to

to be called *Vitrescentes cum alcali*, if their name was to have any connection with their effects.

Having now so far overcome the former ignorance, which was the foundation of the knowledge for distinguishing the mineral bodies into transparent or opaque, hard or soft, we prefer the decision of the fire, though we still labour under the misfortune of not being able to measure the degrees of fire with sufficient accuracy; for which reason we always must suppose a *plus ultra* in the experiments by fire.

Sand in reality is nothing else than very small stones; therefore, if a separate class were to be made of Sands, another class ought to be made, which should comprehend Gravel; a third, Loose Stones; and a fourth, Mountains: This would be a *multiplicatio entium præter necessitatem*; a fault, which under these circumstances may easily be committed, though not so soon perceived.

The Saxa must for the same reason be excluded from any system: Otherwise it would be the same as if a botanist made a difference between the mistletoes, or such like vegetables, according to the different genera or species of trees, plants, walls, or rails on which they grew.

Petrefactions, or *Mineralia larvata*, consist of such principles as ought to be described in their proper places, without regard to their figure; for which reason they cannot be enumerated a second time. The principal reason for collecting them, is to acquire a knowledge of such bodies of the animal and vegetable kingdoms,

doms, as are not usually found in their natural state, and in this respect they belong properly to the studies of the Botanists and Zoologists. For a Mineralist is satisfied with a single specimen of each different substance that has taken the shape of a vegetable or animal body, and this only to illustrate the history of their generation; he leaves it to others to decide if corals are vegetables, or the habitations of worms; and thus receives them very unconcernedly, after they have been mouldered to a chalk, changed into a spar, or into any other stony matter. Nevertheless, I have in the Appendix proposed a method for ranging the *Saxa* and *Petrefacta* in regard to the æconomical uses that may be expected from them.

Slate signifies or denotes the form alone, and not its kind or qualities; however, it regards only its situation in the rock, and not the texture of its particles; which latter I have always endeavoured to take notice of, since some difference in the effects frequently depends on it. And, as nothing is great or small but by comparison, it is difficult strictly to determine in what degree of thickness or thinness a stone begins to deserve the name of a slate. Nevertheless, I would have prevailed on myself to adopt this general name, if the breaking in thin plates had been the property only of any particular kind of stone, but it is by no means the case; because there is found in the province of Jemteland, in Sweden, a pure quartz, limestone, (both solid and scaly) indurated

rated boles, alum ores, and a great number of saxa, which are all of a plated structure, dividing into leaves as thin as pasteboard: And therefore I make no doubt but all kinds of stones may be found of such a figure in some parts of the world. What confusion would it not occasion if all these different kinds were included under one genus? And are there not solid stones found consisting of the same constituent parts as the slates, which are separately considered in systems?

I could not range the ores according to the different kinds of rock in which they are found; for instance, the Goose-dung silver ore, the Liver ore, and many more of the same kind, since observations upon the matrices of ores belongs to another branch of the Mineral Science, called *Geographia subterranea*, or *Cosmographia specialis*; in which likewise the clefts, fissures, and veins or loads, that occur in every sort of rock, (in order to promote the circulation and fixation of the mineral vapours) are treated of. In that Science also the *Petræ Parasiticæ* are pointed out, whose number perhaps is not yet known; as likewise the glossy fissures from which the *Mineræ Speculares* have obtained their name. And this is a branch of science, which, in the hands of a skilful mineralist, is likely to furnish us with a perfect idea of the age of every sort of stone, and also of their different gradations between the two accidents, to which all created beings are subject, Composition and Destruction.

Since

Since it has not been usual to consider the earths and stones as the same, in regard to the principles of which they consist, and only different from one another by the greater or lesser hardness and coherency of their particles; I hope for excuse, in not being able to prosecute this Essay so far as to point out a particular earth for each kind of stone. Perhaps also some of the mineral bodies are already so much hardened, that no earths of this kind are to be found; or, perhaps, the little knowledge we have of them is owing to the neglect of not collecting earths with the same earnestness as we do stones and ores. If, therefore, all the earths which are ranged in certain modern systems, and there distinguished from one another, in regard to the difference of their colours and places where they are found, had fallen into the hands of Mr. Pott, and been tried by him in the fire, as he has tried the stones, and been described in his *Lithogegnesia*, it is very probable that we now should know these bodies better, and their number would certainly be less perplexing.

The hints which are here given may, however, tend to promote the intended point for the future; and then perhaps the earths will be found not to be quite of so many different kinds as I have here been obliged to divide them into, for want of perfectly knowing their affinities and their several origins; because we have strong reasons to believe that the calcareous and argillaceous earths are the two principal ones, of which all

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the rest are compounded, although this cannot yet be perfectly proved to a demonstration.

The *Lusi Naturæ* are not separately treated herein; they may be found every where in the Essay, because the rock crystals do not appear to me less curious than the indurated marles; and the kidney ore is often found of a more surprising figure than the eagle-stone. I cannot therefore find any reason for forming a class of them, nor do I comprehend what others take to be a greater or less sport of nature in the mineral kingdom.

Figured stones, or which contain the representations of vegetables, animals, &c. occasioned by different veins or colours in the stones, are in my opinion of still less consequence, and are also more difficult to range properly in classes; because people seldom, or rather never, agree in their fancies; but what seems to represent an object to one, may make a different appearance in the imagination of another, whereby both confusion and disputes would arise about the bodies of such a class. Besides, a very small advantage, if any, can result from such a class; since all that the Almighty created has required equally his power, and is also equally worthy of our admiration: It gives rather rise to pedantry, whereby the attention is by degrees diverted from true knowledge to mere trifles, of which both ancient and modern books are sad instances; and if Mr. Du Fay had not impeded the evil by discovering the method of improving the figures upon flints
and

and agats, we might still have seen whole collections full of them with such imaginary figures.

Stones that are found in animals and fishes, are partly compounded of phlogiston, salts, and a small quantity of earth, and partly consist of the same matter with animal bones, and can therefore with as little reason have a place in a mineral system as the stones of fruits. Soot, tartar, yeast, and things of such nature, have too great affinity to the vegetable kingdom, and are never to be met with under the surface of the earth; wherefore they may in Botany be considered in the same manner as regules, glasses, and slags are in Mineralogy.

The hair-balls found in animals, and felt, differ from one another in that the former are worked together by means of the peristaltic motion in the bowels of the animals, and the latter by the art of the feltmonger. May not all these stones of animals therefore be ranked among the *relicta animalia*?

By all this it is very evident, that my chief care has been to treat the mineral kingdom in such a manner, that those whose principal study it is, may avoid every thing unnecessary and superfluous; and by a perfect knowledge of the subjects be brought to consider how to employ them to the best advantage; whereby I hope that the pleasure of collecting minerals will rather encrease than be discouraged. If some objects are thrown out from mineral collections on account they do

not belong to them, other collections will be augmented; and thus every thing will be brought into a due order. If some collectors should not immediately be able to comprehend this System or Classification, it cannot much detriment the science; and it is likewise of very little consequence in proportion to the advantage that will accrue to the study by this method, the more it shall be cultivated and improved.

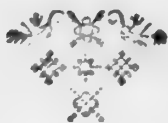
Ptolomy cannot be supposed to have known the value of every book he sent to his great library in Alexandria, and he had doubtless no time to class them himself according to the contents of the different books acquired; however, his love for collecting must have continued during his life: Moreover, the advantages obtainable from it would have been afterwards discovered, had it not been dispersed; or, as sometimes happens, had not the collection been supposed to gain some additional value by being made difficult of access to the learned.

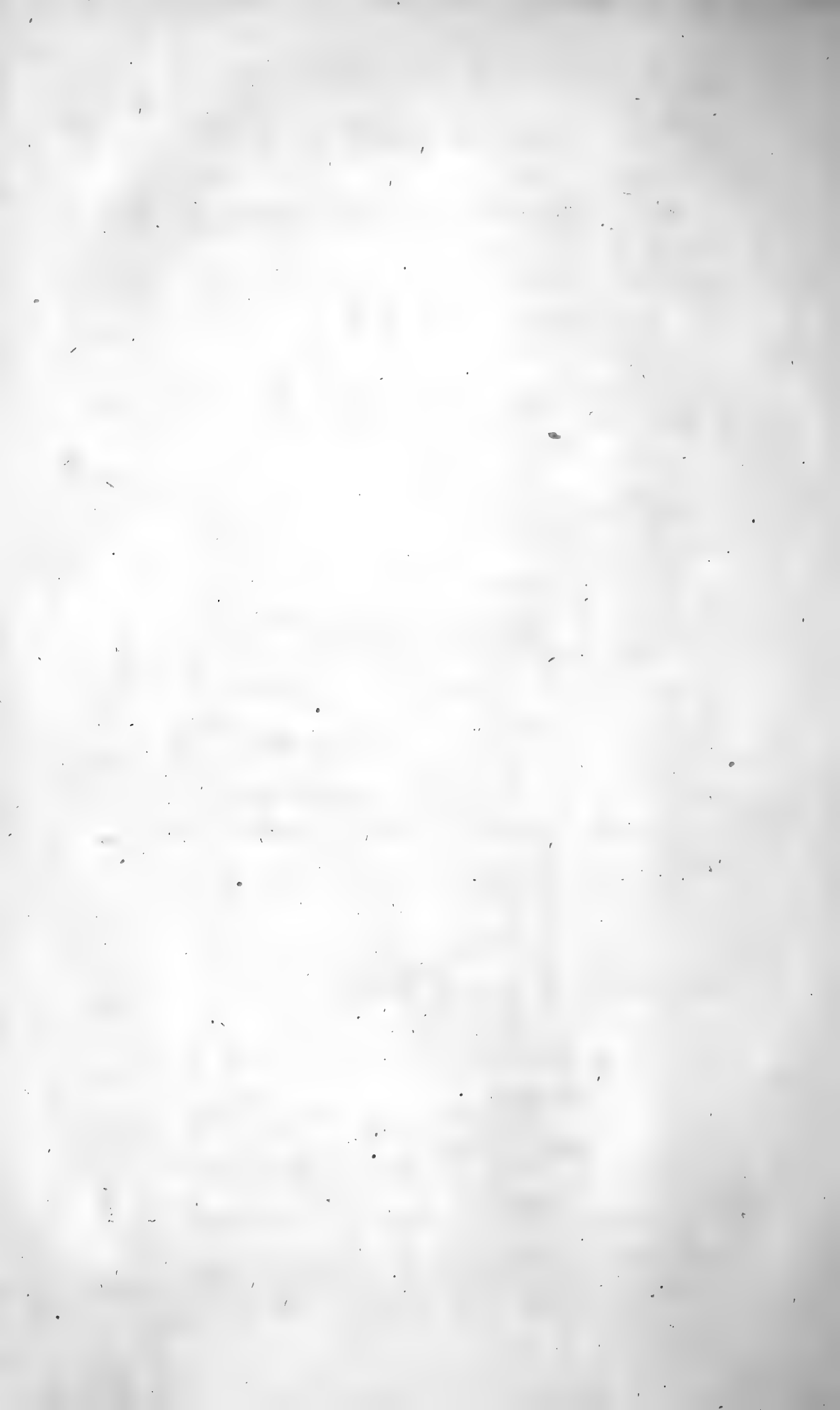
As soon as we are arrived to such a pitch, as by the examination of a mineral body to discover or know all its constituent parts, and can assert with certainty that it can be no further decomposed by any method hitherto known; then such a body ought, according to the intention of this Essay, to receive its specific name, and not before; for otherwise it will be vague and trivial. However, I have not assumed a confidence to do this even with such mineral bodies that I in some respect can aver

I pretty

I pretty well know, and which have not yet obtained any fixed name; as I think it proper to wait that event, until this Essay has passed through that trial which I sincerely wish it deserves to undergo, equally with others of the same nature. Then only will be the proper time to fix the genera and species, according to such characters as shall be found the most natural.

Meanwhile I flatter myself with so much success, that students, who intend to follow this proposed method, will not be so easily mistaken in the subjects of the mineral kingdom, as has happened with me and others in following former systems; and I also hope to obtain some protectors against those who are so possessed with the *figuromania*, and so addicted to the surface of things, that they are shocked at the boldness of calling a *Marble* a *Limestone*, and of placing the *Porphyry* amongst the *Saxa*.





T H E
C O N T E N T S.

I.	EARTHS	—	—	SECT. III.
	I. Calcareous	—	—	IV.
	A. Pure	—	—	V.
	1. Loose	—	—	V.
	2. Friable. Chalk	—	—	VI.
	3. Indurated. Limestone	—	—	VII.
	A. Solid	—	—	VII.
	B. Granulated	—	—	VIII.
	C. Scaled	—	—	IX.
	D. Sparry. Calcareous spars	—	—	X.
	E. Crystallised	—	—	XI.
	F. Stalactitical. Drop-stones	—	—	XII.
	B. United with the acid of vitriol. <i>Gypsum</i>	—	—	XIII.
	1. Loose. <i>Gur</i>	—	—	XIV.
	2. Indurated. Plaster stones	—	—	XV.
	A. Solid	—	—	XV.
	B. Scaled	—	—	XVI.
	C. Fibrous	—	—	XVII.
	D. Sparry. <i>Selenites</i>	—	—	XVIII.
	E. Crystallised	—	—	XIX.
	F. Stalactitical	—	—	XX.
	C. United with the muriatic acid. <i>Sal ammoniac</i>	—	—	} XXI.
	D. United with the phlogiston or inflammable substance	—	—	} XXII.
	1. With the phlogiston alone. The foetid spar	—	—	} XXIII.
	2. With phlogiston and the vitriolic acid. <i>Liverstone</i>	—	—	} XXIV.
	E. Blended with an argillaceous earth. <i>Marle</i>	—	—	} XXV.

	S E C T.
1. Loose	XXVI.
2. Semi-indurated	XXVII.
3. Indurated	XXVIII.
<i>F.</i> United with a metallic calx	XXIX.
1. With iron. White iron ore	XXX.
2. With copper	XXXIV.
3. With lead	XXXVII.
2. Siliceous	XL
<i>A.</i> The diamond	
1. Colourless	XLII.
2. Red, or the ruby	XLIII.
<i>B.</i> The sapphire	XLIV.
<i>C.</i> The topaz	
1. Yellow	XLV.
2. Yellowish green. The Chrysolite	XLVI.
3. Blueish green. The Beryll	XLVII.
<i>D.</i> The emerald	XLVIII.
<i>E.</i> Quartz	L.
1. Pure	
<i>A.</i> Solid	} _____
<i>B.</i> Grained	
<i>C.</i> Sparry	
<i>D.</i> Crystallised	LII.
2. Impure quartz	LIII.
<i>A.</i> Mixed with a black martial clay	} _____
<i>B.</i> _____ with a red copper calx	
<i>F.</i> Flint	LIV.
1. The opal	
<i>A.</i> The sanganon	} _____
<i>B.</i> The white opal	
<i>C.</i> The cat's eye	
2. The onyx	LVI.
3. The chalcedony	LVII.
4. The carnelian	LVIII.
5. The fardonyx	LIX.
6. The agate	LX.
7. The common flint	LXI.
8. Chert	LXIII.
<i>G.</i> Jasper	LXIV.
1. Pure	LXIV.
2. Martial	LXV.
<i>H.</i> Rhombic quartz or felspat	LXVI.
3. The	

C O N T E N T S.

	S E C T.
3. The garnet-kind	LXVIII.
A. The garnet	
1. Martial	
A. The garnet-stone	}
B. Crifallifed garnet	
2. Mixed with iron and tin	LXX.
3. ——— with iron and lead	LXXI.
B. Shirl or cockle	
1. Mixed with iron	}
A. Cockle, or shirl stone	
B. Sparry	LXXIII.
C. Fibrous	LXXIV.
D. Crifallifed	LXXV.
4. Argillaceóus	LXXVII.
A. Porcellane clay	
1. Pure	}
A. Diffufible in water	
2. Mixed with phlogifton, &c.	}
A. Diffufible in water	
B. Indurated	
1. Compac& and foft. <i>French chalk</i>	LXXX.
2. Solid and compac&. <i>Soap rock</i>	LXXXI.
3. Solid and of no vifible particles.	
The ferpentine ftone	LXXXII.
3. Mixed with iron	
A. Diffufible in water	}
B. Indurated	
B. Lithomarga	
1. Of coarfe particles	}
2. Of fine particles. The <i>terra lemnia</i>	
C. Boles. <i>Bolus</i>	
1. Loofe and friable	}
2. Indurated	
A. Of no vifible particles	}
B. Scaly. The <i>hornblende</i>	
D. Tripoli	LXXXVIII.
E. Common clay	
1. Diffufible in water	}
A. Pure	
B. Mixed with lime. <i>Marle</i>	
	— XC.

		S E C T.
2.	Indurated	
	A. Pure	} XCI.
	B. Mixed with phlogiston and the vitriolic acid. <i>Alum slate</i>	
	C. Mixed with lime	
5.	Micaceous — — — — —	XCIII.
	A. Pure mica, or glist	} — XCIIV.
	1. Of large scales or flakes	
	2. Of small scales or flakes	
	3. Chaffy	
	4. Crumpled or twisted	} — XCV.
	B. Martial mica, or glist	
	1. Of large flakes	
	2. Of small flakes	
	3. Crumpled or contorted	
	4. Chaffy	} — XCV.
	5. Crystallised	
6.	Fluores — — — — —	XCVII.
	A. Indurated	} — XCVIII.
	1. Solid	
	2. Sparry — — — — —	XCIX.
	3. Crystallised — — — — —	C.
7.	The Asbestos kind — — — — —	CII.
	A. Of soft and thin fibres	} CIII.
	1. Of parallel fibres. <i>Corium mon-</i> <i>tanum</i>	
	2. Of twisted fibres. <i>Suber montanum</i>	CV.
	B. Of fine and flexible fibres. <i>Asbesti</i>	} CVI.
	1. Of parallel fibres	
	2. Of abrupt or broken fibres	
8.	Zeolites — — — — —	CVIII.
	A. Pure	} CIX.
	1. Solid	
	2. Sparry — — — — —	
	3. Crystallised — — — — —	CXI.
	B. Mixed with iron and silver. <i>The lapis</i> <i>lazuli</i> — — — — —	CIX.
9.	The Manganese kind — — — — —	CXIII.
	A. Loose and friable — — — — —	CXIV.
	B. Indurated	} CXV.
	1. Pure	
	2. Mixed with iron — — — — —	
	3. — — — with iron and tin, or <i>Wolfram</i>	CXVII.

	S E C T.
II. SALTS	CXIX.
1. Acids	CXX.
A. Acid of vitriol	CXXI.
1. Pure	CXXI.
2. Mixed or saturated	CXXII.
A. With metals. <i>Vitriol</i>	CXXII.
B. With earths, Plaster-stone and alum	CXXIV.
C. With phlogiston. <i>Sulphur, or brimstone</i>	CXXV.
D. With alkaline salts. <i>Neutrals</i>	CXXVI.
B. Acid of common salt	CXXVII.
1. Pure	CXXVII.
2. Mixed or saturated	CXXVIII.
A. With earths	CXXVIII.
B. With alkaline salts	CXXIX.
C. With phlogiston. <i>Amber</i>	CXXXIII.
D. With metals	CXXXIV.
2. Alkaline mineral salts	CXXXV.
A. Fixt	
1. Alkali of common salt	CXXXVI.
A. Pure	CXXXVI.
B. Mixed	CXXXVII.
1. With earths	CXXXVII.
2. With mineral acids	CXXXVIII.
2. Borax	CXXXIX.
B. Volatile	CXL.
1. Mixed with the muriatic acid. <i>Sal ammoniac</i>	CXLI.
2. — with earths	CXLII.
III. MINERAL INFLAMMABLES	CXLIV.
A. Ambergrise	CXLV.
B. Amber	CXLVI.
C. Rock-oil	CXLVII.
1. Liquid	CXLVII.
A. Naphta	CXLVII.
B. Rock-oil	CXLVIII.
2. Thick and like pitch. <i>Maltha</i>	CXLIX.
3. Hardened Asphaltum	CL.
D. Sulphur or brimstone	CLI.
1. Native sulphur	CLI.
2. Sulphur that has dissolved metals	CLII.
A. — iron.	CLII.
<i>Pyrites</i>	
B. Sulphur	

S E C T.

B.	Sulphur that has dissolved iron and tin. <i>Black lead.</i>	CLIV.
C.	_____ iron with other metals	CLV.
D.	_____ other metals	CLVI.
E.	Mineral phlogiston united with earths	} CLVII.
1.	With a calcareous earth	
2.	With an argillaceous earth	} CLVIII.
A.	With a small quantity of coal	
B.	With a greater quantity	CLIX.
C.	In very great quantity	CLX.
F.	Mineral phlogiston mixed with metallic earth	} CLXI.
1.	With copper	
2.	With iron	
A.	Fixt	
B.	Volatile	
IV.	METALS	CLXIII.
1.	Metals	} CLXIV.
A.	Gold	
1.	Native gold	CLXV.
2.	Mineralised	} CLXVI.
A.	With sulphur	
1.	By means of iron	
2.	_____ quicksilver	
3.	_____ zinc, tin, and silver	
B.	Silver	CLXVII.
1.	Native	CLXVIII.
2.	Mineralised	} CLXIX.
A.	With sulphur alone. <i>Glass</i> <i>silver ore</i>	
B.	With sulphur and arsenic. <i>Red</i> <i>silver ore</i>	} CLXX.
1.	Grey	
2.	Red	
C.	With sulphurated arsenic and copper. <i>White silver ore</i>	CLXXI.
D.	With sulphurated arsenic and iron. <i>White silver ore</i>	CLXXII.
E.	With sulphurated antimony. <i>Liver and plumose silver ore</i>	CLXXIII.
F.	With sulphur, copper, and antimony	CLXXIV.
G.	With	

		S E C T.	
G.	With sulphur and zinc	CLXXV.	
H.	With sulphur and lead.	} CLXXVI.	
	<i>Potter's lead ore</i>		
I.	With sulphur and anti- mony		
K.	With sulphur and iron	} CLXXVII.	
L.	With the acid of common salt. <i>Horn silver ore.</i>		
C.	Platina del pinto	CLXXIX.	
D.	Tin	CLXXX.	
1.	In form of calx	} CLXXXI.	
A.	Indurated		
1.	Mixed with the calx of arsenic		
	a. Solid. <i>Tin-stone</i>		
	b. Crystallised. <i>Tin grains</i>		
2.	Mixed with the calx of iron		
3.	Mixed with manganese. <i>Wolfram</i>		
2.	Mineralised by sulphur with iron. <i>Black lead</i>		
E.	Lead		CLXXXIV.
1.	In form of calx		} CLXXXV.
A.	Pure		
	1. Friable. <i>Lead ochre</i>	} CLXXXVI.	
	2. Indurated. <i>Lead spar.</i>		
B.	Mixed	} CLXXXVII.	
1.	With calx of arsenic		
2.	With a calcareous earth	} CLXXXVIII.	
2.	Mineralised		
A.	With sulphur. <i>Potter's</i> <i>lead ore</i>	} CLXXXIX.	
B.	With sulphurated silver		
C.	With sulphurated iron and silver	} CXC.	
D.	With sulphurated silver and antimony. <i>Antimoniated</i> <i>lead ore</i>		
F.	Copper	CXCII.	
1.	Native	CXCIII.	
2.	In form of calx	} CXCIV.	
A.	Pure		
	1. Friable. <i>Copper ochres</i>	} CXCIV.	
	2. Indu-		

	S E C T.
2. Indurated	CXCIV.
B. Mixed	
1. Friable	CXCVI.
2. Indurated	
3. Mineralised	
A. With sulphur. <i>Grey copper ore</i>	CXCVII.
B. With sulphurated iron. <i>Marcasitical copper ore</i>	CXCVIII.
C. With sulphur, arsenic, and iron	CXCIX.
D. Dissolved by the vitriolic acid. <i>Vitriol of copper</i>	CC.
E. Mineralised with phlogiston	
G. Iron	CCI.
1. In form of calx	
A. Pure	CCII.
1. Friable. <i>Martial ores</i>	
1. Powdery	CCII.
2. Concreted. <i>Bog ore</i>	
2. Indurated hæmatites	
1. Of an iron colour	CCIII.
2. Blackish brown	CCIV.
3. Red	CCV.
4. Yellow	CCVI.
B. Mixed with heterogeneous substances	
1. With a calcareous earth. <i>White iron ore, or Spathose iron ore</i>	
2. — a siliceous earth. <i>Red chalk</i>	CCVII.
3. Garnet earth. <i>Garnet and spirl</i>	
4. — an argillaceous earth. <i>Bole</i>	
5. — a micaceous earth. <i>Mica</i>	
6. — Asbestos	
7. — Manganese	
8. — an alkali and phlogiston	CCVIII.
1. Blue martial ochre	
9. With an unknown earth. <i>Terras</i>	CCIX.
10. — another unknown earth	CCX.
2. Mineralised.	

	S E C T.
2. Mineralised	
A. With sulphur alone	} CCXI.
1. Saturated. <i>Marcasite pyrites</i>	
2. With very little sulphur	} CCXII.
1. Magnetic	
2. Non-magnetic	
B. With arsenic. <i>Mispickel</i> , or <i>plate mundic</i>	} CCXIV.
C. — Sulphurated arsenic. <i>Zarnick and Sandarach</i>	
D. — the vitriolic acid. <i>Cop-</i> <i>peras</i>	
E. — Phlogiston	
F. — other sulphurated and arsenicated metals	
2. SEMI-METALS	
A. Quicksilver	} CCXVI.
1. Native	CCXVII.
2. Mineralised	
A. With sulphur. <i>Cinnabar</i>	} CCXVIII.
1. Friable	
2. Indurated	
1. Granulated	
2. Radiated	
3. Scaled	
4. Crystallised	
B. With sulphur and gold	CCXVI.
C. — sulphur and copper	CCXIX.
B. Bismuth	CCXXI.
1. Native	CCXXII.
2. In form of calx	CCXXIII.
3. Mineralised	} CCXXIV.
A. With sulphur	
B. With sulphurated iron	CCXXV.
C. Zink or speltre	CCXXVII.
1. In form of calx	} CCXXVIII
A. Pure	
1. Indurated	
B. Mixed	
1. With a martial ochre	
2. — bole	
3. — lead and iron ochre	

		S E C T.
2. Mineralised		
A. With sulphurated iron	}	CCXXIX.
1. In a metallic form. <i>Zink ore</i>		
2. In form of calx. <i>Mock-lead</i>		
	or blende ——— ———	CCXXX.
D. Antimony	————— ——— ———	CCXXXII.
1. Native	————— ——— ———	CCXXXIII.
2. Mineralised		
A. With sulphur	}	CCXXXIV.
1. With coarse fibres		
2. With fine fibres		
3. Granulated		
4. Crystallised		
B. With sulphur and arsenic. <i>Red</i>		
<i>antimony ore</i>	————— ———	CCXXXV.
C. With sulphurated silver.	}	CCXXXVI.
<i>Plumose silver ore</i>		
D. ——— sulphurated silver, copper, and arsenic		
E. ——— sulphurated lead		
E. Arsenic	————— ——— ———	CCXXXVIII.
1. Native. The <i>Scherbencobolt</i>		
A. Solid and laminated	}	CCXXXIX.
B. Scaled		
C. Friable and porous		
2. In form of calx		
A. Pure	}	——— CCXL.
1. Loose		
2. Indurated		
B. Mixed with sulphur. <i>Orpiment</i>		
1. Hardened	}	CCXLI.
1. Yellow or native arsenic		
2. Red or sandarach		
C. Mixed with the calx of tin in tin grains	—————	CLXXXI.
D. With sulphur and silver in the red silver ore	—————	CLXX.
E. With the calx of lead in <i>lead</i> <i>spar</i>	————— ——— ———	CLXXXVI.
F. ——— the calx of cobalt, in the <i>efflorescence or flowers of</i> <i>cobalt</i>	—————	CCXLVIII.
		3. Mineralised

3.	Mineralised arsenic	}	CCXLIII.
A.	With sulphur and iron. The <i>Arsenical pyrites</i>		
	B. With iron. The <i>Misspickel</i> or <i>plate mundic</i>	}	CCXLIV.
	C. With cobalt, in most of the cobalt ores		
	D. With silver	}	CCXLIV.
	E. With copper ———		
	F. With antimony ———	}	CCXLVI.
F.	Cobalt ——— ——— ———		
1.	In form of calx		
A.	With iron without arsenic	}	CCXLVII.
1.	Loose or friable. <i>Cobalt ochre</i>		
	2. Indurated. <i>Schlacken</i> , or <i>slaglike cobalt</i>	}	CCXLVIII.
B.	With the calx of arsenic. <i>Cobalt blood</i>		
1.	Loose or friable. <i>Efflorescence of cobalt</i>	}	CCXLVIII.
2.	Indurated and cristallised. <i>Flowers of cobalt</i> , and <i>cobalt blood</i>		
2.	Mineralised		
A.	With arsenic and iron in a metallic form	}	CCXLIX.
1.	Granulated		
2.	Fine grained		
3.	Coarse grained		
	4. Cristallised	}	CCL.
B.	With sulphurated iron		
1.	Cristallised	}	CCLI.
C.	With sulphur, arsenic, and iron		
1.	Coarse grained	}	CCLII.
2.	Cristallised		
D.	With sulphurated and arsenicated iron and nickel ——— ———	}	CCLIV.
G.	Nickel ——— ——— ———		
1.	In form of calx. <i>Nickel ochre</i>	}	CCLV.
	2. Mineralised		

	S E C T.
2. Mineralised	
<i>A.</i> With sulphurated and arseni- cated iron and cobalt	} CCLVI.
1. Of a flaggy texture	
2. Fine grained	
3. Scaly	
<i>B.</i> With the acid of vitriol. <i>Vitriol</i> of nickel — — —	CCLVII.

A P P E N D I X. CCLIX.

I. SAXA PETRAE — — —	CCLX
<i>A.</i> Compound saxa } — — —	CCLXI.
1. Ophites	
2. Stellsten — — —	CCLXII.
3. Norrka — — —	CCLXIII.
4. Whetstone — — —	CCLXIV.
5. Telgsten — — —	CCLXV.
6. Porphyry — — —	CCLXVI.
7. Trapp — — —	CCLXVII.
8. Carpolithus, or fruit rocks — — —	CCLXVIII.
9. Gronsten — — —	CCLXIX.
10. Granite — — —	CCLXX.
<i>B.</i> Conglutinated Saxa	
1. Breccia } — — —	CCLXXI.
<i>A.</i> Calcareous breccia	
<i>B.</i> Jaspry breccia — — —	CCLXXII.
<i>C.</i> Flinty breccia. <i>Plum-pudding-</i> stone — — —	CCLXXIII.
<i>D.</i> Quartzose breccia — — —	CCLXXIV.
<i>E.</i> Saxeous breccia — — —	CCLXXV.
2. Sand-stones, or <i>free stone</i>	
<i>A.</i> Cemented with clay	} CCLXXVI.
<i>B.</i> — — — with lime	
<i>C.</i> — — — with an unknown cement	
<i>D.</i> — — — with rust or ochre of iron	
3. Sand ores } — — —	CCLXXVII.
<i>A.</i> Made up of larger fragments	
<i>B.</i> Of smaller fragments — — —	CCLXXVIII.
II. PETREFACTIONS — — —	CCLXXX.
<i>A.</i> Earthy	

S E C T.

<i>A.</i> Earthy changes			
1. Calcareous changes	}	CCLXXXI.	
<i>A.</i> Loose or friable			
<i>B.</i> Indurated			
2. Siliceous changes	}	CCLXXXII.	
<i>A.</i> Indurated			
3. Argillaceous changes	}	CCLXXXIII.	
<i>A.</i> Loose or friable			
<i>B.</i> Indurated			
<i>B.</i> Saline changes			
1. By the vitriol of iron	}	CCLXXXIV.	
<i>C.</i> Phlogistic changes	}	CCLXXXV.	
1. By coal			
2. By rock-oil	—	CCLXXXVI.	
3. By marcasite	—	CCLXXXVII.	
<i>D.</i> Metallic changes	}	CCLXXXVIII.	
1. By silver			
2. — copper			—
3. — iron	—	CCXCI.	
<i>E.</i> Extraneous bodies in a state of destruction	}	CCXCIII.	
1. Animal mould			
2. Vegetable mould			
III. NATURAL SLAGS	—	CCXCIV.	
<i>A.</i> The Iceland agate	—	CCXCV.	
<i>B.</i> The Rhenish millstone	—	CCXCVI.	
<i>C.</i> The pumice-stone	—	CCXCVII.	
<i>D.</i> Pearl slag	—	CCXCVIII.	
<i>E.</i> Slag sand and ashes	—	CCXCIX.	

Description and Use of a Mineralogical Pocket Laboratory. Page 273.

Alphabetical Table of different Minerals, with the Swedish and German Names. p. 319.

É R R A T A.

- Page 18, line 25, read, *Of pyramidal, &c.*
— 26, — 3, for *Druseæ*, read *Drusæ*.
— 27, *Antepenultimate line* for *Gypsea*, read *Gypsa*.
— 38, — 32, read *calcareous earth, &c.*
— 58, — 31, for *Seet. I.* read *Seet. L.*
— 67, — 12, for *Sardea*, read *Sarda*.
— 106, — 21, for *Smelling*, read *Smelting*.
— 224, — 4, read, *Of the others, &c.*
In Sig. T, for p. 173—188, read 273—288.



E S S A Y

TOWARDS A

S Y S T E M

OF THE

MINERAL KINGDOM.

SECTION I.

THE Mineral Kingdom contains all those bodies which have been formed under the surface of our earth, whether at the first creation, or any other time since that period; and which are still daily produced from their original or primary principles, being destitute of seed, life, or any circulation of fluids*.

* The limits between the three acknowledged kingdoms of Nature are almost impossible to be ascertained; whence arises the difficulty of giving any true definition of them: and indeed it may be questioned, whether any such definition can take place, when we become so far advanced in knowledge, as to see clearly the dependence and connexion of all natural bodies into one regular Chain or System.

However, at present, it is necessary that the several parts of Natural History should be treated of separately; and as the

These words, *circulation of fluids*, are to be considered as a consequence of what is before supposed, viz. that the mineral bodies are formed *under the surface of our earth*: and by this particular they are distinguished from the subjects of the vegetable kingdom; with which, however, they have some resemblance, some fossils being still produced nearly in the same manner, at least according to our imagination. The clefts, fissures, and countries *, in the rocks, and in the strata of the earth, may be looked upon as answering to the tubes in vegetables, and the water as the fluid common to them both. Fire, of whose nature we still know so little, and which we can hardly determine, whether it belongs to the earth any farther than it exists, and even must exist, within a solar system, may, perhaps, be an auxiliary equally necessary to all the three kingdoms of nature.

On the other hand, we know with a kind of certainty, that if the mineral kingdom is allowed to have existed before the other two, and to have furnished them with materials for their existence, it is at the same time deprived of those wonderful and incomprehensible qualities of life and vegetation, the properties of the animal and vegetable kingdoms.

The descriptions of minerals cannot be extended farther, in a Treatise of Mineralogy, than to

whole extent of this knowledge can hardly be expected from one man; it may perhaps be executed to more advantage by different persons: in the mean time, we must be content with definitions, if they give tolerable ideas of the substances described, though they should not perfectly coincide with the strict rules of logicians. This being premised, I shall endeavour in the Text to give some explanation of my own Essay.

* Countries, an English mine-term for the sides or inclosures of a vein or load of ore, e. g. the country of the load is lime-stone, killas, &c. &c. D. C.

the condition in which they are now found will permit; for, with regard to such bodies as are impossible to be analysed or totally decomposed, no account needs to be given of the principia or primary atoms, which have concurred to their formation; since it may with confidence be asserted, that the Creator made only one kind of matter, from which every thing we meet with in this world has been produced.

Minerals have been defined as bodies that grow by external aggregation of particles; but this definition, on reflection, will hardly be found sufficient and adequate; because the circles produced by the annual stagnation of the sap in the wood of a tree, and the coats or crusts of a stalactites, are effects nearly resembling one another. Should it be said that the particles on which the yearly growth of a tree depends, are not carried by the water, and merely deposited between the bark and the parts of the preceding year now become solid, but that they are juices secreted from the interior parts thro' the pores of the tree; I could likewise show instances in the mineral kingdom, that seem plainly to indicate some process has happened similar to the formation of the callus in a fractured bone; although this happens only at a certain age of the rock: and who knows whether this observation or process does not hold good also in the animal and vegetable kingdoms? But this still remains too great a problem in regard to the mineral kingdom; and we cannot therefore adopt the express meaning of the "circulation of any juices," since we have another refuge left, that is, *shrinking* or *contraction*, and *expression* or *squeezing*, of which more will be said hereafter. We take more notice perhaps of what happens in the animal and vegetable kingdoms, because we are ourselves

subject to the same alterations, and we likewise outlive the greatest part of them, therefore we treat them with more ease and conveniency; whereas the changes which the mineral kingdom undergoes, are hidden to us, and require many centuries to compleat them.

I cannot suppose the mineral bodies to be produced by feeds, for want of proof; and I do not know why the metals should have any preference in that respect. Native or virgin copper and silver are produced in the same manner as the stalactites. The water carries along with it the invisible particles of lime, copper, or silver, and deposits them upon other subjects, either by means of an attractive power in these, or by some alteration in itself, occasioned by its motion. The precipitated particles are, at the beginning, very easily separated; but in process of time they cohere very firmly, as is evidently seen in the native precipitated or Ziment-copper*, which, after it has been some time taken out of the water, is partly malleable. The figure which native gold and silver have in their rocks or beds, does not prove any more than do the metallic iron's or copper's accreting into a moss-like form in the poor or rich roasted ores or reguli at the furnaces; it gives us rather an idea, how those accidents happen, merely by the shrinking and the sudden cooling of their surfaces: and we can then also begin to conceive something of the reason why crystals are found in a pebble form, or in loose nodules, as the *petrified melons of Mount Carmel*, and the Italian iron ores, in form of balls, &c. without wanting to have recourse to the supposition of a

* Called Ziment-copper from its being first noticed in a vitriolic water called ziment, at Herregrund in Hungary.
D. C.

melting heat, if we only carefully observe those marks, which, besides, plainly shew their having once been soft, or dissolved.

That mineral bodies are still prepared in that large workshop of Nature, the *Earth*, in the same manner as those which are already full grown seem to indicate, is hardly to be positively asserted, since we yet want sufficient observations and experiments thereon.

I will, for instance, mention the whole Flinty Class, of which we have not one observation, how they are generated. For if any one pretends to have hit upon the quartz crystals* in the very instant of their shooting, it might be asked, Whether he only depended upon the figure, or if he made such experiments thereon as might convince us, that no calcareous earth, either pure or disguised, was also at the same time mixed therewith? To enumerate the many different ways of generation, which we have any reason to suspect, does not properly belong to this work; besides, it would carry me too far from my subject, and might also surpass my capacity to explain. I will, however, by mentioning the following opinions, try to spirit up persons of more experience and leisure, willing to pursue these enquiries.

Precipitation from or by water, is already mentioned, as well as a hint given about the formation of flints. This last does not suppose such a softness as that of clay when mollified with water, but a sliminess, a gelatinous, or a mucilaginous matter, and consequently a more radical solution,

* The author uses the term Quartz crystals for the true crystals; for all foreign authors call figured spars also crystals; and distinguish them by the name of spath or spar crystals. D. C.

if I may be allowed that expression; and this is again to be considered as a different method.

Another way, and which in our times is much favoured, is that of destruction *, partly by very violent means, such as subterranean fires, and partly by more mild ones, such as the weathering, wasting, or decomposing away; and by this way we have innumerable varieties, and new compositions. The vitriolic and muriatic acids do not lie dormant; and being once let loose by the said way of weathering or destruction, they do not stop till they are saturated with something. Where these acids cannot penetrate by themselves, they are forwarded by the water, which, according to the laws of nature, is almost in a constant motion: but the effects of these salts ought again carefully to be distinguished from those of the water alone, because this latter acts both as a menstruum, for instance, upon the calcareous earth; and at the same time by its *vis inertiae*, heaviness and motion, wears off or abrades some particles from solid bodies, carries them along, and deposits them in other places, where these particles often acquire a different position from what they had before. Are the *Bog-ores* produced of decayed mundics, although no vitriolic matter is found in the waters or tracts around them? or, Are they to be reckoned a sediment of martial earth dissolved in water alone? Would it be amiss to suppose, that a vegetable mould may of itself be changed into iron, since it is found to yield from a grain to about half of its weight of the said metal, as the experiments

* The original has, "Of destruction that acts privative," which I have omitted, as it is quite unintelligible to me.
D. C.

demonstrate made upon the turf-moors which are at the foot of the hills or high rocks in the provinces of Dalarne, Jemtland, and Herjeadalen, in Sweden? or, that certain vapours have predominated, and still shew their power within certain districts, where they attack, and fix themselves to such matters as are most agreeable to them; so that trees, which have been buried in the earth, in some of its subversions, have met with martial vapours in some parts of Bohemia; the flint-producing principle of Loughneagh in Ireland, and at Adrianople; with the inflammable substance in the strata of the coal-pits in England, and at Boserup in the province of Skone in Sweden? or, that shells must, without the destruction of their calcareous principles, be changed into a calcareous spar, as at the Balsberg in Skone; be filled with flint, as at Vernon in France, and in Siberia; or be penetrated with marcasite, as at Andrarum in Skone; or with a green copper ore, as at Jarlsberg in Norway? Silver seems to predominate at Kongsberg in Norway, as the copper does in the north part of that kingdom: and the same kind of stone in which gold abounds at one place of the world, may contain none at all at another place; and other such examples occur.

I now leave this important subject, that I may not discover my farther want of knowledge therein; but I take the liberty, at the same time, to give this advice to beginners, *viz.* not to conclude, that one mineral body is produced by another, only because they are situated near one another, if it cannot at the same time be demonstrated by the analysis, or by artificial mutation: nor to content himself with making his observations only on collections of minerals, or on heaps of

ores, but to prosecute them to the very workshop of Nature herself, where they may be made with more certainty, though in a narrow compass; I mean, in the very mines, quarries, and diggings, of the strata of the earth. For I myself have been astonished to hear that the flint is said to be produced by a calcareous substance, only because it is found in the strata of chalk in England, and in the limestone at Kinnekulle in the province of Westergottland in Sweden: and I am farther of opinion, that a stone, separated from its bed, and thrown loose on the surface of the earth, does not discover more marks of increase, than do bones dispersed in a churchyard.

S E C T. II.

The bodies belonging to the mineral kingdom are divided into four different classes: viz.

1. EARTH, or those substances which are not ductile, are mostly indissoluble in water or oil, and preserve their constitution in a strong heat*.
2. INFLAMMABLES, which can be dissolved in oils, but not in water, and are inflammable.
3. SALTS: these dissolve in water, and give it a taste; and when the quantity of water required to keep them in dissolution is evaporated, they concrete again into solid and angular bodies.
4. METALS are the heaviest of all bodies hitherto known; some of which are malleable,

* The Author, by Earths, does not mean (strictly speaking) only Earths, but includes all the kinds of stones or fossils not inflammable, saline, or metallic. D. C.

and some can be decomposed; nevertheless, in a melting heat they can again be recovered, or brought to their former state, by adding to them the phlogiston they lost during their decomposition*.

S E C T. III.

The FIRST CLASS.

EARTHS, *Terræ*, are those mineral bodies, not ductile, for the most part not dissoluble in water or oils, and that preserve their constitution in a strong heat.

S E C T. IV.

These earths (Sect. III.) are here arranged according to their constituent parts, as far as hitherto discovered, and are divided into nine orders.

* Here occurs the same difficulty in regard to the definitions, as was before (Sect. I.) observed, because these enumerated classes are likewise blended one with another; and therefore some exceptions must be allowed in every one of them: for instance, in the first class, the calcareous earth is in some measure dissoluble in water, and pipe clay with some others diminish somewhat in their bulk, when kept for a long time in a calcining heat. In the third class, the calx of arsenic has nearly the same properties as salts; and there is no possible definition of salt, that can exclude the arsenic, though, at the same time, it is impossible to arrange it elsewhere than among the semi-metals. In the fourth class it is to be observed, that the metals and semi-metals, perfect or imperfect, have not the same qualities common to them all; because some of them may be calcined, or deprived of their phlogiston, in the same degree of fire, in which others are not in the least changed, unless particular artifices or processes are made use of: some of them also may be made malleable, when others are by no means to be rendered so. That the
convex

The FIRST ORDER.

The Calcareous Kinds, *Terræ Calcareæ*. These, when pure, and free from heterogeneous matters, have the following qualities common to them all :

1. That they become friable, when burnt in the fire, and afterwards fall into a white powder.
2. That their falling into powder is promoted, if, after being burnt, they are thrown into water, whereby a strong heat arises, and a partial solution.
3. They cannot be melted by themselves, or *per se*, into glass in the strongest fire.
4. When burnt, they augment the causticity of the lixivium of potashes.
5. They are dissolved in acids with effervescence, in the following manner :
 - a. The acid of vitriol partly unites with them, and forms a precipitate, which is a gypseous earth, and partly shoots into selenitical crystals with that which is kept dissolved, after a due evaporation.

convex surface metals take after being melted, is a quality not particularly belonging to them, because every thing that is perfectly fluid in the fire, and has no attraction to the vessel in which it is kept, or to any added matter, takes the same figure ; as we find the borax, *sal fusibile microcosmicum*, and others do, when melted upon a piece of charcoal : therefore, with regard to all that has been said, it is hardly worth while to invent such definitions as shall include several species at once ; we ought rather to be content with perfectly knowing them separately : however, as this is to be an Essay towards forming a System, I have endeavoured, in most parts, to follow the usual rules.

b. With

- b.* With the acid of common falt they make a *sal ammoniacum fixum*, which also partly precipitates itself.
- c.* The acid of nitre dissolves them perfectly, and does not part with them again, unless some alkaline falt is added.
6. They melt easily with borax into a glass, which suffers impressions in a degree of heat below ignition.
7. They likewise fuse into a glass with *sal fusibile microcosmicum* with an effervescence*.
8. They melt the readiest of all kinds of stones, with the calces, into a corrosive glass or slag.
9. They have also some power of reducing certain metallic earths or calces; for instance, those of lead and of bismuth, and likewise, though in a less degree, those of copper and of iron: thus
10. Do they, in this last mentioned article (9.), as well as in other circumstances, resemble a fixed alkaline falt; from whence also this whole kind is very often, and properly, called alkaline earths.
11. This whole order of earths is common to all the three kingdoms of nature; because it is found in the bones and shells of animals, as well as in the ashes of burnt vegetables; it must, consequently, have existed before any living or vegetable substance; and is, no doubt, proportionable to its universal use, distributed throughout the whole globe.

* It is to be understood, that this effervescence is also made with the borax, as well as with this *sal fusibile microcosmicum*; and it is also to be observed, that the glasses made with these salts are quite colourless and transparent.

SECT. V.

The Calcareous Earth is found,

I. Pure,

1. In form of powder. *Agaricus Mineralis*,
or *Lac Lunæ*.

a. White, is found in moors and at the bottom of lakes, at Reden in the province of Jemtland, at Timmerdala in Westergottland, and also in the provinces of Smoland, Oftergotland, and island of Gottland in Sweden*.

b. Red, is also found in Gottland.

c. Yellow, is found at Timmerdala, in Westergottland †.

* The white mineral agaric, so called from its fineness and lightness, like to the vegetable agaric, is found in such places, i. e. swamp moors or peats in England and Scotland, as likewise in the fissures of the freestone quarries of Oxfordshire, Northamptonshire, &c. but the red and yellow sorts I never heard of in England. See Hist. Foss. nost. p. 82. N^o. vii. D. C.

† This kind of earth seems to be an impalpable powder of mouldered limestones abraded and collected by the waters, and is therefore common in the neighbourhoods where limestones are found; and if the stone is at some distance, which is sometimes the case, still nothing contradictory appears in this opinion of the origin of this species; since in that case it has only been carried farther by the greater rapidity of a stronger current of water. When this earth is found in the clefts of rocks, it receives more pompous names; such as *Gur*, *Lac Lunæ*, &c. &c. It burns readily into lime, if it is previously stamped, that it may better cohere: it is then, or in its native state, used for white-washing, but easily rubs off by the least touch. At certain places in the province of Smoland in Sweden, there is found in the moors a white earth, which, by its external appearance, resembles the species here described; but it does not shew any marks of effervescence with acids, nor does it burn into lime. It were to be wished, that those who have an opportunity of getting any quantity of this latter earth, would undertake to examine it better.

SECT.

S E C T. VI.

II. Friable and Compact, *solida friabilis**.
Chalk, *Creta*.

a. White, *Creta alba*, is found in England, France, and in the province of Skone in Sweden, in which last place it is only found adherent to flint. In the two first kingdoms there are large strata of this substance, in which flint is imbedded. This seems to indicate, that the loose flints, or those dispersed on the surface of the earth, have been by some causes carried from their native beds; but, as yet, no one can prove, that chalk and flint are of the same constituent parts.

Chalk is, however, a vague name, also applied to other earths; whence we hear of chalks of various colours: but I do not know of any which are of a calcareous nature, except this only kind here described, and of which there are no other varieties, otherwise than in regard to the looseness of the texture, or the fineness of the particles.

S E C T. VII.

III. Indurated, or Hard, *Terra calcarea indurata*. Limestone, *Lapis calcareus*.

A. Solid, of no visible particles, or not granulated, *particulis impalpabilibus*.

This kind varies in regard to hardness and colour, for instance,

a. White, from Hull in England.

* *Solida friabilis* seems contradictory and inexplicable; however, I shall strictly adhere to the Author's definitions, though never so faulty, as I only translate the work. D. C.

b. Whitish

- b.* Whitish Yellow, is dug at Balsberg in Skone in Sweden, and in the Venetian territories.
- c.* Flesh-coloured, found in loose masses in the corn-fields in the province of Upland in Sweden.
- d.* Reddish-brown, found in the island of Oeland, the province of Jemtland, at Rettwick in the province of Dalarne, and at Kimnekulle in the province of Westergottland in Sweden.
- e.* Grey, at the same places.
- f.* Variegated with many colours, found in Italy, at Blankenburg, and many other places, and is particularly called Marble*.

* Though it may displease many, yet I must own, I cannot find any characters whereby a marble is to be distinguished from a limestone; and I insist upon it, that nothing but the colours and the texture of the particles distinguish the kinds of limestone. But as Nature has established no rank by colours, and has made every solid limestone equally capable of a polish, before they are spoiled by decaying or decomposing; it is, therefore, out of this species of solid limestone, that such as strike the fancy most, ought to be chosen for ornaments, under the name of Marble.

It belongs to the subterranean geographers to examine, if this solid limestone is ever found otherwise than in strata, and without being mixed with any heterogeneous bodies, that likewise have been changed into a calcareous substance. Here, in the northern parts of the world, it is only found in such a manner as shews it was formed in strata, by water's taking up and carrying its particles, and afterwards depositing them in form of a sediment, just as a slime or mud (which is the finest particles of pounded rocks) gathers together at the stamping mills; and as they are thus formed in the water, there always are heterogeneous parts along with them. These heterogeneous substances are, however, in too small a quantity, to be capable of having changed the whole mass into a calcareous substance (as some pretend); not to mention those circumstances, which, in other respects, make such an opinion very improbable.

g. Black,

- g. Black, in the province of Jemtland in Sweden, and in Flanders. See Sect. xxiii. infra.

S E C T. VIII.

B. Grained or granulated limestone, *Lapis calcareus particulis granulatis.*

1. Coarse grained and of a loose texture. This is called *Salt-flag* in Swedish, from its resemblance to lumps of salt; and is found in the silver mines at Salberg, in the province of Westmanland in Sweden.

a. Reddish yellow.

b. White. Both these varieties are found in the Salberg mines.

The grained flux spar is also sometimes called *Salt-flag*.

2. Fine grained.

a. White, found at Salberg.

b. Semi-transparent, from Solfatam in Italy, in which native brimstone is found.

3. Very fine grained. This is the common limestone at Salberg.

a. White and green, from the mine at Salberg, called *Storgrufsan*.

b. White and black, from the mine at Salberg, called *Herr Stans Bottn* *.

S E C T. IX.

C. Scaly limestone, *Lapis calcareus particulis squamosis sive spatosis.*

* This species has often as beautiful colours as those commonly called marbles; but the texture and coherency of its particles will not admit of a good polish.

1. With coarse or large scales.

- a.* White, found at Garpenberg, a copper mine in the province of Dalarne in Sweden.

It is likewise found at Tunaberg, a copper mine in the province of Sodermanland; but with these different qualities, that it loses in a calcining heat forty per cent. of its weight; and, exposed to the air, gets a brownish efflorescence, a sign that it contains some iron, and is a medium between a limestone and the white iron ore called *Stablsteine*; nor does it excite any effervescence with acids in its crude state.

- b.* Reddish yellow, from Finland.

2. With small scales.

- a.* White, from the parish of Tuna in Dalarne, in the marble quarries at Kolmorden in the province of Ostergotland, the parish of Lillkyrke in the province of Nerike, and at Rimito and Pargas in Finland.

3. Fine glittering or sparkling.

- a.* White, from Carrara in Italy, and Pargas in Finland.
- b.* Of many colours. This variety makes out a great number of the foreign marbles*.

* This species of limestone takes a good polish, and is therefore used as marble whenever it is found of a fine colour.

It is besides to be remarked, that the grained and scaly limestones (Sect. viii. and ix.) are found either in veins, or form whole mountains, that shew no strata, nor signs of petrifications.

SECT. X.

D. Lime or calcareous spars, *Spatum calcareum*.

1. Of a rhomboidal figure.

a. Transparent or diaphanous.

1. Refracting spar, *Spatum islandicum*.

This represents the objects, seen thro' it, double. It is found at Brattfors, an iron mine in the province of Wermeland, and also in Switzerland and Iceland*.

2. Common spar, which shews the object single.

1. White, or colourless.

2. Yellowish and phosphorescent, is found at Jonufwando in Torneo Lappmark in the Swedish Lapland.

b. Opaque, *Spatum romboidale opacum*.

1. White, is found in many places, mostly in clefts, and among crystallisations.

2. Black, from Winorn at Kongsberg in Norway.

3. Brownish yellow, at Salberg.

2. Foliated or plated spar, *Lamellosum*.

This has no rhomboidal figure, but breaks into thin plates so placed as to be not unlike sheets of thin paper, laid over each other.

a. Opaque white, *Spatum lamellosum opacum*, from Winorn at Kongsberg, and Scaragrufvan at Egeren in Norway.

* There are vast quantities of refracting spar (a variety of the Islandic) found in the lead mines of Derbyshire, Wales, and many other parts of England. D. C.

S E C T. XI.

E. Crystallised calcareous spars, *Lapis calcareus crystallisatus*. Spar Drusen*.

It is composed of the last mentioned spar (Sect.x.), that has formed itself exteriorly into several planes or sides, wherefrom many different figures arise, the varieties of which have not yet been fully observed, nor can they be exactly described. The following are therefore mentioned, only as instances of the most regular and common kinds, viz.

1. Transparent, *Spatum drusicum diaphanum*.

a. Hexagonal truncated, *Crystalli spatosi hexagoni truncati*. This is found at the Hartz in Germany, and at Jonuswando in Lapland.

b. Pyramidal, *Pyramidales*.

1. Dog's-teeth, *Pyramidales distincti*. Found at Salberg, and in the iron mines at Dannemera in the province of Upland.

2. Balls of crystallised spar, *Pyramidales concreti* †.

These are balls which have Drusen, pyramidal, octaedral, spars accreted in their hollows or centers: they are found at Rettwin in the province of Dalarne, and other places ‡.

* In my Lectures on Fossils I have adopted this German term of Drusen into our English language, for a cluster of regular figured bodies, as a Groupe conveys the idea of a clutter only, whether regular or of indeterminate figures. D. C.

† The concave figured spar balls in the quarries of Somersetshire, and other counties in England. Such balls of free-stone are not unfrequently found. D. C.

The name Spar is very well known, and only used to determine a certain figure, viz. when a stone breaks into a
rhomboidal

SECT. XII.

F. Stalactitical Spar, *Stalactites Calcareus*. Stalactites, Stone Icicle, or Drop-stone.

rhomboidal, cubical, or a plated form, with smooth and polished surfaces, it is called spar; and as it is thus applied to stones of different kinds, without any regard to their principles, one ought necessarily to add some term to express the constituent parts at the same time as the figure is mentioned; for instance, Calcareous Spar, Gypseous Spar, Flux Spar, Short or Cockle Spar, &c. This term, however, is not applied but only to earths, and such ores as are of the same figure as the Lead Spar, &c.

All crystallised spars, when broken, shew the sparry figure in their particles, and the crystallisation is to be ascribed to the empty space left by the contraction of the sparry principle: such holes filled with Drusen of spars, are in Swedish called *Drake*, or *Druse-hol* †.

The figure of the crystals varies more in this genus than in any other, for which no reason can be assigned; it ought not to be ascribed to salts, as long as the presence of any such cannot be proved: but there are strong indications to suspect, that other substances may likewise have received the same property to assume an angular surface on certain occasions. See Mr. Cronstedt's Introductory Speech at the Royal Academy of Sciences at Stockholm.

Besides, the consideration of those figures is a thing of more curiosity than of real use, because no miner has yet been able to make any conclusion relative to the quantity or quality of the ores, from the difference of the figures of spars found along with them; and the grotto makers never take any notice of the angles or sides, but think it sufficient for their purpose, if they make a fine or glittering appearance at a distance.

It would, nevertheless, be well if any one would take upon himself the trouble to observe, whether each species of spar has not a certain determinate number of figures or sides, within which it is confined, in its accretions. This has hitherto been impossible to do, because all species of spars have been confounded together, without regard to their different principles: though, for my part, I do not think it of any great consequence.

† What the author says in the above note is of little consequence to the English student, as the name of spar is never used with such latitude in our language. All spars of this flakey texture were by our former writers, as Grew and Woodward, called Talc Spar; but that term now is justly exploded. See my Lectures, D. C.

This is formed from water saturated with lime, which, while running or dropping, deposits by degrees the calcareous earth which it has carried along with it from clefts of rocks, or from out of the earth. It is therefore commonly of a scaly, though sometimes of a solid and sparry texture. Its external figure depends on the place where it is formed, or the quantity of the matter contained in the water, and other like circumstances.

- I. Scaled Stalactites of very fine particles, *Stalactites testaceus particulis impalpabilibus*.
 - a. Of a globular form, *S. testaceus globulosus*.
 1. White, the pea-stone from Carlsbad, in Bohemia.
 2. Grey, *Pisolithus*, *Oolithus*, from Gottland in Sweden*.
 - b. Hollow, in the form of a cone, *Coniformis perforatus*.
 1. White, is found every where in vaults made with mortar, and through which water has had an opportunity to penetrate; and also in grottos dug in rocks of limestone.
 - c. Of an indetermined figure, *Figura incerta. Sinter*.
 From the cavern called the Baumans-hole in the Hartz, the aqueduct at Adrianople, in Italy, and elsewhere.
 - d. Of coherent hollow cones, *Conis concretis excavatis*.

* Also the Hammites, from its resemblance to the roes or spawn of fish. It has been exhibited by Authors as petrified roes. The Ketton free-stone, of Rutlandshire, is a remarkable stone of this sort. D. C.

Of this kind is a stalactitical crust, which has formed a stratum, or rather filled a fissure between the strata of the earth at Helsingborg in the province of Skone; it is of a very singular figure, resembling conical caps of paper placed and fixed one in the other, diminishing by degrees both in height and the other dimensions.

2. Solid Stalactites of a sparry texture, *Stalactites solidus particulis spatosis*.

a. Hollow, and in form of a cone, *Coniformis*.

1. White, and semitransparent, from Chaceline near Rouen in France*.

* In making lime-water (*aqua calcis viva*) one may observe how the lime gathers, first like a pellicle on the surface of the water, and afterwards, when this breaks, falls down to the bottom in form of a scaly sediment, which is called *cremor calcis*: after that, a new pellicle is formed, which likewise falls down; and in this manner it continues for a long while, although the lime-water had before been passed thro' a filtre. This we may also imagine to be the way in which the works of Nature are performed: whence the stalactites commonly is of a scaly texture, or at least discovers some tendency towards it. But a stalactites of a sparry texture, such as above-mentioned from Rouen, may be supposed to be owing to a more copious principle concurring at once: and in the same manner the sparry limestone and its crystallisations seem likewise to have been produced, since they, as far as I know, are only found in clefts, which, when they have been filled up with a stony matter, the Swedish miners call *Klyfter*, and *Gangar* or *Veins*. In regard to this, the stalactites, the sparry limestone, and also its crystallisations, might all be ranked under the same title in a systematical description, as very little different from one another, if it was not necessary in describing mines, and other works, to give them their separate names: because it is certain, that a piece which is broken from large spar-crystals, or from sparry stalactites, may in a cabinet pass extremely well for a common sparry limestone, without leaving any suspicion of its former figure, before it was broke.

B. Satiated or united with the Acid of Vitriol, *Terra calcarea acido vitrioli saturata*. Gypsum. Plaster-stone or Parget,

This is

1. Looser and more friable than a pure calcareous earth.
2. Either crude or burnt, it does not excite any effervescence with acids, or at most it effervesces but in a very slight degree, and then only in proportion as it wants some of the vitriolic acid to compleat the saturation.
3. It readily falls into a powder in the fire.
4. If burnt, without being red-hot, its powder readily concretes with water into a mass, which soon hardens ; and then
5. No heat is perceived in the operation.
6. It is nearly as difficult to be melted by itself as the limestone *, and shews mostly the same effects, with other bodies, as the limestone : the acid of vitriol seems, however, to promote its vitrification.
7. When melted in the fire with borax, it puffs and bubbles very much, and for a long while, during the fusion, owing to the nature of both the salts †.

* I have found most of the gypseous kind, and particularly the fibrous, to melt pretty easily by themselves in the fire.

† When a small quantity of any gypsum is melted together with borax, the glass becomes colourless and transparent ; but I have found some sorts of alabaster and sparry gypsum that, when melted in some quantity with borax, yield a fine yellow transparent colour, resembling that of the best topazes. This phenomenon might probably happen with every one of the gypseous kind. But it is to be observed, that if too much of such gypsum is used in proportion to the borax,

8. Burnt with a phlogiston, it smells of sulphur, and may as well by that means, as by both the alkaline salts, be decomposed; but for this purpose there ought to be five or six times as much weight of salt as of gypsum.
9. Being thus decomposed, the calx or earth which is left, shews commonly some marks of iron.

S E C T. XIV.

The Gypseous earth is found

1. Loose and Friable, *Terra Gypsea pulverulenta*. Gypseous Earth, properly so called, *Gubr.*
 - a. White, is found in Saxony.

S E C T. XV.

2. Indurated, *Terra Gypsea indurata*.
 - A. Solid, or of no visible particles, *Solida particulis impalpabilibus*. Alabaster, *Alabastrum*.

This stone is very easy to saw and cut, and takes a dull polish. It is not always found satiated with the acid of vitriol.

 - a. White, alabaster.
 1. Clear and transparent, from Persia.
 2. Opaque, from Italy, and Trapano in Sicily.
 - b. Yellow.

borax, the glass becomes opaque, just as it happens with the pure limestone. See the following Treatise on the Pocket Laboratory, Sect. xxviii.

1. Transparent, from the Eastern countries.
2. Opaque.

S E C T. XVI.

B. Gypsum of a scaled or granulated structure, *Gypsum particulis micaceis*. This is the common Plaster-stone.

1. With coarse scales.
 - a.* White, is found in the copper-mines of Ardal in Norway, where this stone is the country for the copper-ores.
2. With small scales.
 - a.* Yellowish, from Montmartre near Paris.
 - b.* Greyish, from Speremberg in the Mark in Germany.

S E C T. XVII.

C. Fibrous Gypsum, or Plaster-stone, improperly (though commonly) called English Talc by our druggists, *Gypsum fibrosum*, *Alabastrites*.

1. With the fibres coarse.
 - a.* White, from Livonia,
2. With fine fibres.
 - a.* White, is found in very thin strata in the alum rock at Andrarum in the province of Skone,

S E C T. XVIII.

D. Spar like Gypsum, *Gypsum spatiosum*. Selenites. This by some is also called *Glacies Mariæ*, and is confounded with the clear and transparent Mica, *Mica alba pellucida* (Sect. xciv.),

1. Pure

1. Pure Selenites.

A. Transparent, *Spatum Gypseum diaphanum*.

a. Colourless, from Swisserland.

b. Yellowish, from Mont-martre near Paris.

2. Spar like Gypsum, *Marmor metallicum*.

This stone, on account of its heaviness, which comes near to that of tin or iron, is suspected to contain something metallic; but, as far as is hitherto known, no one has yet been able to extract any metal from it, unless some traces of iron, which is no more than what all other gypsum contain.

A. Semitransparent, *Spatum Bononiense*, the Bononian stone or phosphorus. Its specific gravity is 4,500 : 1000.

B. Opaque.

a. White,

b. Reddish, are found in Wildeman, at Hartz, and in other German mines.

3. Liverstone, so called by the Swedes and Germans *. See Sect. xxiv.

* Mr. Margraff has published some curious experiments in the Memoirs of the Academy at Berlin, about the quality these spars have to yield a phosphorus; and has shewn, that every gypseous earth is fit for it, provided metallic particles are not predominant in it: now, as the Bononian spar, which is ponderous, is of this species, and is the most fit to be brought to a phosphorus, it is evident, that no metallic mixture is the cause of its weight. Mr. Scheffer, in the Memoirs of the Academy at Stockholm, for the year 1753, has communicated some experiments upon a stone of this kind from China, which prove that it perfectly agrees with the descriptions given in several books, of a stone called *Petuntse* by the Chinese, and which, it is said, is used in their China manufactories. The phosphorus of Baldwin illustrates Mr. Margraff's experiments. The phosphorescent quality of these stones is, however, different from that of the sparry limestones

S E C T. XIX.

E. Crystallised Gypsum, *Gypsum crystallisatum*,
Gypseous Drusen, *Drusæ Gypseæ*.

1. Drusen of crystals of pure sparry gypsum,

A. Wedge-formed, *Cuneiformes*, are composed of a pure spar-like gypsum. See Sect. xviii. 1.

1. Clear and colourless, from Switzerland,

2. Whitish yellow, from Montmartre.

B. Capillary, *Capillares*.

a. Opaque, whitish yellow, from Stollberget in Kopparberg Slan in Sweden.

C. Of ponderous spar-like Gypsum, *Marmor metallicum Drusicum*.

1. Jagged or like cock's combs, *Cristati*. These resemble cock's combs, and are found in clefts or fissures accreted on the surfaces of balls of the same substance.

2. White, from Hartz and Kongberg in Norway.

3. Reddish, from Wildeman mine in the Hartz.

S E C T. XX.

F. Stalactitical Gypsum, *Stalactites Gypseus*.
Gips Sinter.

This, perhaps, may be found of as many different figures as the calcareous stalactites or sinters. See Sect. xii. *c*.

I have only seen the following, viz.

Limestones and fluors, which is only produced by their being slowly heated, and seems to arise from a phlogiston, which is destroyed in a glowing heat.

1. Of

1. Of no visible particles, *particulis impalpabilibus*, in French *Grignard*.
 - A. Of an irregular figure.
 - a. Yellow, from the plaster-pits at Montmartre near Paris.
 - b. White, from Italy.

This is used in several works, as alabaster, especially when it is found in large pieces; and then it commonly varies in colour between white and yellow, as also in transparency and opacity.
2. Of a spar-like texture, *Textura spatosa*.
 - A. In form of a cone.
 - a. White and yellow, from Trapano in Sicily.
 - B. Of an irregular figure.
 - a. White, from Stollberget in Kopparberg Slan in Sweden*.

S E C T. XXI.

C. Calcareous Earth satiated with the acid of common salt, *Terra calcarea acido salis com-*

* What has been before observed (Sect. xi. xii.) about accreted spars and sinter, may also be applied to this species †.

† Gypseous fossils abound in England. Plaster stone, granulated and solid, some so very fine as to be alabaster, that is, take a surface and politure, are plenty in Derbyshire and Nottinghamshire, where are large pits of it, and also in most of the cliffs of the Severn, especially at the Old Passage in Somersetshire. A very fine semipellucid solid alabaster is found in Derbyshire. Fibrous talcs, very fine, are found in the same pits of plaster stone above mentioned, and many other places. Selenites of many kinds abound in England in clays, insomuch that it is needless to enumerate the places. Very fine gypseous Drusen are found in Sheppy-isle, and the most beautiful I have ever seen, perfectly pellucid as cristal and large, has been dug from the salt-rocks at Nantwich in Cheshire. The Selenites Rhomboidalis, a rare fossil in other countries, is frequently found in England; but Shotover-hill in Oxfordshire, is famous for them. I do not know of many of the spar-like gypsea of English product, but the Isle of Sheppy affords a kind (to my knowledge peculiar

munis saturata. Sal Ammoniacum fixum naturale.

This is found,

1. In sea water.
2. In salt pits.

It is formed in great quantities at the bottom of the salt-pans of the salt works. It attracts the moisture of the air*.

S E C T. XXII.

D. Calcareous Earth united with the inflammable substance, *Terra calcarea phlogisto mixta, seu impregnata.*

These have a very offensive smell, at least when they are rubbed, and receive their colour from the phlogiston, being dark or black in proportion as it predominates.

S E C T. XXIII.

1. Calcareous Earth mixed with phlogiston alone, *Terra calcarea phlogisto simplici mixta. Lapis suillus, Foetid stone and spar, or swine stone and spar.* Perhaps the smell

* Perhaps some kinds of limestones may exist that contain more or less of the acid of common salt, though they are not yet discovered. It is almost incredible what quantity of such dissolved calcareous earth is contained in sea-water; and from which the testaceous animals or shells get the materials for their shells or coverings. Perhaps Nature has a particular and secret method of producing a mineral alkali out of the calcareous earth, and has thus laid this earth, as well as the acid of common salt, together in the water, in order to combine them by degrees, and produce the common salt.

cular and particular to that small spot of ground, and not found any where else in the world) fibrous, and always accreting in radiations like a star on the Septaria, thence called *Stella Septarii*. D. C.

of

of this stone may not be so disagreeable to every one : it goes soon off in the fire. Its varieties, in regard to the texture, are as follow :

- A. Solid, or of no visible or distinct particles, *Solidus particulis impalpabilibus*.
 - a. Black : the marble dug in Flanders, and in the province of Jemtland in Sweden.
- B. Grained, *Particulis granulatis*.
 - a. Blackish brown, from Wretstorp at Skoers in the province of Nerike.
- C. Scaly, *Particulis micaceis*.
 - 1. With coarse scales.
 - a. Black, at Nas in Jemtland.
 - 2. With fine glittering or sparkling scales.
 - a. Brown, from Kinnekulle in the province of Westergottland, and Rettwick in the province of Dalarne.
- D. Sparry.
 - a. Black,
 - b. Light brown,
 - c. Whitish yellow, found in the slate rocks in the province of Westergottland.
- E. Crystallised.
 - 1. In a globular form, dug up at Krasnasele in Ingermanland*.

S E C T. XXIV.

- 1. Calcareous Earth united with phlogiston and the vitriolic acid, *Terra calcarea phlogisto*

* Many of the limestones of England are of this section, being extremely foetid when violently struck. In regard to the foetid spars, I have had them from the lead mines of Flintshire in Wales. D. C.

et acido vitrioli mixta. Leberstein of the Germans and Swedes. *Lapis hepaticus*.

This stone sometimes readily, at other times only when rubbed, smells like the *hepar sulphuris*, or gun-powder. It excites no effervescence with acids, and is a medium between the *gypsum* and the foetid stones of the last section, to which it has, however, generally been classed, although no lime can be made from it; whereas they are the fittest of all the different limestones to be burnt into lime. It is found

A. Scaly.

1. With coarse scales.

a. Whitish yellow, from Stollen at the mine called Gotteshulffe in der Noth at Kongberg in Norway.

2. With fine glittering or sparkling scales.

a. Black, is found in form of kernels or balls in the alum-slate at Andrarum in the province of Skone*.

* The method that Nature takes in combining those matters which compose the liver-stone, may, perhaps, be the same, as when a lime-stone is laid in a heap of mundic, while it is roasting: because there the sulphur unites itself with the lime-stone, whereby the limestone acquires that smell common to liver of sulphur, instead of which the vitriolic acid alone enters into the formation of gypsum. How the sulphur combines itself may likewise be observed in the slate-balls or kernels from Andrarum alum mines, where it sometimes combines itself with a martial earth, of which this slate abounds, and forms therewith pyrites within the very slate-balls. I have called this species the Liver-stone, notwithstanding that name, by reason of its colour, has before perhaps been given to some other kind; but as (in my opinion) the colour is a circumstance of very little or no importance in mineralogy, so as not to deserve to be taken notice of, in preference to other characters of more consequence, I hope my boldness herein will be excused. The foetid or swine-stones, and the liver-stone, are, in regard to the structure
of

S E C T. XXV.

E. Calcareous Earths blended with an argillaceous earth, *Terra calcarea argilla intimè mixta*. Marle, *Marga*.

1. When crude, it makes an effervescence with acids, but
2. Not after having been burnt; by which operation it is observed to harden, in proportion as the clay exceeds the calcareous substance.
3. It easily melts by itself into a glass, and even when it is mixed with the most refractory clay.
4. It is of great use in promoting the growth of vegetables, since the clay tempers the drying quality of the calcareous earth.
5. When burnt in a calcining heat, it readily attracts water: and, exposed to the air, in time, it falls into a powder.

The varieties of this kind, worthy to be taken notice of, depend on the different quantities of each of their component parts, and on the quality of the clay. I shall, for instance, specify the following examples.

S E C T. XXVI.

1. Loose and compact, *Marga friabilis*.

This dissolves in water like common clay.

of their parts, subject to the same varieties as the other species of lime-stone: and it is to be observed, that a volatile alkali is commonly supposed to have entered into the composition of the fœtid stones, though it has never yet been discovered by any experiment.

a. Reddish

- a.* Reddish brown; dug up in the island of Gottland in Sweden.
- b.* Pale red; dug up at Upsal in Sweden. This, when burnt, is of a yellowish colour, and used for making the earthen-ware in the potteries at Rorsstrand near Stockholm.

S E C T. XXVII.

2. Semi-indurated, *Marga indurata aëre fatescens*.

It is nearly as hard as a stone when first dug up, but moulders in the open air. It is mostly flatty, and is not uncommon in the slate rocks of Sweden, where it lies between the thick beds of flatty limestone, and is also found by itself, forming very thick strata. It does not dissolve in water, till, by a considerable length of time, it has mouldered to a powder.

a. Grey.

b. Red.

These are found at Styggforsen, in the parish of Rettwick, in the province of Dalarne.

S E C T. XXVIII.

3. Indurated or stone marle, *Marga indurata*.

A. In loose pieces, *Marga indurata amorphæ*; by the Germans called *Duckstein*, or *Tophstein*.

a. White, from Woxna in Carelen, and in the river at Nykioping in the province of Sodermanland.

b. Grey, found in the provinces of Angermanland and Skone.

It

It is formed from a sediment which the water carries along with it.

B. In continued strata, *Marga indurata stratis continuis*. Hard stony marble.

SECT, XXIX.

F. Calcareous Earth united with a metallic calx, *Terra calcarea metallis intimè mixta*.

Here, as well as in the others, such a mixture or combination is to be understood, as cannot be discovered by the eye alone, without the help of some other means.

The subjects belonging to this division lose the property of raising an effervescence with acids, when they are rich in metal, or contain any vitriolic acid. However, there have been found some that contained twenty or thirty per cent. of metal, and yet have shewn their calcareous nature by the nitrous acid.

There are no more than three metals hitherto known to be united in this manner with the calcareous earth, viz.

SECT. XXX.

1. Calcareous Earth united with Iron, *Terra calcarea marte intimè mixta*. White spar-like Iron Ore, *Minera ferri alba*. The *Stahlstein* or *Weises Eisenerz* of the Germans.

1. This ore, however, is not always white, but commonly gives a white powder when rubbed.

2. It becomes black in the open air, as likewise in a calcining heat.

D

3. In

3. In this last circumstance it loses thirty or forty per cent. of its weight, which by distillation has been found owing to the water that evaporates; and it is possible that some small quantity of vitriolic acid may, at the same time, evaporate with the water.
4. It is of all the iron ores the most easy to melt, and is very corrosive when melted.
This kind is found,

S E C T. XXXI.

A. Loofe, *Minera ferri alba pulverulenta*, and is the mouldered part of the indurated sort.

a. Black.

Is like foot. It is found at Wester-silverberget in Kopparberg Slan in Sweden among the earth that covers the white iron ore.

b. Dark brown.

This somewhat resembles umbre, and is found to this day at Solskienberget in Norberg in the province of Westmanland.

S E C T. XXXII.

B. Indurated, *Indurata*.

i. Solid, of no distinct particles, *Solida particulis impalpabilibus*.

a. Red, *Minera ferri calcarea rubra*.

Looks like red ochre, or the red hæmatites, but dissolves in the acid of nitre with a great effervescence. It is found at Hellefors in the province of West-

Westmanland, and at Grasberg in Grangeriede in the province of Dalarne.

S E C T. XXXIII.

2. Scaly, *Particulis micaceis*.

- a. White, from Naffau Siegen, and Wester-silverberget in the province of Westmanland.
- b. Blackish grey, in Smalkalden, and the Old-mines at Helleforffen in Westmanland*.

3. Spar-like, *Spatosa*.

- a. Light brown, from Naffau Siegen, and Smalkalden.

4. Drufen, *Drusica*.

- a. Blackish brown, from Smalkalden.
- b. White.

- 1. Porous. This is often called *Eisenblute*, or *flos ferri*. It is found at Wester-silverberget.
- 2. Cellular, from Wester-silverberget †.

S E C T. XXXIV.

2. Calcareous Earth united with Copper, *Terra calcarea croco seu calce Veneris intrinsecè mixta*.

* In England in the Forest of Dean, where it is called Grey Ore, and at Bigrig Moor in Cumberland.

† These kinds, in regard to their texture, are so like those calcareous stones we call Limestones (Sect. ix.) and Spars (Sect. x. xi.), that they may be easily confounded with one another, were not the other characters observed at the same time.

A. Loose and friable, *Pulverulenta sive friabilis*. Mountain blue, *Cæruleum montanum*. Germanicè, *Bergblau*.

This dissolves in aquafortis with effervescence.

SECT. XXXV.

B. Indurated, *indurata*.

1. Pure calcareous earth mixed with calx of copper. Armenian stone, *Lapis Armenus*.

Such, according to the description of authors, ought the nature of the stone called *Lapis Armenus* to be, though the druggists substitute in its stead a pale blue *Lapis Lazuli*, free from *Marcasite*.

SECT. XXXVI.

2. Gypseous Earth united with calx of Copper, *Terra gypsea Venere mixta*. Is of a green colour, and might perhaps be called *Turquoise ore*, or *Malachites*; though I do not know if all sorts of *Turquoise ore* are of this nature.

a. Semi-transparent, is found at Ardal in Norway*.

* By chemistry we know, that alkaline salts produce a blue colour with copper, which is changed into green, as soon as any acid is added; and from thence the reason is obvious, why a green colour may be found among calcareous copper ores, viz. when the vitriolic acid is in the neighbourhood of it.

S E C T. XXXVII.

3. Calcareous Earth united with the Calx of Lead, *Terra calcarea cerussa nativa intimè mixta.*

This is a lead ochre, or a spar-like lead ore, which, in its formation, has been mixed with a calcareous earth, and for that reason effervesces with acids.

A. Loose and friable, *Friabilis.*

- a.* White, from Kristerfberget at Nya Kopparberget in Westmanland.

S E C T. XXXVIII.

B. Indurated.

i. Scaly.

- a.* Yellowish, from Kristerfberget †.

S E C T. XXXIX.

Observations on the Calcareous Earth in general.

The calcareous earth is distributed over the whole world in proportion to the great use made of it, though it sometimes is absorbed and concealed in heterogeneous substances. If it could be proved, that Nature, to perform its works, does not require more than those two active

† Both these varieties contain a considerable quantity of lead, viz. forty per cent. more or less, and the calcareous earth is as equally and intimately mixed with it, as in the white iron ore (Sect. xxxiii.). Thus may these be distinguished from other lead-ochres and spar-like lead ores, which are much richer in lead, and never effervesce with acids. These last mentioned also seem to be produced by nature, nearly as the spar-like lead ores, and as the *flores Saturni* are formed in calcining a regule of lead.

agents, the acid and the alkali, and that the calcareous earth might, under certain circumstances, be changed into a mineral alkali, as some have conjectured; the necessity of the existence of the calcareous earth is sufficiently obvious. But all these hypotheses I pass over, since they for a long while have been, and will, perhaps, remain for ever undecided; it being of more consequence to take notice of the advantages which are to be derived from it in human œconomy, since it is more or less employed in most trades. However, I do not intend to enter into all those particulars, but only to mention how the calcareous earth, when in its crude state, is commonly made use of.

When in the form of a loose earth, (Sect. v. 1.) it is used for white-washing; and is mixed with clay in agriculture: for, according to Dr. Kullbell's rules of vegetation, its alkaline quality serves to unite fat substances with water: besides that it is of a drying nature, and renders the clay less coherent, or, as the farmers say, "makes the plowing easier." Hence this loose earth, in some foreign countries, is called marle; for, when added to clay, it promotes the production of marle. The *humus conchacea*, or shell or sea-sand, is looked upon as pretty nearly of the same quality; but it is unfortunate that clay for the most part is scarce in those places, where the calcareous earth is found in plenty, and that sometimes more is expected from this last than it possibly can perform. Loose earth may easily be made into lime, if it is previously slacked with water, and made up in moulds.

The indurated calcareous earth or stones, in masses or lumps, are very useful in arable land, because it moulders by degrees on the surface, and attracting the water, retains it longer than
most

most other kinds of stones. The arable lands in the province of Jemtland, at Rettwick in Dalarne, at Kinnekulle in Westergötland, and in other places, which consist merely of a calcareous earth, or a mouldered slate, would suffer a great deal from the sun, and a dry season, if they were not covered with lumps of limestone.

The art of building cannot be pursued without the use of limestone; and in this business alone it is known, and made use of under different names.

The solid limestone (Sect. vii.) commonly found in Sweden, is mostly flatty, and when it is of such indifferent colours as not to deserve polishing, is called in Swedish *Telgstén*, *Alfvarsten*, and *Oelandsten*, in English simply Limestones. The thickest strata are always employed in large works, to which purpose they are very well adapted; and the thinner are cut into square slabs to pave the floors, and for the stairs of houses, and are also applied to other uses. But great care must be taken in the choice of these stones, since it will happen that the finer works, made of this kind of stone, may, in length of time, crack and break into two or more plates, especially if they are exposed to the open air, because this stone is for the most part set with small partition veins of indurated marle, which moulders in the air. And this is the reason why the uppermost strata, in those quarries, are always rejected, and regarded as a different kind of stone, and are, by the Swedish workmen particularly, called *Gorsten*, in English Rubble-stone.

When the limestone is of brighter colours, though sometimes no more than only of a dark brown, it receives the pompous name of Marble: and for such works as are to be polished, the pieces are always chosen out

of the thick and solid strata, which lye so deep under-ground, that they have not been spoiled by weathering or decaying. This stone is likewise the most proper for that purpose, in preference to all other limestone, because it is perfectly opaque, and reflects the light from the surface. Most of the Italian and antique marbles are of this kind, for instance :

<i>Marmore Nero di Fiandra,</i> —	The black marble of Flanders.
— <i>Giallo Antico,</i> —	Yellow, with some white veins.
— <i>di Fiume d'Arno,</i> —	Yellow, with black dendrites.
— <i>di Fiorenza, Paesino,</i> }	Yellow, with brown figures, resembling ruins.
— <i>di Porto Venere,</i> —	Black, with yellow veins.
— <i>Nero et Bianco di Carrara,</i> —	Black and white.
— <i>Tartufato d'Urbino,</i> }	Pale yellow, with spots of a blackish grey colour.
— <i>Brocatella di Spagna,</i>	Yellow white and red.
— <i>Palombina antica,</i> —	Pale yellow.
— <i>Alberino di monte Gallicano,</i> —	Olive colour, with deeper coloured cross-lines and dendrites.
— <i>Rosso di san giusto,</i> —	Brownish red.
— <i>Carnagione di Pistoia,</i>	Flesh-coloured and yellow.
— <i>Fior di Persico di Saravezza,</i> —	Crimson, white and grey.
— <i>Pavenazzo,</i> —	Reddish-brown lumps on a whitish ground.
— <i>Bardiglio,</i> —	Bluish-grey.

With infinite more varieties, whose number is improperly augmented by those who for interest-sake collect specimens, and likewise by some virtuofos, who pay too much regard to colours and figures. From the above we find, that the Italian names are for the most part taken from the colours. When they have a marble from an unknown place, they call it *antico*. Every one that has a number of bright colours, is called *brocatello*,

brocatello, or *brocettelato*. The figures are chiefly regarded in the *Paesino di Fiorenza*, *Alberino di Monte Gallicano*, &c. &c. When some of the originals are wanted to compleat the whole set of marbles, they are substituted either by others, that have the most resemblance to them, or by white marbles stained or coloured; and this is the case with the *Marmore di sangue di Dragone*.

To this species of solid limestone also belongs the marble from Blankenburg, which is red, black, and white; likewise that from the province of Jemtland in Sweden, which is black and white, or only black, and the French marbles, viz. *Serfontaine*, *Antin*, *Seracolin*, *St. Baume*, *Servelat*, &c. &c. which have several bright colours.

The finest solid modern marbles are those from Italy, Blankenburg, France, and Flanders. There are also marbles dug in Saxony, and other parts of Germany, in Norway, and Sweden; but either they are not of such agreeable or striking colours, or else are of that species which is called the Scaly glittering Limestone, mentioned Sect. ix.

There are, however, several among the above-mentioned marbles, which are partly mixed with the scaly limestone (Sect. ix.), though not in such a quantity as to constitute the principal part of the stone, but only as a substance which has joined together lumps of the solid limestone, or else filled up its empty crevices or cracks. This kind, however, ought not to be rejected, but might be used as a marble, if only such pieces were chosen that have the finest texture: because those with coarse scales, when polished, are of an icy appearance, as masons term it, and do not shew their true colours, by reason of the semi-trans-

transparency of their particles, and their different positions in regard to one another, which may be seen in the marble from the parish of Perno in Finland.

Of the fine glittering limestone (Sect. ix.), are the following :

Marmore Bianco di Carrara, the white marble, the *Saligno*, the *Parian*, the white Italian marble; which, however, is never polished when made use of, but only finely ground down; the *Bigio antico*, *Porta Santa*, *Carnagione di Verona*, et di *Siena*, *Tigrato antico*, *Rosso antico*, *Giallo antico in oro*, *fiorito*, et *Giallo abrusciato*; every one of which is somewhat transparent at the edges.

In the parish of Pargas near Abo in Finland is found a white marble, which, to judge from the samples I have seen, gives room to hope that it is as good as the Italian, when they have got beneath the first stratum. But the other Swedish white limestones, for instance, that from Lillkyrke and other places, are either of too coarse a texture, or so intermixed with semi-transparent particles, as to give them, at a distance, a very disagreeable appearance, as if they were dirty.

The antient statuary marble is likewise very transparent: but as this transparency is equally diffused through all parts of the stone, it does no harm, but makes it rather look like alabaster.

While we are on the subject of marbles, it is necessary to observe, that as the Italians have a well founded right of giving names to the different varieties of marbles, and of furnishing us with samples, both of such as are found in their country, and of foreign ones which in former ages have been employed there, and now are called *Antichi*; it is in regard to those collections, or *studie*, that most stones which take a polish, have

have been called Marble, although the Italian mason himself knows extremely well how to distinguish a Marble, a Jasper, and a Granite, from one another, giving the two last names only to marbles of such colours as those species generally have, when he either cannot get any real ones of those harder stones, or will not give himself the trouble to polish them. This confusion in the names may, however, in regard to this system be tolerated, since these three different species of stones, viz. the limestones, the jaspers, and the granites, are here separately described: but since they cannot all be worked in a like manner, nor do they equally resist the violence of time, they deserve to be known by the architects in a clearer manner, and by separate names.

A yet less confusion is that of the *Saxum*, which, tho' compounded of limestone and serpentine *, is called Marble, not only when it contains a greater quantity of the limestone, as the marble from Kolmorden in the province of Ostrogottland, but also when the serpentine predominates, as in the marble called *Pozzevera de Genova*, and also a kind of green marble from Spain, because this kind of stone is as easy to cut and work as a true marble, although the serpentine is somewhat softer, and easier to polish.

The calcareous spar (Sect. x.), and its crystallisations (Sect. xi), are more difficult to be burnt into lime, than other limestones; they are therefore of no great use in architecture, any further than that they may be employed in making grottos: Nature has also made the quantity of this kind proportionable to its use.

* What our Author calls Serpentine, is a species of nephritic, and of the class of Talcs. D. C.

But the gypsum or plaster stone, on the contrary, is of very great consequence in building; and its strata, which are very sparingly distributed in the earth, are worth searching for. If it is true, that the strata of the earth are situated in a regular order throughout the whole globe, as some assert, and concerning which they have formed systems to themselves, founded upon observations made only at some few places, we might expect to have a considerable quantity of this stone; but there are innumerable experiments yet wanted, before this can be demonstrated. In the mean while, it may be asked, and with some reason, If the gypsum is to be searched for in any other places besides those strata where there is a positive proof of their being formed in the middle age, by means of water carrying their particles with it, and depositing them as a sediment there, and where also the vitriolic acid has been present? Likewise, If these strata ought before to have been set on fire, whereby the vitriolic acid has been separated from the inflammable substance, and afterwards fixed itself to a pure calcareous earth †?

The miners use crude limestone to make the *hearth*s of their iron furnaces, and as fluxes in melting their ores. The solid and the scaly limestones are both employed to the former use; but the scaly (Sect. ix.) is the best, and next to that the grained limestone (Sect. viii.).

Those who intend to search for limestone to make lime, and are afraid to mistake the white iron ore (Sect. xxx.) for it, ought only to observe, that the latter always decays in the open air into

† This whole paragraph, especially the latter lines, is very obscure and unintelligible. D. C.

a black or blackish brown powder, and becomes also of the same colour in the fire. However, when this iron ore contains only a very small quantity of iron, it may be used to make lime; though it becomes of a grey colour, just as when clay is mixed with limestone, as is the *Alfwarsten*, in which there is always some mixture.

It seems as if the white iron ore might be used with advantage, and preferably to others, in making cement, whose constituent parts are always lime and iron; but neither is it apt to concrete, when once mouldered; nor by experiments made for that purpose, has it discovered any quality of binding or uniting: we must, therefore, examine other substances, which may better answer the intention; and then it will be found, that iron, which is too much in its metallic state, is easily affected by the vitriolic acid, whereby the cement made of it would in length of time be dissolved, and rendered useless; nor, on the contrary, is a perfectly calcined iron of so much service, as when it has some of its phlogiston left. For instance, a cement prepared from the slags of a smith's forge, mixed with lime and coarse sand, has been found, in some respect, to answer all the good effects expected, it depending only on time to shew, if it is durable enough. The *Terra Puzzolana* and *Terras* are nothing else than iron ores mixed with a yet unknown earth. Its effect, however, in the cement, may, perhaps, depend only on the iron, which has been reduced into a particular substance by means of subterraneous fires, for their native places retain evident signs thereof.

If the slate in Henneberg, or Kinnekulle in the province of Westergottland, should happen

happen to catch fire, the uppermost stratum, which now consists of a mixture of iron and different kinds of rocks called *Graberg*, in the accounts given of them, they might, perhaps, be changed, partly into slag, and partly into *Terra Puzzolana*.

S E C T. XL.

The SECOND ORDER.

The Siliceous Kind, *Siliceæ*.

This siliceous earth is, of all others, the most difficult to describe and to distinguish perfectly: however, it may be known by the following characters, which are common to all bodies belonging to this order.

1. In its indurated state it is hard, if not in regard to the whole, yet at least in regard to each particle of it, in a degree sufficient to strike fire with steel, and to scratch it, when rubbed against it, though the steel be ever so well tempered.
2. When pure, and free from heterogeneous particles, it does not melt by itself, neither in a reverberatory, nor in a blast furnace.
3. After being burnt, it does not fall to a powder, neither in the open air, nor in water, as the calcareous order does, but becomes only a little looser and more cracked by the fire, unless it has been very slowly, and by degrees, heated.
4. It excites no effervescence with acids.
5. In the fire it melts easiest of all to a glass with the fixt alkaline salt; and hence it has got the name of Vitrescent, though this name is, properly speaking, less applicable

to this order, than to a great many other earths †.

SECT. XLI.

The mineral bodies that are comprehended in this order, are, indeed, somewhat different from one another. This difference, however, on first sight may be discerned; but, in regard to their effects in the fire, and other chemical experiments, it cannot be esteemed of any great consequence, at least while we are no farther advanced in the art of decomposing these hard bodies, and as long as no one has thought it worth the trouble and expence to use those means which are already discovered for this purpose; I mean the burning-glass or concave mirror; and to continue such experiments which Mr.

† It is not yet known, if there is any loose earth of this kind to be found, or if the indurated one is produced of a clay, either pure, or mixed with the calcareous earth, which afterwards has been dissolved, in order to produce this: because I have not yet, at least for my own part, found any loose earth that I can suspect to be a siliceous one, except that which remains after stones of this kind are decayed, and which is found in form of a white crust on the surface of those stones that lye to the day, or on the earth. This being afterwards worn off, and carried away by the water, is, perhaps, gathered together in form of strata. In the same manner window glass likewise moulders in length of time: but it cannot, therefore, be supposed, that any such decayed particles may, without being previously dissolved in some new menstruum, be reduced into their former substance. I am rather inclined to believe, that Tripoli is such a mouldered siliceous earth, and that the method of Nature in producing most of the flinty kind, is such as we do not rightly know, nor have patience to follow, yet imagine that we in some measure imitate it in making of glass, since both these have some effects common with one another.

Pott has ingeniously begun, as a basis for his *Lithogeognosia*. For want of this, there is no other way left, than to consider these bodies as simple substances (how much soever compounded they may be), in the following manner.

S E C T. XLII.

A. Diamond, *Adamas gemma*,

Which,

1. Of all stones, is the hardest.
2. Is commonly clear, or transparent; which quality, however, may, perhaps, only belong to its crystals, but not to the rock itself from which they have their origin.
3. Its specific gravity is nearest 3,500. When brought to Europe in its rough state, it is in form either of round pebbles, with shining surfaces, or of crystals of an octoedral form *.
 - a. Colourless, or diaphanous, or the diamond properly so called.

But it also retains this name when it is tinged somewhat red or yellow. Being rubbed, it discovers some electrical qualities, and attracts the mastic.

* The diamonds commonly crystallize into octoedral forms, which, however, often are found somewhat irregular, especially when the surface inclines to crystallize, during the shooting of the whole crystal, and also when several of them unite together into a groupe; in which latter circumstance the one hinders the other from assuming its regular form; and of this I have seen several instances. But the octoedral is not the only regular form which the diamond assumes; I have lately seen a rough diamond, or in its native state, in a regular cube, with its angles truncated or cut off. E.

SECT. XLIII.

B. Red, Ruby, *Adamas ruber.* *Rubinus.*

Which, by lapidaries and jewellers, is, in regard to the colour, divided into,

1. The Ruby, of a deep red colour, inclining a little to purple.
2. Spinell, of a dark colour.
3. The Balass, pale red, inclining to violet.

This is supposed to be the mother of the rubies.

4. The Rubicell, reddish yellow.

However, all authors do not agree in the characters of these stones.

* These gems are rather too precious to be examined by all possible experimental means; however they are, by reason of their hardness, and the particular form of their crystals, with more propriety looked upon to be produced from their own separate principle, being either formed in a single drop, or crystallised out of their matrix, rather than to be ranked among the quartz crystals; for if the heat of the sun, or the climate were the cause of the hardness of the diamonds, why is not a quartz crystal on the coast of Barbary harder than one from the province of Jemtland in Sweden? and who can assure us here in Europe, if, at the place where the diamonds are dug, there is any kind of rock, or not, which is the basis or matrix of these precious stones, in the manner as the quartz is of the rock or quartz crystals? The account which Tavernier has given us, about the digging of diamonds at Golconda, agrees with that of the crystals in Jemtland, viz. that they lye bedded in clay within clusters of crystals, and in clefts. Now such of our crystals are always the clearest, as have never been adherent to the rock, and next to them, such, as by some unknown accidents in nature, have been separated from their basis; but such, as are yet fixed to the rock, are very seldom fit for any use: if this, therefore, should happen to be the case likewise with the diamonds, it is no great wonder, that they do not at the very place take any notice of the rock, and still less, that they do not bring any of it to Europe. The clusters or groupes of crystal from Schneckenstein in Saxony, wherein topazes and rock crystals

SECT. XLIV.

B. Sapphire, *Saphyrus gemma*.

It is transparent, of a blue colour, and is said to be in hardness next to the ruby, or diamond.

are found promiscuously mixed, having each their different forms, colours, and hardness, furnishes a proof that nature forms the so called precious stones or gems, each from its particular matter or principle.

The round diamonds may be supposed to have undergone the same fate with some of the rock crystals, viz. to have been, by changes in the earth, broken from their beds, and by the agitation of waters, ground and rubbed against one another, until they have been rounded or reduced to this form; since they are mostly found amongst sand, and are discovered in places worn down by heavy showers of rain.

The ruby is crystallised into an octoëdral form, as well as the diamond *, and differs also very little from it in hardness and weight; I have, therefore, considered these two, as being of one and the same kind, and that with as much right as others, who have ranked them under the rock crystals, which last are more regular than any other earthy substance, as they assume, during their crystallisation, a determined form, viz. the hexagonal, with a point at one or both ends.

A sort of diamond is found, which is said to be very soft, and is called the Jargon †, but this sort is still unknown to me, nor have I found that any experiments have been made relating to its hardness and principles.

I have seen in the collection of the mine-master, M. Van Swab, a diaphanous octoëdral crystal of fluor, which, according to those, who only mind the figure, ought to be called a Diamond.

* What I have observed about the octoëdral form of the diamonds, may also be applied to the rubies. Besides, the rubies are also sometimes found of irregular hexagonal figures. E.

† The Jargon, so called by the English jewellers. Its natural shape is not yet known, it being found in form of pebbles in the Indies, where it is split into thin pieces, and thus sent to Europe. The jargons are of different colours, viz. white, light yellow, and brown. According to some lapidaries, they come nearest to the sapphires in hardness; and as they have, when cut and polished, a great resemblance to the diamond, they are also by some called Soft Diamonds, and one may easily be imposed upon in purchasing these for true diamonds, when they are made up in any sort of jeweller's work. E.

In consequence of the ignorance I plead in regard to these sorts of stones, I have given this a place by itself.

Sapphires are said to be found in Alfatia, at St. Amarin, but accounts of this kind are in general not to be depended upon, as the fluors are frequently met with in collections and the druggists shops under the name of sapphires, when they are of a deep blue colour; not to mention that the quartz is always termed a precious stone, whenever it is found clear, and of a fine colour. The sapphire is said to lose its blue colour in the fire. Those which are but a little tinged are called white sapphires. The sapphire is seldom found of a very deep blue colour, and free from parallel flaws which run through it †.

S E C T. XLV.

C. Topaz. *Topazius, gemma.*

This is a precious stone, which, when rough and perfect, is sold in a cristallised

† The sapphires in their rough or native state cristallize most generally like two oblong hexagonal pyramids pointed at their tops, and joined at their bases: yet they are sometimes found of an hexagonal columnar form. In the fire they lose their blue colour.

I have found some of the deep blue sapphires, and some of a milky colour, which, when looked through, varied their colours in the same manner as the milky or bluish opals (Sect. iv. 2, 3.): this is however no reason why those opals should be ranked under the name of sapphire, and less so, since there are also agats found of the same quality (Sect. lx. in the note) it might rather give rise to a question, whether the name of *milky or bluish opal* is not to be considered as a vague term, since that principal quality is found in stones of a somewhat different nature, tho' they all belong to the flinty order? E.

form. At Schneckenstein in Saxony, these crystals are found of a prismatical octoëdral form, with no points, but flat, and with some facets at the top; however without doubt the oriental topazes have another figure*.

Experiments by fire have been made on the Schneckenstein topazes by Mr. Pott, as may be seen in his *Lithogegnesia*.

To this kind I refer

a. The pale yellow topaz.

Which is nearly uncoloured, and is found at Schneckenstein.

b. The yellow topaze, from Schneckenstein.

c. Deep yellow, or gold coloured topaz, or oriental topaz.

d. Orange coloured topaz.

SECT. XLVI.

E. The yellowish green topaz, or *Chrysolite*.

Is of a grass green colour, and may perhaps belong to some other species, which might be discovered, if it could be obtained rough, or in its matrix, and large

* I have got some rough Brazil topazes, which are prismatical, and of a rhomboidal quadrangular figure, pointed at one end; but as these seem to be broke off at the other end, it is very likely, that they, as well as many other crystals, may be pointed at both ends, when nothing has impeded them during their cristallifation.

Besides these, I have got some fragments of other topazes, likewise said to be from the Brazils, which are all of them prismatical, but plainly shew, that some are pentagonal, and other regular hexagons with points.

The topazes lose their colour in the fire, but some of them turn red in a certain degree of heat, and are therefore very much used instead of the pale rubies, and even are often sold as such.

enough

enough or in such quantity as is necessary for experiments to be made.

F. The yellowish green and cloudy topaz, the *Chrysolite*.

This is perhaps the substance which serves as a matrix to the chrysolite: for those I have seen of this kind are like the clear-veined, called in Swedish milk crystal, and quartz, which is of the first degree of crystallisation.

S E C T. XLVII.

E. Bluish green topaz, or the Beryll.

This varies in its colours, and is called, when

1. Of a sea-green colour, the *aqua marina*.
2. When more green, the Beryll.

They are found in the stream-works in Saxony and Bohemia, in form of pebbles, or round pieces.

S E C T. XLVIII.

D. Emerald. *Smaragdus gemma*.

Its chief colour is green, and is transparent. I believe it to be, or to have been, a crystal of its own separate principle, since in its qualities it differs both from the above-mentioned, and from the rock-crystals; but I cannot positively assert this, since I know no more of it, than that it is the softest of precious stones, and that, when heated, it is phosphorescent, like the fluors; and what in some cabinets is given out for its matrix, and said to come from Egypt, is nothing else than a deep green

cockle-spar *, of which colour we likewise find cockle, or shirl, in the island of Uto, near Stockholm, and at Norbery, in the province of Westmanland.

Mr. Maillet informs us, that in former times the best emeralds were found in Egypt †.

S E C T. XLIX.

Observations on the preceding bodies called, precious-stones, or gems.

I have before mentioned the reasons, why I give these their separate places from the following

* The original Swedish has *Skiorl spat*, that is cockle or shirl spar, of which see fully Sect. lxxiii. infra. but the German translation terms it, *ein Schoen spat*, a fine spar; that is to say, (in this sense) a fine fluor. The schorl, or schirl, of the Germans, is a substance called by our Cornish miners *Cockle*. I have therefore in my lectures on fossils adopted the names of cockles or shirls for this substance in the English language, D. C.

† The emeralds, in their rough or native state, consist of hexagonal columns, mostly truncated at both ends, though some of them now and then may be found faceted at the ends. I have samples of both transparent grass-green, and light green, which in a gentle heat become colourless, but white and opaque in a strong fire, without the least mark of any fusion.

When crystallised cock'e, or shirl, is found of a green colour, transparent, and free from cracks or flaws, it is commonly called emerald by the jewellers, though it is generally of a deeper colour than the true emeralds, and also wants its lustre: and hence it is, that the cockle-spar from Egypt is called the mother of the emeralds.

However it may be, that this cockle was in antient times fashionable in Egypt, under the name of emerald, though now-a-days it is not so much valued as the emerald of this (the siliceous) kind. See Section lxxv. Note under the cockle.

stones, among which they else might have been ranked equally as here, as they are already in other systems : to which I venture to add, that, as a naturalist, I cannot conquer that general weakness of valuing them so highly ; for besides their surprizing hardness, and fine colours, that please the eye, it is not without foundation, that they might be thought applicable to every use for which the siliceous kind is employed, if they were to be had in large quantities : and by this alone it is they deserve to have the preference of the other stones of this order. In regard to the colours, it is to be observed, that those of the ruby and emerald are said to remain in the fire, but that the colour of the topaz flies off : whence it is usual to burn that gem on purpose that it may be made use of instead of the diamond, as it is harder than the quartz crystal. The colours of gems are commonly supposed to depend on metallic vapours : but may they not more justly be imagined to arise from a phlogiston, united with a little metallic or some other earth ? because we find that metallic earths, which are perfectly well calcined, give no colour to any glass, and that the manganese, on the other hand, gives more colour than can be ascribed to the small quantity of metal which is to be extracted from it. (Section cxiii.)

The phlogiston may perhaps have more difficulty to escape through the pores of the hardest of the precious stones, if it is true, that the property of losing the colour is in proportion to their hardness, as some authors seem to indicate, by assuring us, that none but the coloured diamonds and the rubies keep their colours in the fire ; but in this circumstance I likewise want experience, but hope to see it illustrated

by those who may happen to get an opportunity of discovering the true methods to deliver the world from the many ambiguities and distinctions, which have been made on this subject, and which perhaps are all formed upon as great reason, as those we still use in distinguishing the oriental and occidental gems, which signifies in other words, no more than hard and clear, or soft and flawy, deeper or paler, or of good or bad colours *.

* To the precious stones belong also the jacinths, or hyacinths, which are crystals harder than quartz crystals, transparent, of a fine reddish yellow colour, when in their full lustre, and formed in prisms pointed at both ends: these points are always regular, in regard to the number of the facets, being four on each point, but the facets seldom tally: the sides also, which form the main body, or column, are very uncertain, in regard both to their number and shape, for they are found of four, five, six, seven, and sometimes of eight sides: further, the column or prism is in some also so compressed, as almost to resemble the face of a spherical faceted garnet. These crystals lose their colour, become white, and do not melt in the fire, by which qualities chiefly they may be distinguished from garnets, (Section lxxiii. 3.) which are likewise sometimes found of a colour not inferior to the true jacinths. The author had not, at the time when he wrote this Essay, seen the true jacinths, but mentions in Section lxxix. C. c. that the reddish yellow garnets from Greenland, are sold by the jewellers for jacinths; so are likewise the East Indian garnets of the same colour, and, what is still more, there are some jewellers that do not know the true distinctions between a jacinth and a garnet at all, but buy and sell the garnets for jacinths, when they are of a fine reddish yellow colour: this must in particular be owing to the scarcity of the true jacinth.

Mr. Cronstedt has since informed me by letter, that he had lately got some jacinths of a quadrangular figure, which did not melt in the fire, but only became colourless; this confirms what I have already mentioned about the jacinths I tried, and which are above described. E.

S E C T. L.

E. Quartz. *Quartzum**

This stone is very common in Europe, and easier to be known than described. It is distinguished from the other kinds of the siliceous order, by the following qualities.

1. That it is most generally cracked throughout, even in the rock itself, whereby
2. As well as by its own nature, it breaks irregularly, and into sharp fragments.
3. That it cannot easily be made red hot, without cracking still more.
4. It never decays in the air.
5. Melted with pot-ashes, it gives a more solid and fixed glass than any other of the siliceous order.
6. When there has been no interruption in its natural accretion, its substance always cristallises into hexagonal prisms, pointed at one or both ends.
7. It occurs in clefts, fissures, and small veins in rocks. It very seldom forms large veins, and still seldomer whole mountains, without being mixed with heterogeneous substances.

S E C T. LI.

The Quartz is found,

- 1, Pure, *Quartzum purum*.

A. Solid, of no visible particles with a glossy surface. *Particulis impalpabilibus superficie polita.* Fat Quartz.

* I shall adopt this name of quartz in English as it has already gained access into the other European languages. D. C.

a. Uncoloured and clear, *Diaphanum*.

Is found in the copper mines in the north part of Norway, and in Siberia. This has no cristallised form, but is nevertheless as clear as quartz cristals of the best water.

b. White, the common fat quartz.

c. Blue, from the island of Uto in the province of Sodermanland.

d. Violet, from the island of Uto.

B. Grained, *Textura granulata*.

a. White, from the gold mines at Adelfors in the province of Smoland, and the copper mines at Loviseberg in Westmanland.

b. Pale green, from Adelfors.

C. Sparry quartz, *Textura spatosa*.

This is the scarcest, and ought not to be confounded with the white Felt-spat Sect. lxvi. being of a smoother appearance, and breaking into larger and more irregular planes.

a. Whitish yellow, from the gold mines in Hungary.

b. White, from the island of Uto.

SECT. LII.

D. Cristallised Quartz, *Quarzum cristallisatum*. Rock cristal. Quartz cristal. *Cristallus montanus*.

Its figure is already (Sect. I.) described, and, in regard to the colours, the following varieties occur.

I. Opaque, or semi-transparent, *Cristallus opacus vcl semi-diaphanus*.

a. White, or of a milk colour.

b Red

- b.* Red, or of a carnelian colour, from Oran in Barbary.
- c.* Black, from the same place.
2. Clear, *Diaphanus*.
- a.* Blackish brown, smoaky topaz, or *Raunch Topas* of the Germans, is found at Egera in Norway, and at Lovisa in Finland.
- b.* Yellow, found in Bohemia, and sold instead of topazes.
- c.* Violet, the amethyst, from Saxony, Bohemia, and Dannemora in Upland.
- d.* Uncoloured, Rock Cristal, properly so called, from Bohemia: also from the province of Jemtland, and many other places; when these coloured cristals are not clear, they are called Flufs, for instance Topaz-Flufs, Amethyst-Flufs, &c. &c.

S E C T. LIII.

2. Impure Quartz, *Quartzum heterogeneis intimè mixtum*.

A. Mixed with iron, in form of a black calx, *Quartzum calce ferri atro intrinsece mixtum*. This is black, of a glossy texture, and contains a great quantity of iron.

It is found at Staf's iron mine in Sodermanland, and at Gierdesiostrand in the parish of Offerdal in Jemtland, at which last place the iron also discovers itself by its rust in the cracks of the stone.

B. Mixed with copper in form of a red calx, *Quartzum croco Veneris mixtum*.

Red

Red, and is found in Sunnerskog's copper mine in the province of Smoland *.

SECT. LIV.

F. The Flint, *Silex pyromachus*. *Lapis corneus*, or *Hornstein* of the Germans.

This is equally common with the Quartz, and it is full as difficult to describe it; especially as it forms a kind of intermediate substance between Quartz and Jasper, both

* That the colour in these latter bodies depends on metals, is easily proved by metallurgical Essays, and the resemblance they have with compositions of glass, made on the same principle; but the same cannot be affected of the precedent coloured quartzes (Sect. li. lii.), before it be evidently demonstrated.

It is very likely, that a quartz may be found which is intimately mixed with a calcareous earth, and such is, perhaps, the Hungarian sparry quartz (Sect. li. C.), which, however, I recommend for further examination.

The quartz in general, and especially its crystals, are very commonly thought, when yet in their soft or dissolved state, to have included within them some vegetables, for instance, grass and moss. This I cannot absolutely deny, but I must at the same time observe, that it deserves to be carefully examined, if that, which is shewn as a grass, be not an asbestos, or a striated cockle, and the moss, only branched vacuities filled with earth, which, by their being ramose, bear a vegetable appearance: it is very common in agates, and makes them of less value than otherwise they would be; this is most generally the case with those stones, which are shewn as including vegetables, and for my own part I have never been so fortunate as to meet with any others.

When the rock crystals are semi-transparent, or intermixed with opaque veins, they are, by the Swedish lapidaries, called *Milk crystals*; when they are found in form of round pebbles, which is occasioned by their being tossed about and rubbed against one another by floods, or by the sea, they are called by the English lapidaries, *Pebble crystals*. They come from the Indies, Siberia, and other places, but these cannot be ranged separately, for evident reasons, or otherwise for reasons already mentioned in their proper places.

which

which it so nearly resembles, that it is not easy to point out such characters as shall readily distinguish it from them. The best way, perhaps, will be to speak of its properties comparatively; and then we may say that,

1. It is more uniformly solid, and not so much cracked in the mass as the quartz; and,
2. It is more pellucid than the jasper.
3. It bears being exposed to the air, without decaying, better than the jasper, but not so well as the quartz.
4. It is better for making of glass than the jasper, but is not quite so good as quartz for that purpose.
5. When ever there has been an opportunity in this matter of its shooting into crystals, quartz crystals are always found in it; just as if the quartz had made one of its constituent parts, and had on certain circumstances been squeezed out of it; this is to be seen in every hollow flint, and its clefts, which are always filled up with quartz.
6. It often shews most evident marks of having been originally in a soft and slimy state.

The several varieties of this species have obtained distinct names, more with respect to their colours, than from any real difference in their substance; but these are still necessary to be retained, as the only names used by jewellers and others, who know how to value them accordingly.

SECT. LV.

I. The Opal. *Opalus Pæderota.*

It is the most beautiful of all the flint kind, owing to the changeable appearance of its colours by reflection and refraction, and must therefore be described under both these circumstances.

a. The Opal of Nonnius, the Sangenon of the Indians.

This appears olive-coloured by reflection, and seems then to be opaque, but when held against the light, is found transparent, and of a fine ruby red.

That opal is supposed to have been of this kind, which Pliny mentions in his Natural History, chap. 307. sect. xxi and which he says, was in the senator Nonnius's possession, who rather suffered banishment, than part with it to Antony.

This stone was in Rome at that time valued at 20000 sesterces. But the stone here particularly described, was found in the ruins of Alexandria; it is about the size of a hazle-nut, and was bought for a trifle of a French druggist, named Roboly, and presented to the French general consul Lironcourt, who afterwards offered it to sale in several places, for the sum of 40,000 rixdollars. See Hasselquist's Travels to the East, under the article of Opal. *

* This very stone was in the year 1763 in the possession of his excellency the duke de Nivernois, then ambassador to the British court, and I have often been honoured by his excellency of having it for some days in my possession. D. C.

There

There is, however, another of the same kind in Sweden, which by reflection appears rather brown; but by refraction is red, with violet veins.

b. The white opal. Its ground is white, of a glass-like complexion, from whence are thrown out green, yellow, and bluish rays; but it is of a reddish or rather flame colour, when held against the light.

1. Of many colours. The oriental opal.
2. Of a milky colour*, from Eibenstock, in Saxony.
3. Bluish, and semi-transparent. This is not so much valued, as those which are

* I have lately got a small piece of pseudo-agate, from the East-Indies, which is of a yellowish brown, and pale blue, or rather milky colour, with a shining brightness, exactly like that of the milky opals of this section, and received also some other specimens found at St. Georgio, near Turin, in Piedmont, there called by the name, *Pseudo agate* (Bastard agate), a name which seems very well adapted to this stone, since in every respect, hardness excepted, it comes nearest to the agates; because, 1. It is transparent in the same degree as agates, and varied with red and grey colours, interspersed sometimes with white opaque veins, or rings, and black dendritical figures. 2. It is of a very fine and shining texture, when broke, rather superior to that of the agates, but so soft, that it scarce yields any sparks, when struck against steel; and does not admit of any polish, but what is inferior to the lustre of its natural texture: however, it slightly marks common window glass. 3. When broke through the dendrites, it is as smooth and shining at that place as in any other; and these dendrites vanish in the fire, without leaving any pores in the stone. 4. It does not melt before the flame, by the blow-pipe, but becomes perfectly white and opaque. 5. Nor is it fusible even with borax. 6. It does not ferment with the acid of nitre.

more opaque, because it is easier to be imitated by art †.

S E C T LVI.

The Cat's Eye. *Pseudopalus*.

This stone is opaque, and reflects green and yellowish rays from its surface, and is found in Siberia *.

Sometimes this stone is surrounded with a white crust, like common flints in the strata of chalk; which crust has likewise the same effect as that of the flint, when this last-mentioned has been previously freed from the adherent chalk; viz. 1. It does not ferment nor dissolve in the acid of nitre; 2. is not fusible by itself in the fire; 3. but melts pretty easily with borax, though without any effervescence, contrary to what we observe with calcareous substances; and thus borax will dissolve a quantity equal to about three quarters of its own bulk, though not without difficulty, especially towards the end of the operation; but the glass becomes quite clear and colourless, instead of growing white and opaque, as with calcareous substances. E.

† Not only this, but also some of the other kinds of opals, have been well imitated by art, there being found compositions of glass, which shew very different colours by refraction from what appear by reflection. A curious antient one of this kind is to be seen in the Royal Abbey of St. Dennis, near Paris, which is green on the outside, and shews a fine ruby colour when viewed against the light. And lately an ingenious gentleman at London made some pastes, which are of a yellowish dark brown by reflection; but some of which, when held against the light, appear of a fine blue colour, and others either purple, or like hyacints, garnets and rubies.

* The earlier writers on stones mention other varieties of this kind; for instance, the *Oculus Mundi* §, which, after hav-

§ There are in the British Museum at London, three of these stones called *Oculus Mundi*. The largest of them is about the bigness of a cherry-stone, though in an oval form. It is opaque, and its colour like that of a common yellow pea; it may be scratched, though not without difficulty, by a knife; it seems however to leave a mark on common glass, and does not ferment with the acid of nitre.

When it has lain in water some hours, it becomes transparent, and of a yellow amber colour. This change begins soon after the immersion, and at one end, in form of a little spot (but in a small one of the same kind

S E C T. LVII.

3. The Onyx. *Onyx Camebūja*. Memphites.

This stone is the hardest of the flinty tribe, and consists of differently coloured veins, which run parallel to one another, sometimes in straight, sometimes in curved lines. It is found of two sorts.

a. Nail-coloured onyx, having pale flesh-coloured, and white lines. From the river Tomm in Siberia.

b. With black and white lines. The Oriental onyx.

The old Romans were accustomed to cut figures on the straight-lined onyxes in relief, which they called *Camebūja*; these are still counterfeited, and called *Cama-yeu*. Those which consist of concentric circles were called Memphites; and we have now of this kind cut to be set in

ing been laid in water, shines like a piece of red-hot charcoal; the *Asteria*, which is said to shew luminous stars on its surface, &c. But these are no longer to be met with, since fashion has given preference to the more transparent hard stones; and it is also very difficult rightly to understand the descriptions of antient authors, in regard to colours, and their different mixtures with one another †.

Kind the beginning is round the edges) which increases by slow degrees until the whole stone is become uniformly clear throughout: when taken out of the water, it loses its transparency, first at one end, then gradually over the remainder, until the whole stone has recovered its former opacity; and this change happens in less time than that of its becoming transparent. No other experiments have yet been made upon this stone, because it is so very seldom to be met with; and these are not sufficient to determine exactly of what kind it is. E.

† Amongst these cannot be reckoned the *Tourmaline*, so much renowned of late for its electrical qualities. It is but a crystallised cockle, of a green or brown colour, more or less deep, so as to turn to a black, and sometimes to a bluish colour, when looked through; others appear quite black. [See Sect. LXXV.] E.

The *Brazilian emerald* seems to have the same properties of becoming electrified positively in one side, and negatively in the other: it belongs also to the *Shirl* kind. [See Sect. XLVIII. Note †.]

rings, under the name of *Occhi di Gatti*, which, however, ought not to be confounded with the pseudopal, (Sect. lvi.) or cat's-eye.

S E C T. LVIII.

4. The Chalcedony, or white agate.

Is a flint of a white colour, like milk diluted with water, more or less opaque: it has veins, circles, and round spots. It is said to be softer than the onyx, but much harder than those agates which are sometimes found of the same colour.

a. The white opaque Chalcedony, or *Cacholong*, from the Buckarish Calmucks. This was first made known by one Renez, a Swedish officer, who for several years had been in that country. The inhabitants find this flint on the banks of their rivers, and work idols and domestic vessels out of it.

b. Of white and semi-transparent strata, from Ceylon.

c. Bluish grey, from Ceylon and Siberia,

S E C T. LIX.

5. The Carnelian, *Carniolus*.

Is of a brownish red colour, and often entirely brown. Its name is originally derived from its resemblance to flesh, or to water mixed with blood.

a. Red, from the East, and Turkey.

b. Yellowish brown, looks like yellow amber, from the river Tomm, in Siberia. It is said not to be so hard as the Chalcedony.

S E C T.

There is in Europe great quantities of most varieties of agates*, particularly at Oberstein in the Palatinate, where they are cut and polished: but they are likewise found in every part of the world. In Sweden there is not yet, as far as I know, more than one species of agate found; namely, at Gasebeck, in the province of Skone, which is of a white and deep red colour.

S E C T. LXII.

8. Common Flint, *Silex communis Pyromachus*.

Is really of the same substance as the agate; but as the colours are not so striking

* I have lately got a specimen of a hollow agate ball, with pale amethysts in the inside, between which is crystallised a calcareous substance into a fibrous form. These fibres are parallel, white, shining, and very minute, exactly resembling the finest asbest, for which it also might be mistaken, if it was to be judged only by the eye. But by experiment it is found neither to be an asbestus nor a gypsum, which sometimes shoot also into a fibrous form, but entirely a pure calcareous substance. The whole mass does not adhere together, but is nearly divided into small triangles, which are placed upon one another, so as almost to form a large figure of the same kind. These fibres however, although very minute, may be found by means of a proper magnifying-glass, to be of an angular figure, like those mentioned in the note at page 82. The shape of balls and irregular nodules, is the most general form in which agates and flints are commonly found. Nevertheless, besides what I have seen in several collections in London and abroad, I have likewise some specimens of native silver, from Potof, in the Spanish West Indies, which run in a grey and blue transparent agate, with white opaque veins; which seems to confirm the opinion, that agates may form veins in the rocks, as well as other sorts of stones. [See the note of Sect. LXIII.] E.

or agreeable, it is commonly considered as a different substance.

- a. Blackish grey, from the province of Skone.
- b. Yellow semi-transparent, from France.
- c. Whitish grey.
- d. Yellowish brown.

When the flints are small, they are in England called pebbles; and the Swedish sailors, who take them as ballast, call them *singel*.

S E C T. LXIII.

9. Chert, *Petrofalex*, *Lapis Corneus*. The *Hornstein* of the Germans.

Is of a coarser texture than the preceding, and also less hard, which makes it consequently not so capable of a polish. It is semi-transparent at the edges, or where it is broke into very thin pieces.

- a. Chert of a flesh colour, from Carl-Schakt, at the silver-mine at Salberg, in the province of Westmanland.
- b. Whitish yellow, from Salberg.
- c. White, from Kristiersberg, at Nya Kopparberget, in Westmanland.
- d. Greenish, from Prestgrufvan, at Hellefors in Westmanland*.

* There are not yet any certain characters known, by which the Cherts and Jaspers may be distinguished from each other: by sight, however, they can easily be discerned, viz. the former, or chert, appearing semi-transparent, and of a fine sparkling texture, on being broken; whereas the jasper is grained, dull, and opaque, and has exactly the appearance of a dried clay: the chert is also found forming larger or smaller veins, or in nodules like kernels in the rock; whereas the jasper, on the contrary, sometimes constitutes the chief substance of the highest and most extended chains
of

of mountains. The chert is likewise found plentifully in the neighbourhood of scaly limestone, as flint is in the strata of chalk. What connexion there may be between these bodies, perhaps time will discover.

But flints and agates being always found in loose and single irregular nodules, and never in rocks, as the chert, is a circumstance very insufficient to establish a difference between them; for there is agate near Constantinople running vein-like across the rock with its country, of the same hardness, and as fine and transparent as those other agates, which are found in round nodules at Deux Ponts. We must therefore content ourselves with this remark concerning flints, That they seem to be the only kind of stone hitherto known, of which a very large quantity has been formed in the shape of loose or separate nodules, each surrounded with its proper crust; and that the matter which constitutes this crust, has been separated from the rest of the substance in like manner as sandiver, or glass gall, separates from, and swims upon glass during its vitrification; tho' sometimes the formation of this crust may have been prevented by the too sudden hardening of the matter itself: I shall therefore take the liberty to call this matter of the crust, which sometimes is an indurated terre verte, by the name of *Agate-gall*.

Other species of stones, which are found in loose pieces, or nodules, except ores, and some sorts of stalactites, shew evidently by their cracks, angles, and irregular figures, that they have been torn from rocks, rolled about, and rubbed against one another in torrents, or by some other violent motions of water. That flints have originally been in a soft state, as I have mentioned, is easy to be seen in the Egyptian pebbles, which have impressions of small stones, sand, and sometimes perhaps grass, which however have not had any ingress into the very flint, but seem only to have forced the abovementioned agate gall or crust out of the way †.

SECT. LXIV.

G. Jasper, *Jaspis*.

All the opaque flints are called by this name, whose texture resembles dry clay, and which have no other known quality, whereby

† The erroneous notion of the once soft state of stones, see discussed in my First Lecture on Fossils. D. C.

they may be distinguished from other flints, except that they may be more easily melted in the fire; and this quality perhaps may proceed from some heterogeneous mixture, probably of iron.

1. Pure jasper, *Jaspis purus*.

Which by no means yet known can be decomposed.

- a. Green with red specks or dots, the *Heliotrope*, or blood-stone, from Egypt.
- b. Green, from Bohemia.
- c. Red, *Diaspro rosso Italarum*.
- d. Yellow.
- e. Red with yellow spots and veins, *Diaspro florido* of Sicily, Spain, and Constantinople.
- f. Black, from Finland, and Neskott, in the province of Jemtland.

S E C T. LXV.

2. Jasper containing iron, *Jaspis martialis*, *Sinople*.

A. Coarse grained.

- a. Red and reddish brown, *Sinople*, from the Hungarian gold mines.

B. Steel grained, or fine grained.

- a. Reddish brown, from Altenberg, in Saxony; looks like the red ochre or chalk used for drawing, and has partition veins, which are unctuous to the touch, like a fine clay, and other like kinds.

C. Of a solid and shining texture, like a flag.

- a. Liver-coloured, and

- b. Deep red. Both these are found at
Lang-

Langbanshyttan in the province of Wermeland, and at Sponwik in Norway.

c. Yellow, from Bohemia.

This last mentioned, when calcined, is attracted by the load-stone, and being assayed, yields 12 to 15 per cent. of iron.

* Jasper, when fresh broke, so nearly resembles a bole of the same colour, that it can only be distinguished by its hardness. In the parish of Orsa, in the province of Dalarna, there is a red bole found in spaces like glands or kernels, in that sort of sandstone from which grindstones are cut; and some miles distant, in the rocks at Serna, a red jasper of the same colour and texture as the above bole, is found in a much harder kind of sandstone. In other places jasper is found in such unctuous clefts, as if they had contained unctuous clays; as pipe clays, and red chalk: and there are likewise some jaspers which imbibe water. May it not then be supposed with some probability, that jasper is an indurated bole, a reddle, or terre verte? That jasper, as well as these, consists of clay and iron; though, by reason of its being hardened, it becomes as difficult to extract these principles from it, as to reduce a small quantity of scorified iron to its metallic form, when melted with a large quantity of slag or glass? That the same bole or clay, together with another substance, perhaps lime, after being dissolved by a menstruum, not yet determined, is sufficient for the production of flint stone? and that so much of the bole as was superfluous, being separated from the mass, is found adhering to the surface, or in the fissures, &c.

Thus one might imagine, that jasper could easily be produced, and that the soft kinds might become harder by length of time; but its particles cannot be supposed to approach nearer and nearer to one another during the hardening; nor can it be imagined, that the jasper should by that means become of a finer texture. On the other hand, we know extremely well, and have the experience of it every where, that porphyry in the rocks decays into a white crust, wherever it is exposed to the air, although internally it remains very hard and black; for instance, at Klitten, in Elfdalen, in Sweden. From whence it may be supposed, that water, which washes off the mouldered particles, must by degrees collect them somewhere, and at length present us

SECT. LXVI.

H. Rhombic Quartz, *Spatum scintillans Felt-spatum* *.

This has its name from its figure †, but seems to be of the same substance as the jasper. I have not however ranked them together, for want of true marks to distinguish the different sorts of the flinty tribe from one another.

This kind is found,

1. Sparry.

a. White.

b. Reddish brown, occurs in the Swedish and also in the foreign granites.

c. Pale yellow.

d. Greenish.

This last mentioned resembles very much the schorl or cockle-spar, (Sect. lxxiii.) but is neither so easy to melt in the fire, nor of so exact a figure.

2. Crystallised.

with them in form of an earth, which perhaps we do not know in that state. It may be asked, Whether this earth will be ductile as clay, or rough to the touch as powder of bricks? Perhaps Tripoly is produced in this manner.

* The Germans and other nations call this substance *Feld-spat*, that is *feild* or vague spar; a name very inadequate to its nature, as it touches no wise on the sparry class. I have therefore, in my Lectures, given it the English name of Rhombic Quartz, a name very significant, as the name quartz expresses its class; and the quality of it, of always breaking into angular (rhombic) fragments, is also expressed by the adjective of rhombic. D. C.

† What Cronstedt means, that the *feld-spat* has its name from its figure, is unintelligible. D. C.

A. In separate or distinct rhomboidal crystals, from the iron mine called Mossgrufvan, at Norbery in Westmanland *.

S E C T. LXVII.

OBSERVATION ON THE SILICEOUS ORDER.

The œconomical uses of this order are not so manifold as those of the Calcareous and Argillaceous classes; however, moral reflections laid aside, it will be necessary briefly to mention how far this order is considered and employed in common life.

The Europeans have no farther trouble with the precious stones, than either to cut them from their natural or rough figure, or to alter them, when they have been badly cut in the Indies; in which latter circumstance they are called *Labora*: and it may be observed, that for cutting the ruby, spinell, ballas, and chrysolite, the oil of

* This species is very seldom found alone in form of veins, and still more rarely as constituting the substance of whole mountains; but is generally mixed either with quartz and mica, as in the granites, or with jasper, having some occasional concurring particles of quartz, cockle, and hornblende, as in the porphyry. If the rhombic quartz and jasper were of the same species, that sort of porphyry which is made up of these two bodies only, ought to be ranked among the jaspers, instead of being placed with the Saxa in my Appendix, Sect. cclxvi.

It is however observable on old monuments, which are exposed to the open air, that though the porphyry has decayed, and consequently lost its polish, yet granite of the same age, composed for the most part of rhombic quartz, has kept its lustre. This, however, does not contradict the possibility of rhombic quartz being of the same substance as the jasper; because the calcareous spar is found to bear the weather, and even fire, better than the limestone.

vitriol is required, instead of any other liquid, to be mixed with the diamond powder.

If the petty princes in those parts of the Indies where precious stones are found, have no other power nor riches proportionable to the value of these gems; the reason of it is as obvious as of the general weakness of those countries where gold and silver abound, viz. because the inhabitants, placing a false confidence in the high value of their possessions, neglect useful manufactures and trades, which by degrees produces a general idleness and ignorance thro' the whole country.

On the other hand, perhaps some countries might safely improve their revenues by such traffic. In Saxony, for example, there might probably be other gems found, besides aquamarines and topazes; or even a greater trade carried on with these than at present, without danger of bad consequences; especially under the direction of a careful and prudent government.

The half precious stones, so called, or gems of less value, as the opal, the onyx, the chalcedony, the carnelian, and the coloured and uncoloured rock crystals, have been employed for ornaments and œconomical utensils, in which the price of the workmanship greatly exceeds the intrinsic value of the stones. The antients used to engrave concave or convex figures on them, which now-a-days are very highly valued, but often with less reason than modern performances of the same kind. These stones are worked by means of emery on plates of lead, copper, and tin, or with other instruments; but the common work on agates is performed at Oberstein, with grindstones, at a very cheap rate. When once such a
manufac-

manufactory is established in a country, it is necessary to keep it up with much industry and prudence, if we would wish it to surmount the caprice of fashions; since how much soever the natural beauty of these stones seems to plead for their pre-eminence, they will at some periods unavoidably sink in the esteem of mankind, but they will likewise often recover, and be restored to their former value.

The grindstones at Oberstein are of a red colour, and of such particular texture, that they neither admit of any polish, nor are they of too loose a composition.

Most part of the flinty tribe is employed for making glass, as the quartz, the flints and pebbles, and the quartzose sands. The quartz, however, is the best; and, if used in due proportion with respect to the alkali, there is no danger of the glass being easily attacked by the acids; as has sometimes happened with glass made of other substances: for instance, of bottles filled with Rhenish and Moselle wines, during the time of a voyage to China.

In the smelting of copper ores, quartz is used to render the slag glassy, or to vitrify the iron; quartz being more useful than any other stone, to regain or revive this metal.

The presence of the quartz in the rock-stones, (Sect. cclxii.) and also in crucibles, and such vessels, contributes most of all to their power of resisting the fire: it appears likewise probable, that the quartzose matter makes the grind and whetstones fit for their intended purposes.

S E C T. LXVIII.

The T H I R D O R D E R.

The Garnet Kind, *Terræ Granatææ*.

The matter composing the substance of garnet, and schorl or cockle, except that small portion which is metallic, does in its indurated state resemble the siliceous tribe, so far as relates to external appearance and hardness; and therefore I would willingly have followed the opinion commonly received, of considering these two substances as arising from one another, if I had not been persuaded to the contrary by the following qualities of the garnet.

1. It is more fusible, in proportion as it contains less metallic matter, and is more transparent or glassy in its texture; which is quite contrary to the siliceous kind.
2. This is the reason, perhaps, why the garnet, mixed with the salt of kelp, may on a piece of charcoal be converted to a glass by the blow-pipe, which cannot be done with the flints: and,
3. Why the most transparent garnet may, without any addition, be brought to a black opaque slag by the same means.
4. It is never, so far as is hitherto known, found pure, or without some mixture of metal; and especially iron, which may be extracted by the common methods.
5. The garnet matter, during the cristallisation, has either been formed in small detached quantities, or else has had the power of shooting into cristals, though closely

closely confined in different substances : since garnets are generally found dispersed in other solid stones, and oftentimes in the harder ones, such as quartz and chert*.

SECT. LXIX.

I. Garnet, *Granatus*.

Which is a heavy and hard kind of stone, crystallising in form of polygonal balls, and is mostly of a red, or reddish brown colour.

A. Garnet mixed with iron, *Granatus martialis*.

* It is certain, that the metallic calces being mixed with other earthy substances, make great alteration in respect to their fusibility; and we know from experience, that the presence of iron in the argillaceous, and most particularly in the micaceous kinds, renders them fusible; however, though there may be good reasons for considering the garnet as a quartz impregnated with iron; yet as quartz becomes less fusible by any addition of iron, of which the Swedish *Torrstén*, (Sect. ccxiii. in the note) a martial ore, commonly mixed with quartz, is an instance; and as even the species of quartz naturally mixed with that metal, (Sect. liii. *A.*) are far less easily fusible than the garnet; it might perhaps be better to call the garnet a stone of a different order, until by sufficient experiments we may have reason to reduce the number of the earths. Though if we should ever arrive at an exact method of classing in this respect, perhaps the economical use of these bodies will rather require such a distribution of them as shall more regard their present existence, than that which they have been originally derived from.

The garnet earth, so far as I know, is not yet found, but in an indurated state; and, as such, it is divided into the garnet, and into shirl or cockle, and that in regard to the figure of their crystals, more than any thing else: though their colour has also had some share in this division. I have here followed custom, which, perhaps, may have some reason, however ill founded it be.

1. Coarse grained garnet stones, without any particular figure, *Granatus particulis granulatis figura indeterminata*; in Swedish called *Granat-berg*; in German *Granatstein*.
 - a. Reddish brown garnet, found in the mine called Granat-Skierpningen, at Nya Kopparberg, in the province of Westmanland.
 - b. Whitish yellow, from Torrakeberget, in the parish of Gorbom, in Wermeland.
 - c. Pale yellow, from Siksioberget, and Vesterfilfverberget, in Kopparberg-flan, in Sweden.
2. Crystallised garnet, *Granatus crystallifatus*.
 - a. Black, from Swappawari, in Lapland.
 - b. Red, semi-transparent, and cracked, from Engso, at the Lac Malaren, in Westmanland.
Transparent, *Granatus gemma*.
 - c. Reddish yellow transparent, the jacinth, or hyacinth, *Hyacinthus gemma*, from Greenland, and Bergen's Stift in Norway.
I am not certain whether the oriental jacinth and that from Siberia are of the same kind; but this garnet from Greenland is by the jewellers fold as a jacinth.
 - d. Reddish brown, from Kallmora and Stripas, at Norbery, in Westmanland.
 - e. Green, from Eibenstock in Saxony, and Gellebeck, in Norway.
 - f. Yellowish green, from Gellebeck.

S E C T. LXX.

B. Garnet mixed with iron and tin, *Granatus trocis Martis et Jovis mixtus.*

1. Coarse grained, without any particular figure, *Granatus particulis granulatis figura indeterminata.*

a. Blackish brown, from Moren, at Westanfors, in Westmanland.

2. Crystallised.

a. Blackish brown, from Moren.

b. Light green or white, from Gokum, at Dannemora, in the province of Upland.

The Bergs-radets, or mine-masters, Mr. Brandt and Mr. Rinman have published some experiments on this kind of garnet, in the Memoirs of the Royal Academy of Sciences at Stockholm.

S E C T. LXXI.

C. Garnet mixed with iron and lead, *Granatus calcibus Martis et Saturni mixtus.*

1. Crystallised.

a. A reddish brown, from Arset, in the parish of Froderyd, in the province of Smoland.

This was discovered, and accurately examined by the Bergs-radet Mr. Von Swab*.

* When any of the garnet kind is to be tried for its containing metal, the iron ought to be melted out of it by the common process; and if the garnet, at the same time, contains both tin and lead, these two metals are likewise included in the iron: however, they may be extracted out of the iron, by

SECT. LXXII.

- 2- Cockle or Shirl, *Basaltes*; *Corneus crystallisatus Wallerii*; *Stannum crystallis columnaribus nigris Linnæi*.

Is a heavy and hard kind of stone, which shoots into crystals of a prismatical figure, and whose chief colours are black or green. Its specific gravity is the same as the garnets, viz. between 3000 and 3400, though always proportionable to their different solidity.

A. Cockle, or shirl, mixed with iron, *Basaltes martialis*.

1. Coarse, without any determined figure, *Basaltes particulis palpabilibus figura indeterminata*.

a. Green, found in most of the Swedish iron mines.

by exposing it to a heat augmented by degrees, because then the tin and lead sweat out in form of drops, almost pure, though always somewhat mixed with iron.

The crystallisations of the garnets are so far different from one another, that some have a greater and some a less number of facets, or sides; but this has no relation or dependence either on their contained metals, their colour, or their transparency; wherefore, in order to avoid a prolixity, which is unnecessary, I have omitted such varieties, and only observed that they are round or spherical, with facets. Besides, there is not yet discovered any figure amongst them which is absolutely particular and remarkable, for the *granatus dodecaedros ex rhombis Linnæi* are dispersed every where in the rocks at Kongsberg, in Norway.

S E C T. LX.

6. The Sardonyx.

Is a mixture of the chalcedony and carnelian, sometimes stratum-wise, and sometimes confusedly blended and mixed together.

a. Striped with white and red strata: this serves as well cut in cameo as the onyx.

b. White, with red dendritical figures.

This very much resembles that agate which is called the Mocha stone, but with this difference, that the figures are of a red colour in this, instead of black, as in that agate.

I have unwillingly distinguished the onyx, carnelian, chalcedony, sardonyx, and agate, as separate species, since there is no real difference between them, except some inexplicable degrees of hardness; but I have been induced to continue these names for the reasons before given in Sect. liv.

S E C T. LXI.

7. The Agate, *Achates*.

This name is given to flints that are variegated with different colours, promiscuously blended together; and they are esteemed in proportion to their mixture of colours, their beauty and elegance. Hence also they have obtained variety of names, mostly Greek, as if the business of the lapidary in cutting of them, and admiring their several beauties and figures, had been derived from that nation alone.

As it ever was and must be very difficult to give intelligent descriptions of colours, so we are quite at a loss to understand the meaning of the antients in this respect; but this indeed is of little consequence, as we seem to have the same right, under the same circumstances, of inventing new names for them; and that in whatever language we please. Nevertheless I have described some few varieties of those which at this time are the most common, to serve as instances.

- a. Brown opaque agate, with black veins, and dendritical figures, the Egyptian pebble.
- b. Of a chalcedony colour, *Achates chalcedonifans*.
- c. Semi-transparent, with lines of a blackish brown colour, and dendritical figures, the Mocha stone.

This is much esteemed, and makes a valuable part of some collections, where it has a place chiefly for the sake of its figures, resembling vegetables, animals, &c. which however are often improved by art.

- d. Semi-transparent with red dots, *Gemma divi Stephani*.

When the points are very minute, so as to give the stone a red appearance, it is by some called *Sardea*.

- e. Semi-transparent, with clouds of an orange colour.
- f. Deep red or violet, and semi-transparent.
- g. Of many colours, or variegated.
- h. Black.

There

S E C T. LXXIII.

2. Sparry, *Basaltes spatofus*.
- a. Deep green, (the mother of the emeralds) from Egypt *.
 - b. Pale green, from Westersilfverberget, and Hagge, at Norberke, Linbastmoren, at Grangierde, in the province of Westmanland, &c.
 - c. White, from Silf-udden, at Westersilfverberget, Pargas in Finland, the lime-rocks at Lillkyrkie, in the province of Nerike, &c.

This occurs very frequently in the scaly lime-stones, and its colour changes from deep green to white, in proportion as it contains more or less of iron.

S E C T. LXXIV.

3. Fibrous, *Basaltes particulis fibrosis*; Striated cockle, or shirl: it looks like fibres, or threads made of glass.
- A. Cf parallel fibres, *Basaltes fibris parallelis*.
- a. Black, from Gustavsberg, in the province of Jemtland, the island Uto, in the Lake Malaren, &c.
 - b. Green, in most of the Swedish iron mines.
 - c. White, from Westersilfverberget, in the province of Westmanland, Lillkyrkie in Nerike, and Pargas in Finland.

* The Plasma, or mother of the emerald of authors, is a fine pellucid true quartz, of a green or emerald colour, not a stone of this kind. D. C.

- B. Of concentrated fibres, *Basaltes fibris concentratis*; The starred cockle, or shirl, from its fibres being laid stellarwise.
- a. Blackish green, from Salberg, in Westmanland, where, being found together with a steel grained lead ore, the whole is called, *gran-ris-malm*, or pine-ore, from its resemblance to the branches of that tree. This kind of cockle is also found at Uto, in Malaren.
 - b. Light green, from Kerrbo, at Skin-skatteberg, in Westmanland.
 - c. White, at Lillkyrkie in Nerike, Westerfilfverberget in Westmanland, and Pargas in Finland.

S E C T. LXXV.

4. Cryftallifed cockle, or shirl, *Basaltes cryftallifatus*.
- a. Black, from France, Yxfio at Nya Kopparberg, in the province of Westmanland, Umea in Lapland, Ofterbottn in Sweden.

* To this species of cockle, or shirl, belong most of those substances called *imperfect asbesti*; and as the cockle perfectly resembles a slag from an iron furnace, both in regard to its metallic contents, and its glassy texture, it is no wonder that it is not soft enough to be taken for an asbestus. It has however, only for the sake of its structure, been ranked among the asbesti; and it is surprising, that the fibrous gypsum, from Andrarum, in the province of Skone, has escaped being on the same account confounded with them. The striated cockle, or shirl, compared to the asbesti, is of a shining and angular surface (though this sometimes requires the aid of the magnifying-glass to be discovered) always somewhat transparent, and is pretty easily brought to a glass with the blow-pipe, without being consumed, as the pure asbesti seem to be. (See Asbesti, Sect. cii.)

b. Deep

- b. Deep green, from Salberg in Westmanland.
- c. Light green, from Enighets-grufvan at Norberg, in Westmanland,
- d. Reddish brown, from Sorwik, at Grengie in Westmanland, and Glanshammar, in the province of Nerike.

The Tauffstein, from Basil, is of this colour, and consists of two hexagonal cristals of cockle grown together in form of a cross: this the Roman Catholics wear as an amulet, and is called in Latin, *lapis crucifer*, or the cross-stone * †.

* It is not impossible, that there may be some kinds of cockles, or shirls, which, besides iron, also contain tin or lead, as the garnets: but I am not quite convinced of it; though I have been told, that lead has been melted out of a cockle, from Rodbeck's Eng, at Umea, in Lapland; and it seems likewise very probable, that the cockles which are found in the English tin mines, may contain some tin. There are some cristals of cockle found, which are fusible to a greater degree than any sort of stone whatsoever: these are always of a glassy texture, and semi-transparent.

The figure of the cockle cristals is uncertain, but always prismatical: the cockle from Yxfio, at Nya Kopparberg, is quadrangular; the French kind has nine sides, or planes, and the Tauffstein is hexagonal ||.

† The cross-stone is composed of two classes, for the basis I make a fluor, (See my Lectures) and the crosses on it I agree with our author are accretions of shirl, or cockle. He denominates it, the *Basler Tauffstein*. Whether he means by Basler the city of Basil, as I have put it, or whether he means Bessler, the author who first described it, I cannot tell; but certainly it is not found at or near Basil, being, as far as I know, a local fossil, namely, of St. John de Compostella, in Andalusia in Spain. D. C.

|| The name Cockle for these substances is an old Cornish mineral name; but is also given sometimes to other very different matters. The name Shirl I have now adopted in English, from the common German mineral term.

We have not in England any great quantity of species of cockles; the chief are found in the tin mines of Cornwall, and I have seen some fine cristallised kinds from Scotland.

S E C T. LXXVI.

OBSERVATION ON THE GARNET KIND.

When this kind contains so much of iron as renders it profitable to be worked, it is considered as a good iron ore, and no notice is taken of its natural character, in the same manner as is done with clays and jaspers that contain iron: for the richness of metal in these rises in a gradual progression, until they acquire the colour and appearance of the iron itself.

Thus a kind of garnet is melted in a furnace, not far from Eibenstock, in Saxony, and the same species is found, and might also be employed at Moren, in Westmanland. Jaspers are for this purpose melted in Hungary, and clays in England; but as the greatest part of the garnet kind contains so little iron as to yield only between six and twelve per cent. which is too poor to be worked any where in the world as a profitable iron ore, the rest and the greatest part of it being a mere earth, it must in a natural history be considered and ranked among the earths.

The tin grains should have got a place in this order, 1. If I had known any of them to contain tin in so small a portion as five per cent. as this quantity of tin is the most that ever can be obtained from the garnets; 2. If it was proved that a calx of iron always was mixed with it, as in the garnet; and, 3. If I did not believe that the

The English mineral name of *Call*, has been used by some authors as synonymous with cockles, and is even confounded together at the mines; but the *Call*, definitely speaking, is the substance called *Wolfram* by the Germans. &c.

Garnets, though small, are often found in micaceous stones in England; but extreme good garnets are found in great plenty also in like stones in Scotland. D. C.

tin calx might by itself take a spherical polygonal figure, at its induration, as well as the garnet. The white tin grains, (Sect. ccx.) out of which no tin, but only iron, is to be got, might with more reason be placed here, if it was not so excessively refractory in the fire, and if it did not, at last, melted either by itself, or with borax, give a clear and colourless glass, contrary to what the garnet does, which difference arises from the different fusibility of these two substances.

The garnet and cockle are not yet known to me in form of an earth or clay, taken in the common idea we have of those bodies. It is true, that there is a bole found at Swappawari, in Lapland, which has the same figure as the garnet; and the hornblende, (Sect. lxxxviii.) which is somewhat harder than this bole, has often the appearance of a cockle. We cannot, however, do more than problematically suppose them to be the nearest related to the garnet kind, as we have not yet discovered a method how to separate earths from the contained metals, without destroying their natural form, and especially from iron, when it is so strongly united with them, as if it had a part in their formation itself.

SECT. LXXVII.

The FOURTH ORDER.

The Argillaceous Kind, *Argillaceæ*.

The principal character whereby these may be distinguished from other earths, is, that they harden in the fire, and are compounded of very minute particles, by which they receive a dead or dull appearance when broken.

Moreover, there are some of this order which grow soft in water, and, when only moistened, become ductile and tenacious: these are commonly called clays. Some crack in the water, after having imbibed a sufficient quantity of it, but do not grow softer in it, and are therefore in the first degree of induration: some imbibe the water, but do not crack or fall to pieces; these are yet more indurated: and finally, some there are, in which the water has no ingress at all. Thus, by following the successive gradation of induration of a substance, which throughout all these circumstances is easily discovered to be the same, one may with great reason conclude, that the hardness of the jasper may perhaps be the last degree of hardness, and that this stone consequently consists of an argillaceous substance, (Sect. lxxv.) that already possesses a quality which the other clays cannot acquire but in the fire; having, besides, the same effect as the boles (Sect. lxxxvi.) when melted in the fire together with calcareous or other earths.

SECT. LXXVIII.

*A. Porcelain Clay, Terra Porcellanea, vulgò
Argilla Apyra.*

Is very refractory in the fire, and cannot in any common strong fire be brought into fusion any farther than to acquire a tenacious softness, without losing its form: it becomes then of a dim shining appearance and solid texture, when it is broke; strikes fire with steel; and has consequently the best qualities required, as a substance whereof vessels capable of resisting a melting

ing and boiling heat, and of holding salts and acids, can be made. It is found,

1. Pure, *Pura*.

A. Diffusible in water.

1. Coherent and dry.

a. White, from Japan.

I have seen a root of a tree changed into this clay. (Appendix, Section cclxxxiii.)

2. Friable and dry.

a. White, is found in clefts of rocks at Westerfilfverberget in Westmanland, and between the coal, in the coal-pits at Boserup, in the province of Skone*.

2. Mixed with phlogiston, and a very small quantity of inseparable heterogeneous substances, *Terra porcellanea phlogisto aliisque heterogeneis minimâ portione mixta*. Of these are,

A. Diffusible in water,

a. White and fat pipe clay, from Cologne and Maestricht.

Less unctuous is found in small fissures in a vein of *lapis ollaris*, at Swartwik, in the parish of Swerdzio, in the province of Dalarne.

b. Of a pearl colour, from Maestricht.

c. Bluish grey, *La belle terre glaise* from Montmartre, near Paris, in France.

d. Grey, France, Hesse, Bôsempin, Skone.

* These may be called pure, since after being burnt, they are quite white, though they have been exposed to a quick melting heat; and it may be queried, if all such clays must not be somewhat harsh, or at least not unctuous to the touch.

- e. Black, *La terre noire*, at Montmartre.
 f. Violet, also from Montmartre *.

S E C T. LXXIX.

B. Indurated, *Indurata*.

Is commonly unctuous to the touch, and more or less difficult to be cut or turned, in proportion to its different degrees of hardness; is not diffusible in water, grows hard, and is very refractory in the fire; pounded and mixed with water, it will not easily cohere in a paste: however, if it is managed with care, it may be baked in the fire to a mass, which, being broke, shews a dull and po-

* These contain a phlogiston, which is discovered by exposing them to a quick and strong fire, in which they become quite black interiorly, assuming the appearance of the common flints, not only in regard to colour, but also in regard to hardness: but if heated by degrees, they are first white, and afterwards of a pearl colour. The fatter they seem to be, which may be judged both by their feeling smooth and unctuous, and by their shining, when scraped with the nail, they contain a larger quantity of the inflammable principle. It is difficult to determine, whether this strongly adherent phlogiston is the cause of the above-mentioned pearl colour, or prevents them from being burnt white in a strong fire; yet no heterogeneous substance can be extracted from them, except sand, which may be separated from some, by means of water, but which sand does not make out any of the constituent parts of the clays. If they be boiled in aqua regis, in order to extract any iron, they are found to lose their viscosity. In the less unctuous clays, I have found pure quartz in greater and smaller grains; but still I would not venture to assert, that one is produced from the other, according to the rule I have laid down in Sect. ix. 1. I have likewise found this sort, upon certain occasions, attract the phlogiston in the fire. These remarks may serve as hints for the less experienced, who have a mind to examine those clays, which are of so great consequence for their oeconomic uses.

rous texture. It takes for the most part, and without much labour, a fine polish. It is found,

1. Compact and soft, *Particulis impalpabilibus mollis*; Smectis, Briançon, or French chalk.
 - a. White, from the Lands End, in Cornwall.
 - b. Yellow.
 - c. Red and white, Land's End: the Soap Earth, Switzerland. It looks like Castile soap.

S E C T. LXXX.

2. Solid and compact, *Particulis impalpabilibus solida*; Steatites, and also Soap Rock.
 - a. White, or light green, from Risver, in Norway, Bareuth, and Siksioberget, at Norberke, in Westmanland.
 - b. Deep green, from Salberg, in Westmanland, Swartwik, in Dalarne, Jonufwando, in Lapland, Salvisto, at Tamela, in Finland, &c.
 - c. Yellow, from Juthyllen, at Salberg, Torrakeberget, at Gosborn, in the province of Vermeland, and China*.

* It is a very difficult matter to specify all the varieties of the soap-stones, in regard to their hardness or softness, since they cannot be compared with any standard measure. Those from Risver, Siksioberget, and China, are a great deal harder and more solid than the English kind, from the Land's End, which breaks between the fingers; but are soft in comparison to that from Salberg, which is there called *Serpentine*, although both these varieties may indiscriminately be made use of for cutting and turning. The soft ones, however, are not so apt to crack, when they are worked, as the harder.

S E C T. LXXXI.

3. Solid, and of visible particles, *Solida particulis majoribus*; Serpentine stone, *Lapis Serpentinus*.

1. Of fibrous and coherent particles, *Lapis serpentinus fibrosus*.

This is composed, as it were, of fibres, and might therefore be confounded with the asbestus, if its fibres did not cohere so closely with one another, as not to be seen when the stone is cut and polished. The fibres themselves are large, and seem as if they were twisted.

a. Deep green.

Is sold for the *lapis nephriticus*, and is dug at some unknown place in Germany.

b. Light green, from Skienshyttan, in Westmanland; is used by the plate-smiths, instead of the French chalk.

S E C T. LXXXII.

2. Fine grained Serpentine stone, *Serpentinus particulis granulatis*: the Zoebnitz Serpentine.

But none of these varieties is found in the rock, without being interspersed with the unctuous clefts. When they are too many, too close to one another, and make the stone unfit for use, they are in this case called by the Swedish miners, *Skjolige*; and of this kind is a great quantity found at Salberg and Swartwik. Most part of the soap-rock, which is found in Sweden, is likewise mixed with glimmer or mica, and then it is called *Telgsten*, that is, *Ollaris*, Sect. cclxv,

a. Black.

- a. Black.
- b. Deep green.
- c. Light green.
- d. Red.
- e. Bluish grey.
- f. White. These colours are all mixed together in the serpentine stone, from Zoëblitz, but the green is the most predominant colour.

S E C T. LXXXIII.

3. Mixed with iron, *Terra porcellanea marte mixta*. This is
- A. Diffusible in water.
 - a. Red, *la terre rouge*, from Montmartre, and China.

Some of the bricks which are imported from some certain places in Germany, seem to be made of this kind.
 - B. Indurated.
 - 1. Martial soap earth, *Creta Brianzonica martialis*.
 - a. Red, from Jarfberg, in Norway.

It is likewise mixed with some calcareous matter.
 - 2. Martial soap rock, *Steatites martialis*.
 - a. Black, from Sundborn, in Dalarne, Torrakeberget, in Wermeland, Offerdal, in Jemtland.
 - b. Red, from Siljejord in Telemarken, in Norway*.

* Since the iron renders the so called refractory clays, as well as other clays, easier fusible than they really are by themselves; it might be queried, how it can be determined, of what species of argillaceous matter these consist? To this it

SECT. LXXXIV.

B. Stone Marrow, *Litbomarga* : *Keffekil* of the Tartars.

I have given this name to a kind of clay, which,

1. When dry, is as fat and slippery as soap: but,
2. Is not wholly diffusible in water, in which it only falls to pieces, either in larger bits, or resembles a curd-like mass.
3. In the fire it easily melts to a white or reddish frothy slag, therefore consequently is of a larger volume than the clay was before being fused.
4. It breaks into irregular scaly pieces.

A. Of coarse particles: Coarse Stone Marrow.

a. Grey, from Osmundsberget, in the parish of Rettwik, in Dalarna, and is there called *walklera*, that is, fuller's earth. It is mentioned in an account of Osmundsberget, published in the Transactions of the Academy of Sciences at Stockholm, in the year 1739, by the Berg's-radet, or mine-master, Mr Tilas.

b. Whitish yellow, from the Crim Tartary, where it is called *Keffekil*,

it is answered, That they are found together in the same beds with the porcelain clay: that they have all the same external signs, and differ from it only in the colour, being red, brown, or black, in regard to the contained metal: that they are more refractory in the fire than any other martial clay; and that, though they may be reduced so as to resemble a black or iron-coloured slag, they yet retain their form.

and

and is said to be used for washing instead of soap.

B. Of very fine particles: Fine Stone Marrow.

a. Yellowish brown, *Terra Lemnia*.

Is of a shining texture, falls to pieces in the water with a crackling noise; it is more indurated than the precedent, but has otherwise the same qualities*.

SECT. LXXXV.

C. Bole, *Bolus*.

Is a fine and dense clay of various colours, containing a great quantity of iron, which makes it impossible to know the natural and specific qualities of the bole itself, by any easy method hitherto in use. It is not easily softened in water, contrary to what the porcelain and the common clays are (*A. & E.*), but either falls to pieces in form of small grains, or repels the water, and cannot be made ductile. In the fire it grows black, and is then attracted by the load-stone.

* This cannot properly be called a *fuller's earth*, since it neither is of that kind used in the fulling business, nor is likely to be applicable to it †. It is, besides, a very scarce clay. It is not found indurated, so far as I know; and if it should at any time be discovered, it will be necessary to examine, if it is not a Zeolites (or the eighth order), or at least very nearly approaching to it, in regard to the effects both undergo in the fire.

† As the best sort of Fuller's Earth did not come into our author's hands, it is no wonder that he excludes it from its due place. The true Fuller's Earth of England is exactly like the stone marrow in all the above-mentioned properties; and in regard to the texture and colour, it comes nearest to the above-described coarse stone marrow. E.

SECT.

S E C T. LXXXVI.

1. Loose and friable boles, or those which fall to a powder in water.

a. Flesh-coloured bole, from Kristiersberg, at Nya Kopparberg, in Westmanland.

b. Red.

1. Fine, *Bolus Armenus*.

2. Coarse, *Bolus communis officinalis*, from the sand-stone quarries at Orsa, in the province of Dalarne.

3. Hard, *Terra rubrica*.

c. Green, *Terre verte*.

1. Fine, from Italy.

2. Coarse, from Stenstorp, in the province of Westergottland.

d. Bluish grey, from Stollberget, in Kopparbergslän, in Sweden.

Is ductile as long as it is in the rock, but even then repels the water; it contains forty per cent. of iron; which metal being melted out of it in a close vessel, the iron crystallises on its surface.

e. Grey.

1. Crystallised in a spherical polygonal figure: from Swappawari, in Lapland.

2. Of an undetermined figure, from Grengerberget, in Westmanland*.

† At the time when the *terræ sigillatæ*, or sealed earths, were in general use, the druggists endeavoured to have them of all colours; and for that reason they took all sorts of clays and sealed them; not alone the natural ones, but likewise such as had been coloured by art, or had been mixed with *magnesia alba officinalis*, or other things, were afterwards vended for true boles; and for this reason the species of
boles

S E C T. LXXXVII.

2. Indurated Bole, *Bolus indurata*.

A. Of no visible particles, *Particulis impalpabilibus*.

This occurs very often in form of slate, or layers in the earth, and then is made use of as an iron ore. However, it has usually been considered more in regard to its texture, than to its constituent parts, and has been called slate, in common with several other earths, which are found to have the same texture.

a. Reddish brown, from England †.

b. Grey, from Coalbrookdale, in Shropshire, and most collieries of England.

S E C T. LXXXVIII.

B. Of scaly particles, *Particulis squamosis* :
The hornblende of the Swedes.

boles is still thought to comprehend so many varieties. Thus the Cologne clay (Sect. lxxviii.) is by the druggists ranked among the white sealed earths, and is called a *white bole* : and this same clay is by the Swedish potters called *Englesk jord*, or English earth ; and by the tobacco-pipe makers, *Pip-lera* or pipe clay, &c. which shews how great a confusion there must ensue, if the knowledge of these bodies was not founded upon a surer ground than the colour, figure, and names invented by common mechanics. Since the most part of these *terræ sigillatæ*, or sealed earths, are found to contain iron, I conclude, that the bole must be a martial clay ; and, as such, it seems to be more fit for medical uses than other clays, if any dead earth must be used internally, when there is such an abundance of finer substances.

† In most collieries between the seams of coal, as at Hanam, in Kingswood, near Bristol, Blanavon, in Monmouthshire, &c. D. C.

Is distinguished from the martial glimmer, or mica, (Sect. xcv.) by the scales being less shining, thicker, and rectangular.

a. Black. This, when rubbed fine, gives a green powder.

b. Greenish.

Both these, particularly the black, are found every where in Sweden among the iron ores, and in the Grunsten (Section cclxix *).

S E C T. LXXXIX.

D. Tripoli, *Terra Tripolitana*.

Is known by its quality of rubbing hard bodies, and making their surfaces to shine, the particles of the tripoli being so fine, as to leave even no scratches on the surface. This effect, which is called polishing, may likewise be effected by other fine clays, when they have been burnt a little. The tripoli grows somewhat harder in the fire, and is very refractory : it is with difficulty dissolved by borax, and still with greater difficulty by the microcosmic salt : it becomes white when it is heated : when crude, it imbibes water, but is not diffusible in it : it tastes like common chalk, and is rough or sandy between the teeth, although no sand can by any means be separated from it. It has no quality common

* The hornblende grows hard in the fire, which is the reason why it is ranked here among the clays, though in all its other qualities it much resembles the cockle or shirl. (Section lxxii.) E.

with any other kind of earth, by which it might be considered as a variety of any other. That which is here described, is of a yellow colour, and is sold by druggists, who do not know where it is found*.

S E C T. XC.

E. Common Clay, or Brick Clay, *Argilla communis ; vulgaris Plastica.*

This kind may be distinguished from the other clays, by the following qualities.

1. In the fire it acquires a red colour, more or less deep.
2. It melts pretty easily into a greenish glass.
3. It contains a small quantity of iron and of the vitriolic acid, by which the preceding effects are produced.

It is found,

A. Diffusible in water.

1. Pure.

- a. Red clay, from Kinnekulle, in the province of Westergottland.
- b. Flesh coloured, or pale red, is found on the plains between Westeras and Sala, in the province of Westmanland.
- c. Grey, in the corn-fields in the province of Upland.

* I have got of this kind of tripoli from Scotland, which has been lately discovered there. But the rotten-stone, so called, is another sort found in England, viz. in Derbyshire. It is in common use here in England among workmen for all sorts of finer grinding and polishing, and is also sometimes used by lapidaries for cutting of stones, &c. D. C.

A SYSTEM OF

- d.* Blue, is very common in Sweden, in the provinces bordering upon the Baltic.
- e.* White, is found in the woody parts of Sodermanland, Dalarne, and of other provinces. It is often found in a flaty form, with fine sand between its strata. It is not easy to be baked in the fire: when it is burnt, it is of a pale red colour, and is more fusible than the preceding ones.
- f.* Fermenting clay, *Argilla intumescens.*

This is very like the preceding (*e*), as to the external appearance, and other qualities; but when they are both found in the same place, which is not uncommon in several of our mine countries, they seem to be different in regard to the fermenting quality of this variety. This fermentation cannot be the effect of the sand mixed with it, because sand is found in them both: and besides, this kind ferments in the same manner when it is mixed with gravel or stones; and then it ferments later in the spring than the other, since by the stones, perhaps, the frost is longer retained in it.

2. Mixed with lime, see Marle, Section XXV,

SECT. XCI.

B. Indurated.

1. Pure.

a. Grey slaty.

b. Red slaty, from Kinnekulle, in the province of Westergottland.

2. Mixed with phlogiston, and a great deal of the vitriolic acid. See Alum Ores, Sect. cxxiv.

3. Mixed with lime. See Lime, Sect. xxviii*.

* It is probable, although it is not easily demonstrable, that the common clay, and especially the blue, grey, and pale red, which are the soils of our plains and dales bordering upon lakes, has its origin from mud, and that the mud owes its existence to vegetables; consequently that these varieties of clay are nothing else than a mould, or *humus ater*, somewhat altered by means of water, and by length of time. The following circumstances contribute greatly to confirm this opinion, viz. that a great quantity of sea-plants rot every year in the lakes, and are changed into mud; that very little, however, of this mud is seen upon the shores after the water is dried in summer-time; and that the clay begins where the mud ceases. Concerning the turf, or peat, it is to be observed, that this is not always produced from vegetables growing upon the very same spot where it is cut, but from such vegetables as have been thrown together from other places: for in what other manner could hazle-nuts occur in the turf-moors, in places where no hazle-trees grow, even at a distance of many miles? not to mention other instances of the same nature. Secondly, the turf, or peat, is cut in humid and low marshes, which are not constantly covered with water, as on the banks of lakes over-grown with grass. If the origin of turf was any other than here mentioned, there ought to be turf found instead of mud at the bottom of lakes where there is plenty of grass.

The quantity of iron, and of the vitriolic acid contained in this clay, would perhaps not be found greater than to answer in proportion to the quantity of each of these substances, that enters into the composition of vegetables, whilst growing, if there were any possibility of making the comparison. Mean

S E C T. XCII.

O B S E R V A T I O N O N C L A Y S in general.

Those who have taken upon themselves to examine the mineral bodies according to the principles upon which this System is built, will readily, I hope, excuse those faults which may have been committed in classing the clays; because they must well know, not only how difficult it is to procure a number of different varieties of this order in their natural state, which have not been previously washed or prepared for

while I have in dry summers observed on the sea-shore, that a perfect iron vitriol has been growing out of the mud, clays, and vegetables not yet rotted, which has been thrown up there together.

When this opinion is once proved to be true, one may venture to go farther, and endeavour by observations and experiments to prove likewise, that in the subversions or changes that the earth has more than once suffered in every part of it, and in which water has contributed the most to carry off the particles, and to change the strata, the clay has been gathered together, and lodged in beds together with other substances. Some of those strata have afterwards been indurated, by which means they are turned into the above slaty and limy clays; and when they have been mixed with a great quantity of vegetables, and of the inflammable substance, they may in length of time be changed into pit-coal: but when they have been mixed with less phlogiston, and a great quantity of the vitriolic acid, they constitute the alum ores, &c.

Others of those strata, which are not yet hardened, prove still, by their being set or divided with some separating veins of sand, that they have been formed in the same manner as the settlings or sediments of stamping mills, and may perhaps, throughedulcoration in water, or through age, have lost their fertility, since they never are so good to improve lands with, as those strata which are supposed to be of a more recent formation, such as *b. c. d.*

use, as the sealed earths, &c. but also that it is no easy matter distinctly to describe some little circumstances that occur to the eye, both in their natural state, and during the experiments. Besides, they cannot but remember, that the progressional degrees both of hardness, and of the quantity of mixed heterogeneous bodies, especially iron, produce a number of imperceptible differences between them, in regard to colour and effects; so that they cannot with due precision be separated and divided into their true genera, species, and varieties, before some more evident differences between them may, by repeated experiments, and perhaps by processes yet unknown, be discovered. In examining the clays, one ought carefully to observe the different degrees of fire due to each kind: for without this knowledge they can never be employed to any real use in common life. Next to this, there is another point equally necessary to be taken notice of, that is, the manner of working the clays, which is often different in different kinds, and which, not less than the different degrees of fire, is productive of different effects; and therefore, if both these circumstances are not at the same time exactly described, it is as wrong to assert with some authors, that a refractory clay does never crack in the fire, as it is deceiving to pretend that the same clay does never imbibe the water, when it has been baked. Hence comes that great difference in regard both to appearances and qualities, between a tobacco-pipe, which is very little baked, and a jar from Waldenburg, between a common brick and the other sort called a water clinkert.

The use of clays, in common life, is more extensive than I have been able to inform myself of; for which reason I will only mention some particulars relating to it.

The porcelane clay is employed to make vessels which have that quality already mentioned (Sect. lxxviii.). I make no doubt but it enters into the composition for making the fine porcelane ware at some places; at least vessels are prepared from it of the same goodness in every respect: and there are likewise some varieties of this clay, which become quite white in the fire, a quality which is esteemed the most valuable in the fine China ware.

The indurated porcelane clay cannot be easily heated without cracking, and is therefore of no great service, if hardened in the fire alone, and in its natural state: though this circumstance is of less inconveniency, than when it has original cracks, or is mixed with heterogeneous substances. The steatites * is found purer and more solid in China than in any place in Europe. The natural faults of the European ones may, however, be altered by adding some fat substance to it, when it is to be burnt; by which means it becomes black or brown; and this method is said to be used at Bareith. The coarse porcelane-like earth, which goes by the name of *French clay*, is used at the glass-houses, steel furnaces, and other works of the same nature, for the same reasons as it is the

* The steatites here meant is the substance of which the Chinese josses or figures commonly called rice figures are made: it is, according to my method, of the class of Talcs, and of the genus of Nephritics. D. C.

principal ingredient in the making of crucibles, retorts, &c.

The boles have almost lost their value as medicines, and are employed to make bricks, potters-ware, and pig-iron.

The tripoli is an indispensable article for the polishing of metals, and some sorts of stones; it is likewise on certain occasions preferred for making moulds to cast metals in.

The common clay is of the greatest benefit in agriculture, except however the white clay and the fermenting clay, both of Sect. xc. which varieties we know not yet how to apply to any use. By virtue of its coherency, this clay retains humidity, on which perhaps its chief benefit to vegetables depends, its other effects being occasional, owing either to nature or art; unless the clay has formerly been a mould or *humus ater*, in which case it is just, that part of it should enter again into the formation of the new vegetables. The clay used in the refining of sugar, wants no other quality than that it may not dry too soon. But that species which is to be employed in fulling, must, if we were to judge *à priori*, besides the fineness of its particles, be of a dry nature, or such as attracts oils; though this quality may perhaps not be found in all those clays which are now employed in that business.

S E C T. XCIII.

The FIFTH ORDER.

The Micaceous Kind, *Micacæ*. The Glimmer, Daze, or Glist.

H 4

These

These are known by the following characters.

1. Their texture and composition consist of thin flexible particles, divisible into plates or leaves, having a shining surface.
2. These leaves, or scales, exposed to the fire, lose their flexibility, and become brittle, and then separate into thinner leaves: but in a quick and strong fire, they curl or crumple, which is a mark of fusion; though it is very difficult to reduce them into a pure glass by themselves, or without addition.
3. They melt pretty easily with borax, the microcosmic salt, and the alkaline salt; and may, by means of the blow-pipe, be brought to a clear glass, with the two former salts. The martial mica is, however, more fusible than the uncoloured ones.

There is not yet discovered any loose earth of this kind, but it is always found indurated.

SECT. XCIV.

A. Colourless or pure mica; Daze, Glimmer, or Glist; *Mica alba, sive pura*.

1. Of large parallel plates, *Mica constans lamellis magnis parallelis*. Muscovy glass, *Vitrum Muscoviticum*.

Is transparent as glass; found in Siberia, and Elfdalen in the province of Wermeland.

2. Of small plates, *Mica squamosa*, from Silberberget, at Runneby, in the province of Blekinge.

3. Of

3. Of particles like chaff, or chaffy mica, *Particulis acerosis*.
4. Of twisted plates, crumpled mica, *Mica contorta*, *Talcum officinale*.

S E C T. XCV.

B. Coloured and martial glimmer, *Mica colorata martialis*.

1. Of large parallel plates, *Mica lamellosa martialis*.
 - a. Brown semi-transparent, from Kola, in Lapland.
2. Of fine and minute scales.
 - a. Brown.
 - b. Deep green, from the mine of Salberg, in the province of Westmanland.
 - c. Light green, *Talcum officinale*, found in the ollaris, from Handol, in the province of Jemtland.
 - d. Black, found in the granites, in the province of Upland.
3. Twisted or crumpled glimmer, *Mica contorta martialis*.
 - a. Light green, in the ollaris, from Handol.
4. Chaffy glimmer, *Mica martialis particulis acerosis*.
 - a. Black, is found in the stone called *hornberg*, which occurs in most of the Swedish copper-mines; for instance, those at Norberg, Flodberg, &c.
5. Crystallised glimmer, *Mica drusica*.
 1. Of concentrated and erect scales, *Drusa micacea constans squamis concentratis perpendicularibus caryophylloides*.

2. Of

2. Of hexagonal horizontal plates, *Drusa micacea constans squamis hexagonis horizontalibus*. This is found in the mines at Salberg, in the province of Westmanland.

SECT. XCVI.

OBSERVATION ON THE MICÆ, OR GLIMMERS.

The stones belonging to this order are by most authors considered as Apyri, which they really are in some degrees of heat, and when they are mixed with certain bodies : but they may at the same time with equal propriety be called Vitrescents, both *per se* or by themselves, because they melt with that degree of fire in which neither quartz nor limestone are in the least altered ; and are still more readily fused, when mixed with a martial earth, either by nature or art : hence, if *hornberg* is naturally mixed with copper ores, as is frequently found in Sweden, it is no way detrimental to the smelting of them, as they commonly contain a sufficient quantity of sulphureous acid, which scorifies the iron. But when the glimmer is mixed with quartz, it may perhaps be impossible to melt it, because it renders the quartz so compact, as to prevent it from cracking, which may be seen on the rock-stone (Sect. cclxii.) : The mica does the same, when it is interspersed in an apyrus clay ; and this is the reason why the ollaris so strongly resists the fire.

The mica has in some degree the same qualities as an argillaceous earth ; but, for want of sufficient experiments and observations, we cannot yet assert it to be a product of clay.

The

The martial mica in a calcining heat acquires a yellow shining colour, which has induced many to examine it for gold; but nothing can be obtained from it except iron, which may be dissolved or extracted by means of aqua regis: although a late German author has pretended that he produced from the mica an unknown semi-metal, which resembled iron mixed with zink. Nevertheless he owns, that he has not examined this semi-metal, and that for obtaining it he used a flux, composed of several metals, some of which probably united with the iron in the mica: wherefore it is probable we shall never hear more of it.

Some of the micaceous kind seem fat and unctuous, and others harsh and dry: it is not improbable that the former may contain a phlogiston, although this cannot be extracted from them in form of a pure *oleum talci*; in other particulars, they are so like one another, that there is no reason for making them two distinct genera.

The *talci cubes*, as they are called, which have the figure of alum, and are sometimes found in the copper-mine of Falun, in the province of Dalarne, and which are very much valued by some fossilogists, are, when broke, found to consist of an iron ore, often mixed with a yellow or marschalitical copper ore, and only covered with a very thin coat of mica.

The transparent Muscovy glass is used for windows, and upon all occasions where panes of glass are wanted. Perhaps it might also be advantageously employed to cover houses.

The twisted or crumpled mica, which is found at Handol in Jemtland, is there manufactured into kettles and other vessels, as also for hearths of chimnies; and the powder which falls in the
working

working of this stone may be mixed with the common salt, for the distillation of the muriatic acid.

S E C T. XCVII.

The SIXTH ORDER.

The Fluors *, *Fluores Minerales*. Suet. *Fluss-arter*. Germ. *Fluss-arten*.

These are commonly called fluxing vitrescent, or glass spars, because most part of them have a sparry form and appearance: they are, however, often met with in an indeterminate figure.

These are only known in an indurated state, and distinguish themselves from the other earths, by the following characters.

1. They are scarce harder than a calcareous spar, and consequently do not strike fire with the steel.
2. They do not ferment with acids, neither before nor after calcination, notwithstanding a phlogiston or an alkali had been added in the calcination.
3. They do not melt by themselves, but only split to pieces when exposed to a strong fire †. But,
4. In mixtures with all other earths, they are very fusible, and especially when they are

* I have adopted the name of Fluors, in English, to this order. D. C.

† There may, perhaps, be some fluors that are pretty refractory in the fire, so as not to be melted: however, all those which I have tried, have melted pretty easily by the blow-pipe; but I have always taken great care in these experiments, that they might not fly away before they were heated through. E.

blended with the calcareous earth, with which they melt to a corroding glass, which dissolves the strongest crucibles, unless some quartz or apyrus clay is added thereto.

5. When heated slowly, and by degrees, they give a phosphorescent light: but as soon as they are made red-hot, they lose this quality. The coloured ones, and especially the green, give the strongest light, but none of them any longer than whilst they are well warm.
6. They melt and dissolve very easily by the addition of borax, and next to that by the microcosmic salt, without ebullition.

S E C T. XCVIII.

A. Indurated Fluor, *Fluor mineralis induratus.*

1. Solid, of an indeterminate figure, *Fluor particulis impalpabilibus, figurâ indeterminate.*

Is of a dull texture, semi-transparent, and full of cracks in the rock.

- a.* White, found in Batgrufvan, at Yxjö in Nya Kopparberget in Westmanland.

S E C T. XCIX.

2. Sparry Fluor, *Fluor Spatosus.*

It has nearly the figure of spar, though, on close observation, it is found not to be so regular, nothing but the glossy surfaces of this stone giving it the resemblance of spar.

- a.* White,

- a. White, found in Stripas at Norberg, in the province of Westmanland.
- b. Blue, from Norrgrufve, at Westersilfverberget in Westmanland.
- c. Violet, from Diupgrufvan, at the last mentioned place, and also from Stripas and Fogerlid; and Gislof in the province of Skone.
- d. Deep green, from Stollberget in Stora Kopparbergslan.
- e. Pale green, from Kuppgrufven, at Garpenberg in the province of Dalarne.
- f. Yellow, from Gislof in Skone.

S E C T. C.

- 3. Crystallised Fluor, *Fluor crystallifatus*, when in single cristals; but Fluor Druse, when many cristals are heaped together.
 - 1. Of an irregular figure.
 - a. White.
 - b. Blue, both from Norberget and Norberg in Westmanland.
 - c. Red, from Heslekulla iron-mine, in the province of Nerike.
 - 2. Of a cubical figure.
 - a. Yellow, and
 - b. Violet, from Gislof in Skone, Blyhall in the parish of Barkaro in the province of Westmanland.
 - 3. Of a polygonal spherical figure.
 - a. White, from Bockbackeveggen in Falun copper-mine in Dalarne.
 - b. Blue, from Bondgrufvan, at Norberg in Westmanland.

4. Of

4. Of an octoëdral figure.
a. Clear, colourless. This I have seen in the collection of the mine-master Mr. Von Swab.

S E C T. CI.

O B S E R V A T I O N on the F L U O R S.

There are not yet any probable reasons given, why these stones should be ranked amongst the calcareous or any other earths; and if I am not quite mistaken in my judgment, they are so much the more different from the calcareous earth, as they, when melted together with it, produce an effect which never can be ascribed to the alkaline earths; not to mention, that there is by no method yet known any calcareous substance to be extracted from them, nor is there any possibility of decomposing them.

That which causes the phosphorescent light vanishes in the fire, it being impossible to collect it: in the present ignorance of the nature of this matter, it cannot therefore be asserted, whether it is one of the constituent parts necessary to the composition of these stones, or if, in regard to its small quantity, it even deserves any attention. I take it to be a subtle phlogiston, which being modified in various manners, gives rise to such various colours.

At mineral works this kind of stone is very useful in promoting the fusion of the ores, and is therefore as much valued by the smelters, as the borax is by the assayers: it has also from this quality got the name of *fluor*, or *flux*.

The resemblance between the coloured fluors, and the compositions made of glass, has perhaps contributed

contributed not only to the fluors being reckoned of the same value as the coloured quartz crystals, by such collectors as only mind colour and figure; but also to their obtaining a rank among the precious stones in the apothecaries and druggists shops. They, however, may be permitted to enjoy that honour, since our modern physicians do not make more use of them than of the others.

SECT. CII.

The SEVENTH ORDER.

The Asbestos Kind, *Asbestinae*.

These are only yet discovered in an indurated state: their characters are as follow.

1. When pure, they are very refractory in the fire.
2. In large pieces they are flexible.
3. They have dull or uneven surfaces.
4. In the fire they become more brittle.
5. They do not strike fire with the steel.
6. They are not attacked by acids.
7. They are easily brought into fusion by borax.

In this order are included both those varieties which by fossilogists have been mentioned under the names of *Amianti* and *Asbesti*, and have often been confounded together.

S E C T. CIII.

1. Asbestus which is compounded of soft and thin membranes, *Asbestus membranaceus*; *Amiantus Wallerii*.

A. Of parallel membranes, *Asbestus membranis constans parallelis*: *Corium*, five *Caro Montana*, Mountain-leather.

1. Pure.

a. White, from Salberg in Westmanland.

2. Martial.

a. Yellowish brown, from Storrginnigen, at Dannemora, in the province of Upland.

This melts pretty easily in the fire to a black slag, or glass.

S E C T. CIV.

B. Of twisted soft membranes, *Asbestus membranis constans contortis*: *Suber montanum*, Mountain cork.

1. Pure.

a. White, from Salberg in Westmanland.

2. Martial.

a. Yellowish brown, from Dannemora.

This has the same quality in the fire as the martial mountain leather.

S E C T. CV.

2. Of fine and flexible fibres, *Asbestus fibrosus*: *Asbestus*, or Earth Flax, *Asbestus Wallerii*.

I

A. With

A. With parallel fibres, *Asbestus fibris constans parallelis*: *Byffus*.

1. Pure and soft.

a. Light green, from Schelkowa Gora in Siberia.

b. White, from Ulrica's Ort in the mine of Salberg in Westmanland: it is there found together with mountain leather.

2. A little martial, and more brittle.

a. Greenish, from Bastnas Grufva, at Ryddarhyttan in Westmanland. There it forms the greatest part of the vein out of which the copper ore is dug; a great part of it is consequently melted together with the ore, and is then brought to a pure semi-transparent martial slag or glass.

S E C T. CVI.

B. Of broken and recombined fibres, *Asbestus fibris constans abruptis et conglutinatis*.

1. Martial.

a. Light green, from Bastnas Grufva at Riddarhyttan.

S E C T. CVII.

It has been already observed under the title of Cockle, or Shirl, (Sect. lxxiv.) that the asbestus is often confounded with it.

OBSERVATION ON THE ASBESTUS KIND.

I am much inclined to believe that the Asbesti, as well as the Micæ, are produced from an argillaceous

gillaceous earth, both because they become brittle in the fire, which is a proof that they harden, and because they become more fusible by the admixtion of a martial earth: but the method nature makes use of for this change is as unknown, as it might perhaps in other respects be necessary, not to force the earths together, for some slight reason, within the compass of a few orders.

The Siberian Asbestos, which may be considered as the principal and chief of the fibrous kind, is, as it were, consumed by the flame of a blow-pipe, and does not leave any more certain mark of fusion; but it melts readily with borax to a clear and colourless glass.

The natural store of this kind is in proportion to its œconomical use, both being very inconsiderable. It is an old tradition, that in former ages they made cloaths of the fibrous asbesti, which is said to be expressed by the word *Byssus*; but it is not very probable, since, if one may conclude from some trifles now-a-days made of it, as bags, ribbons, and other things, such a dress could neither have an agreeable appearance, nor be of any conveniency or advantage. It is more probable that the Scythians dressed their dead bodies, which were to be burnt, in a cloth manufactured of this stone; and this has perhaps occasioned the above fable.

Paper is likewise made from this stone, only to shew its fixity in the fire, and to procure some esteem and value to this curious substance.

It was reported some years ago, that the French searched for asbesti, in order to mix it with the tar for preserving houses and ships; but the question is, If the asbesti can be of more service than pounded mica, or charcoal-dust employed to the same purpose?

S E C T. CVIII.

The EIGHTH ORDER.

Zeolites.

This is described in its indurated state, in the Transactions of the Academy of Sciences at Stockholm, for the year 1756, and there methodised as a stone *sui generis*, in regard to the following qualities.

1. It is a little harder than the fluors, and the calcareous kind: it receives however scratches from the steel, but does not strike fire with it.
2. It melts easily by itself in the fire, with a like ebullition as borax does, into a white frothy slag, which not without great difficulty can be brought to a solidity and transparency.
3. It is easier dissolved in the fire by the mineral alkali (*sal sodæ*), than by the borax and microcosmic salt.
4. It does not ferment with this last salt, as the lime does; nor with the borax, as those of the gypseous kind.
5. It dissolves very slowly, and without any effervescence, in acids, as in oil of vitriol and spirit of nitre. If concentrated oil of vitriol is poured on pounded zeolites, a heat arises, and the powder unites into a mass*.

* Since the publication of this Essay, there has been discovered more varieties of the zeolites, particularly at Adelfors's gold-mines in Smoland in Sweden, of which some sorts do not melt by themselves in the fire, but dissolve readily in the acid of nitre, and are turned by it into a firm jelly. E.

6. In the very moment of fusion it gives a phosphorus or light.

S E C T. C I X.

The zeolites is found in an indurated state.

1. Solid, or of no visible particles, *Zeolites solidus particulis impalpabilibus.*

A. Pure, *Zeolites durus.*

a. White, from Iceland.

B. Mixed with silver and iron.

a. Blue, *Lapis lazuli*, from the Buckarian Calmucks.

This, by experiments made with it, has discovered the following properties.

1. It retains for a long time its blue in a calcining heat, but is at last changed into a brown colour.
2. It melts easily in the fire to a white frothy slag; which, when exposed to the flame of a blow-pipe, is greatly puffed up, but in a covered vessel, and with a stronger heat, becomes clear and solid, with blue clouds in it.
3. It does not ferment with acids: but,
4. Boiled in the oil of vitriol, it dissolves slowly, and loses its blue colour.

When a fixed alkali is added to this solution, a white earth is precipitated, which being scorified with borax, yields a silver regulus, that varies in bigness, according to the various samples of the stone.

A SYSTEM OF

5. By scorification with lead, there has been extracted two ounces of silver out of a hundred pounds weight of the stone.
6. The presence of silver is not discovered with the same certainty by the spirit of nitre as by the oil of vitriol.
7. When the spirit of sal ammoniac is added to any solution, made either of crude, or of a perfectly calcined lapis lazuli, there is no blue colour produced; which proves that this colour is not owing to copper, as some have pretended: and this is farther confirmed by the fixity of the blue colour in the fire (1, 2.), and by the colour of the slag or glass (2.).
8. It is a little harder than the other kinds of zeolites, but does not however in hardness approach to the quartz, or to other stones of the siliceous kind in general; because the purest and finest blue lapis lazuli may be rubbed with the steel to a white powder, although it takes a polish like marble.
9. The lapis lazuli, when perfectly calcined, is a little attracted by the loadstone; and scorified with lead, the slag becomes of a greenish colour, not such a colour as copper gives, but such as is always produced by iron mixed with a calcareous substance*.

* The lapis lazuli is seldom found pure, but is most generally full of veins of quartz, limestone, and marcasite: however,

S E C T. CX.

2. Sparry Zeolites, *Zeolites spatofus*.

This resembles a calcareous spar, though it is of a more irregular figure, and is more brittle.

a. Light red, or orange-coloured, from Nya Krongrufvan, one of the gold-mines at Adelfors, in the province of Smoland.

ever, for these experiments none but the purest pieces have been picked, such as have been examined through a magnifying-glass, and been judged as free from heterogeneous mixtures as possible. It is to be wished, that those who have a sufficient quantity of this stone would continue these experiments, in order to discover what substance it is that makes this blue colour, which is so constant in the fire, since it cannot depend either on copper or iron; for though those metals, on certain occasions, give a blue colour, yet they never produce any other but what instantly vanishes in the fire, and is destroyed by means of an alkali. What is mentioned in several books about the preparation of the ultramarine from silver, can by no means be objected here, since in those processes the silver employed is mixed with copper, and other substances, which contain a volatile alkali, whereby the blue colour is produced †.

In regard to the above-mentioned qualities of this stone, it cannot be classed under any other kind of earth than this.

† Mr. Margraf has since, in his Chemical Dissertations, printed in German in the year 1761, published some experiments on the lapis lazuli; and in the chief agrees with our author, without, however, knowing any thing of these his experiments. Mr. Margraf also proves that there is no copper in this stone; and besides tells us, that he has found both a calcareous and a gypseous substance in it, although he took care to pick out only the very pure bits for his experiments. However, I am led to imagine, that the calcareous substance is not essential to the existence of the lapis lazuli, since Mr. Cronstedt expressly says, that the stone he tried did not ferment at all with acids. He farther mentions this remarkable circumstance, which makes it still more evident that the lapis lazuli belongs to the zeolites, viz. that, when calcined and dissolved in the acids of vitriol, of common salt, and of nitre, it turned all those acids into a jelly. However, he does not take any notice of its containing any silver, because he did not prosecute his experiments so far on that point; but some of his experiments, nevertheless, seem to indicate, as if all sorts of lapis lazuli did not contain silver. E.

S E C T. CXI.

3. Crystallised Zeolites, *Zeolites crystallisatus*.

Is more common than the two preceding kinds, and is found,

A. In groupes of crystals in form of balls, and with concentrical points, *Crystalli zeolitis pyramidales concreti ad centrum tendentes*.

a. Yellow, from Swappawari, in Tornea in Lapland.

b. White, from Gustavsgrufvan, in the province of Jemtland.

B. Prismatical and truncated crystals, *Crystalli zeolitis distincti figura prismatica truncata*.

a. White, from Gustavsgrufvan in Jemtland.

C. Capillary crystals, *Crystalli zeolitis capillares*.

Are partly united in groupes, and partly separate. In this latter accretion they resemble the capillary, or feather silver ore (Sect. clxxiii.), and is, perhaps, sometimes called *Flos ferri*, at places where the nature of that kind of stone is not yet fully known.

These crystals are found,

a. White, from Gustavsgrufvan in Jemtland.

S E C T. CXII:

OBSERVATION ON THE ZEOLITES:

This kind of stone has nearly the same qualities in the fire as the boles (Sect. lxxxv); so that both
of

of them, when more nicely examined, may perhaps be found to belong to the same order, and perhaps be some kind of earth, whose properties have been long and perfectly known.

The *terra porcellanea Luneburgica*, which Bruckman mentions, and Mr. Wallerius has ranked among the gypsa, may, perhaps, belong to this order: but I have not been able to procure a specimen of it, to compare it with the zeolites, which also is very scarce, not being found in our country except in very small veins and cavities. To this scarcity is owing, that it has not yet been tried in the fire together with other kinds, except with the sparry fluor. With that it does not fuse very readily, because, when equal parts of them are melted together, an opaque slag or glass is produced of the same colour with the alcali of nitre, of a fibrous texture, and of an uneven surface.

The quality of swelling in the fire, like the borax, is peculiar to the crystals, (Sect. cxi.) because the other varieties rise only into some small blisters, which are of a white colour at their edges, and instantly cover themselves with a white glassy skin, after which they become quite refractory.

SECT. CXIII.

The NINTH ORDER.

The Manganese Kind, *Magnesia*.

The stones belonging to this order, are in Swedish called *Brunsten*, in Latin *Syderea*, or *Magnesia nigra*, in order to distinguish them from the *Magnesia alba officinalis*, and in French *Mangonese*, &c. They are by some litho-

lithographists entirely omitted, and by others ranked among the iron ores; but, as I am convinced both by my own experience, and by that of others, that they contain no greater quantity of metal than sometimes two or three per cent. of iron, and sometimes a little tin, I think that the remaining part, which must consequently be considered as a kind of earth, deserves its particular separate place in a mineral system, at least until a farther insight into its nature may be obtained: and to this opinion I have been persuaded by its following peculiar qualities:

1. The manganeses consist of a substance, which gives a colour both to slags, and to the solutions of salts, or, which is the same thing, both to dry and to liquid menstrua; viz.
 - a.* Borax, which has dissolved manganese in the fire, becomes transparent, of a reddish brown or jacinth colour.
 - b.* The microcosmic salt becomes transparent with it, of a crimson colour, and moulders in the air.
 - c.* With the fixed alkali, in compositions of glass, it becomes violet; but if a great quantity of manganese is added, the glass is in thick lumps, and looks black.
 - d.* Scorified with lead, the glass gets a reddish brown colour.
 - e.* The lixivium of a deflagrated manganese is of a deep red colour.
2. It deflagrates with nitre, which is a proof that it contains some phlogiston.
3. When reckoned to be light, it weighs as much as an iron ore of the same texture.
4. Being melted together with glass compositions, it ferments during the solution: but
it

- it ferments in a still greater degree, when it is melted with the microcosmic salt.
5. It does not excite any effervescence with the spirit of nitre: aqua regia, however, extracts the colour out of the black, and dissolves likewise a great deal of it, which, by means of an alcali, is precipitated to a white powder.
 6. Such colours as are communicated to glasses by manganese, are easily destroyed by the calx of arsenic or tin: they also vanish of themselves in the fire.
 7. It is commonly of a loose texture, so as to colour the fingers like soot, although it is of a metallic appearance when broke.

S E C T. CXIV.

Manganese is found,

A. Loose and friable, *Magnesia friabilis terriformis*.

- a. Black, seems to be weathered or decayed particles of the indurated kind, from England.

S E C T. CXV.

B. Indurated, *Magnesia indurata*.

1. Pure, in form of balls, whose texture consists of concentric fibres, *Magnesia pura spherica radiis concentratis*.

- a. White, *Magnesia alba strictè sic dicta*, is very scarce. I have seen a specimen of this kind in a collection from an unknown place in Norway; and by examining a piece of it, I found that it differed from
the

the common manganese, by giving to the borax a deep red colour in the fire: this sort acquires a reddish brown colour when it is calcined.

- b. Red manganese is said to be found in Piedmont. This I have never seen; but I have been told by an ingenious gentleman, that this variety is free from iron, and gives to glass rather a red than a violet colour.

S E C T. CXVI.

2. Mixed with a small quantity of iron, *Magnesia parum martialis*.

- a. Black manganese, with a metallic brightness. This is the most common kind, and is employed at the glass-houses, and by the potters.

It is found,

1. Solid, of a slaggy texture, *Magnesia textura vitrea*, from Skidberget, in the parish of Lekсанд, in the province of Dalarne.
2. Steel grained, also from Skidberget.
3. Radiated, *Radiata*, still from Skidberget, and Tiveden, in the province of Ostergottland.
4. Crystallised.
 - a. In form of coherent hemispheres, *Hemispheriis continuis*, from Skidberget in Lekсанд.

S E C T. CXVII.

3. Blended with a small quantity of iron and tin, *Magnesia parva cum portione martis*

tis et jovis mixta: Spuma Lupi, or Wolfram.*

I. With coarse fibres.

a. Of an iron colour, from Altenberg in Saxony. This gives to the glass compositions, and also to borax and the microcosmic salt, an opaque whitish yellow colour, which at last vanishes.

S E C T. CXVIII.

OBSERVATIONS ON THE MANGANESE.

Though it may seem difficult to many, to distinguish the kinds of manganese by their appearance, or external marks; yet it is extremely easy to know them by experiments made in the fire, if attention is had to the above-mentioned phenomena (Sect. cxiii.). From hence it is not difficult to comprehend why manganese has hitherto been either omitted, or erroneously ranked in systems, viz. because it has, like many other mineral bodies, been examined only by sight, while the more troublesome method of examining it in the fire, has been overlooked.

Some might perhaps imagine the manganese to be the remainder of some metal, which cannot be reduced again into its metallic state; but it ought to be remembered, that no metal can, by any means yet known, be brought to an absolutely irreducible earth or calx, unless perhaps by the burning-glass, and therefore there is no reason to suspect that nature gives such a production. Ig-

* Wolfram is a name which is also sometimes given to mock lead, and sometimes to cockle, or shirl, as also to other minerals; however, it is chiefly given to this species of manganese, when it occurs in the tin-mines. E. and D. C.

norance and idleness have invented certain terms or expressions, to avoid giving an account of those ores or mineralisations, which are not easy enough to be decomposed; for instance, *wild, rapacious, arsenical, volatile, &c.* and some iron ores in particular have been thus called; by which means it has happened, that œconomical reflections have often been added to natural and philosophical descriptions: and thus others are deterred from examining many bodies, of which we have got, and still retain false notions by this way of proceeding.

The manganese has by systematists been commonly ranked among such iron ores; but the artificers who make use of it in the manufacture of glass do not know it; nor can they by any means be persuaded to use any of the pretended bodies a-kin to it, instead of the manganese itself, since experience prevails more with them than suppositions. The consumption of the manganese is but small, and therefore it is not a very profitable article.

SECT. CXIX.

The SECOND CLASS.

The SALTS, *Salia.*

By this name those mineral bodies are called, which can be dissolved in water, and give it a taste; and which have the power, at least when they are mixed with one another, to form new bodies of a solid and angular shape, when the water in which they are dissolved is diminished to a less quantity than is required to keep them

them in solution; which quality is called Crifal-
lification *.

S E C T. CXX.

In regard to the known principal circumstances
or qualities of the mineral falts, they are divided
into

1. Acid Salts, or Mineral Acids, *Salia Acida*.
2. Alcaline Salts, or Mineral Alcalis, *Salia
Alcalina*.

The F I R S T O R D E R.

Acid Salts, *Salia Acida*.

The characters of these falts are, that
they,

1. Have a four taste.
2. Are corrosive; that is to say, have a power
of dissolving a great number of bodies.

* No other falts ought to be considered and ranked in a
mineral system, but those which are found natural in the
earth (Seçt. i.) ; and for this reason a great number of falts
will be in vain looked for here, viz. all such as are either na-
tural or prepared by art in the other two kingdoms of nature,
and from substances belonging to them. Amongst these is
nitre itself, and its acid, and the vegetable acid, since these
are never had from true mineral bodies ; nor is it demonstrated,
that they have their origin from the true mineral vitriolic
and muriatic acids. There have, indeed, been many attempts
made to reduce most of them to a vitriolic acid, which by
many is called the universal acid : but experiments will not
agree with it ; at least nobody has yet been able, by uniting
a phlogiston with another acid than the true vitriolic, to
produce any substance in every particular resembling the true
brimstone, or sulphur. For this reason I cannot yet give my
assent to Doctor Pictsch's opinion, who endeavours to prove,
that the acid of nitre is derived from the vitriolic acid, that is,
before his theory is confirmed by experience in the large way,
and the analysis has been more plainly laid open : but I think
the

3. They have a strong attraction to the alkaline salts and earths, whence they always unite with them with an effervescence, and sometimes with a strong heat: by this mixture bodies are produced, which are employed in common life under the names of *vitriols*, *neutral salts*, *gypsum*, &c.
4. They change most of the expressed blue juices of vegetables into red.

the question remains still undecided, if the nitrous, vegetable, and urinous acids are primitive substances? or if they owe their origin to one and the same principle? and, if this last be the case, of what nature this principle is? But howsoever this may prove, the consideration of these acids seems more properly to belong to another science. The same may be said of the doctrine which holds, that the nitre is produced from the principles of the sea-salt, by a certain peculiar modification.

The above-mentioned two mineral acids, whose qualities we know nothing of, until they have been by art extracted from the vitriols, and the sea-salt, are indeed never found pure in nature, because as soon as they, on any occasion, are, either by a natural or artificial heat, separated from any substance, they instantly attack and unite with another. Nevertheless, as they may, and perhaps sometimes really do exist in form of vapours, which escape our sight; and that the theory of the salts, and the saline ores, is founded upon qualities already discovered in these acids; I have thought it necessary to describe them such as they are, when mixed with pure water alone; and this the rather, since the water is their most common vehicle, in the exercise of their effects in the mineral kingdom.

It has been observed before (Sect. xi.), that the qualities of arsenic in form of a calx may agree with the definition of the salts, and at the same time be reckoned among the semi-metals, which cannot be any otherwise explained, than that the arsenic considered in a certain respect and form, is a salt; and when considered in other circumstances, a metal. This is the case with several other bodies of the mineral kingdom.

5. They

5. They separate the alkali from the fat, when they have been united in soap; which effect is called to *curdle*, or coagulate.
6. They are volatile and subtile, so as never to be observable by the naked eye, unless they are mixed with heterogeneous bodies; and therefore the figure of the pure mineral acids cannot be defined but by guess.

S E C T. CXXI.

A. The vitriolic acid, *Acidum vitrioli aluminis et sulphuris.*

I. The pure vitriolic acid, *Acidum vitrioli purum.*

Is, in abstract, considered as possible to occur in nature: its qualities, when mixed with water, in which it is caught by distillation, are as follows.

1. When mixed with the least possible quantity of water, it is of an unctuous appearance, and is for that reason improperly called oil of vitriol.
2. It has in that state a considerable heaviness, viz. in comparison to water, as 1700 to 1000.
3. It dissolves silver, tin, the regulus of antimony, and quicksilver; but,
4. When mixed with more water, it dissolves zinc, iron, and copper.
5. It dissolves likewise the calcareous earth, and precipitates with it in form of a gypsum, of which a part shoots into gypseous Drusen, *Selenites et crystalli gypsei.*
6. It unites with the earth of quartz, when it has been previously dissolved in the

liquor silicum; and with a pure argillaceous earth, dissolving it without any fermentation: with both these earths it makes alum.

7. It has a stronger attraction to the inflammable substance, than to the alkaline salt, and forms with it a body, which properly may be called the *mineral sulphur*.
8. When it is perfectly united with phlogistic substances belonging to the vegetable kingdom, and the water has been perfectly separated, this mixture catches flame in the open air, and is consumed, as may be seen by the powder called *Pulvis pyrophorus*.
9. It attracts water strongly, and the aqueous vapours out of the air: and if a great quantity of water is added to it at once, a strong heat arises.
10. It unites readily and easily with the alcalis, whereby, according to their nature, different compounds are produced, which have obtained the names of *Tartarus vitriolatus*, *sal mirabile*, and *sal ammoniacum fixum*.

S E C T. CXXII.

- The vitriolic acid mixed or saturated, *Acidum vitrioli aliis corporibus saturatum*.
 - A. With metals, *Metallis saturatum*. *Vitriola*, *Vitriols*.
 - a. Simple vitriols, *Vitriola simplicia*.
 1. Martial vitriol, green vitriol or copperas, *Vitriolum martis simplex*.

This

This is the common green vitriol, which naturally is found dissolved in water, and is produced in abundance by decayed or calcined marcasites.

2. Copper vitriol, blue vitriol, *Vitriolum Veneris seu Cypricum*.

This is of a deep blue colour, and is found in all Ziment waters, as they are called; for instance, at Neufohl in Hungary, in St. Johan's mine at Fahlun in the province of Dalarne, at Nya Kopparberget in Westmanland, and the copper-mines at Wicklow in Ireland, &c. It is however seldom perfectly free from an admixture of iron and zink.

3. Zink vitriol, *Vitriolum zinci*.

Is white and clear as alum, and is found at the Rammelsberg in the Hartz, as also in the rubbish at Stollgrufvan in Westmanland, where the mock lead has decayed either spontaneously, or after having been burnt.

S E C T. CXXIII.

- b. Compound vitriols, *Vitriola composita*.

1. Vitriol of iron and copper, *Vitriolum ferrum et cuprum continens*.

Is of a bluish green colour.

2. Vitriol of iron, zinc, and copper, *Vitriolum ferrum zincum et cuprum continens*.

This verges more to the blue than to the green colour. It is made at Fahlun in Dalarne, from the water which is pumped out of the copper-mines: in this water large crystals of vitriol are often ready formed. If this vitriol is dipped in water, and afterwards rubbed on clean iron, the copper does not precipitate from it.

3. Vitriol of zinc and iron, *Vitriolum zinco-ferreum*. This is the green vitriol from Goslar in the Hartz.
4. Vitriol of zinc and copper, *Vitriolum cupreo zinereum*. This is the blue vitriol from Goslar.
5. Vitriol of nickel and iron, *Vitriolum ferrum et niccolum continens*.

Is of a deep green colour, and is contained in the ochre or decayed parts of the Nickell, at the Cobalt-mines at Los, in the province of Helfingland*.

* Most part of the vitriols owe their formation to art: because when such ores as contain sulphur, are dug out of the mines by means of fire, the phlogiston of the sulphur is by the heat expelled, leaving the acid behind, which, being let loose or freed, is thereby enabled to attract and unite with watry vapours, dissolving at the same time the metals; and it is thus the vitriols are formed. Every sort of ore does not commonly decay or weather in a natural manner, without being promoted by art; and this decaying or weathering is mostly performed in the open air; for which reason no very great quantity of vitriol can be expected in that way: for when any ore thus weathers or decays, the dissolved particles are by degrees carried off by the rain, and are at last found in a dissolved state in certain springs or mineral waters. All such ores may therefore be called true vitriol ores, as contain iron, copper, zinc, and nickel mineralised with sulphur. The acid in the vitriols, however, is not dulcified by the metals, as it is by the alkali in the true neutral salts.

SECT. CXXIV.

B. The acid of vitriol mixed or saturated with earths, *Acidum vitrioli terris mixtum seu saturatum*.

1. With a calcareous earth. Gypsum. See Sect. xiii.

2. With an argillaceous earth. The Alum kind, *Alumina*.

a. With a small quantity of clay, *Acidum vitrioli argillâ saturatum*. Native or plumose alum, *Alumen nativum sive plumosum*.

Is found on decayed alum ores in very small quantities; and therefore through ignorance the alabastrites and selenites, both of which are found among most of the alum slates, are often substituted in its stead; as is also sometimes the asbestus, notwithstanding the great difference there is between the alum and these, both in regard to their uses and effects*.

b. With a greater quantity of pure clay, *Argilla pura acido vitrioli imbuta*. White alum ore, *Minera aluminis alba*.

* The gypsum and asbesti, but more especially the latter, have been used through ignorance, in most countries, for plumose native alum; and the sort sold formerly in the shops for it was a greenish white kind, from Germany, very rigid, but extremely brittle, and breaking into spicula or prickles. Selenites was never substituted for alum; and the reason the asbesti and fibrose gypsum were substituted for it, was only on account of the similitude of structure, not, as our author says, on account of their being found together. See my Lectures. D, C.

1. Indurated pale red alum ore, *Schistus aluminis Romanus*. Is employed at Lumini, not far from Civita Vecchia in Italy, to make the pale red alum called Roach Alum. This is, of all alum ores, the most free from iron; and the reddish earth which can be precipitated from it, does not shew the least marks of any metallic substance.
- c. With a very large quantity of martial clay, which likewise contains an inflammable substance, *Argilla martialis et phlogistica acido vitrioli imbuta*. Common alum ore.

Is commonly indurated and slaty, and is therefore generally called Alum Slate, *Schistus aluminosus ater et brunescens*.

It is found,

1. Of parallel plates, with a dull surface, *Schistus lamellosus regularis*, from Andrarum in the province of Skone, Hunneberg and Billingen in the province of Westergottland, Rodoen in the province of Jemtland, and the island of Oeland, &c.*
2. Undulated and wedge-like, with a shining surface, *Schistus aluminosus undulatus et cuneiformis fissuris splendentibus*.

This at the first sight resembles pit coal; it is found in great abundance in the parish of Nas in Jemtland †.

* In England, the great alum works at Whitby, in Yorkshire, are of this kind. D. C.

† The purity above-mentioned (b. 1.) of the earth of the Roman or roach alum, is meant with the same restriction

SECT. CXXV.

C. Vitriolic acid united with phlogiston, *Acidum vitrioli phlogisto combinatum*. The sulphur kind, *Sulphura*. See Sect. cli.

SECT. CXXVI.

D. Vitriolic acid saturated with alkaline salt, *Acidum vitrioli alcali minerali saturatum*.

as in general is understood by that expression, viz. that the heterogeneous particles are not very obvious, nor of any great consequence.

The phlogiston which is contained in the black alum slates, may perhaps during the calcination dispose the iron to be easier dissolved; and it may also occasion the black colour in some of them, that even contain but very little of iron, as most likely in part of those from Nas (c. 2.).

It is not easily determined, whether the earth in the alum slates is argillaceous or quartzose, or whether it is a black indurated *humus*, or mould, because all those three earths, when dissolved in the vitriolic acid, produce alum. The Cologne pipe-clay is a plain proof of the first; the quartzose earth, in *liquor filicum*, of the second; and aluminous fossil-woods are actually employed for making alum in Bohemia and Hesse. These earths may, or may not, contain iron; however, they prevent, in the former case, the phlogiston, together with the vitriolic acid, from mineralizing all the iron, and making a marcasite of it, excepting here and there, in some insignificant quantity, as in cracks, or when it meets with some heterogeneous bodies, as shells, insects, &c. in the said earths. There is a remarkable progression from the black alum slates to the pit-coal, in proportion as the quantity of the phlogiston encreases, and the quantity of the earth decreases (Sect. clix.). It is this phlogiston which makes this alum slate capable of burning by itself, when it is once lighted; wherein it differs from the alum ores of Lumini, which, in order to be brought to moulder, require the being exposed to the heat of the sun, and to be sprinkled with water: the former has also within itself sufficient matter to spontaneously flame upon certain occasions, according to what the

- a. With the alcali of the common falt, or fea-falt, *Alcali minerali saturatum: Sal mirabile Glauberi.*

This is a neutral falt, prepared by nature, as well as by art, containing more or lefs of iron, or of a calcareous earth, from which arifes alfo fome difference in its effects, when internally ufed. It fhoots eafily into prifmatical criftals, which become larger in proportion to the quantity of water evaporated before the criftallifation. When laid on a piece of burning charcoal, or elfe burnt with a phlogifton, the vitriolic acid discovers itfelf by the fmell like to the *hepar fulphuris.*

It is found in a difsolved ftate in fprings and wells, and in a dry form on walls, in fuch places where aphronitrum has efflorefced through them, and the vitriolic acid has happened to be prefent; for inftance, where marcasites are roasted in the open air. This falt is often confounded with the aphronitrum, or a pure mineral alcali; and a learned difpute once arofe, which of thefe falts ought with the greateft propriety to be called natron, *Baurach veterum, fal mirabile,* or Epfom falt; whereas it might eafily have been decided by chemical ex-

celebrated experiments of Lemery, and others, demonftrate, and from which caufe many volcanos and earthquakes may perhaps be deduced. The *pulvis pyrephorus* is alfo made of alum, intimately united with a phlogiftic fubftance; in the preparing of which, they ought carefully to avoid that any iron enters the mixture, becaufe the acid has too ftrong an attraction to the iron, and cannot unite with the phlogifton alone, which, however, is quite neceffary in this operation.

periments,

periments, if their qualities had been regarded, in preference to their figures, or their native places.

This may be called English or Epsom salt, when it has naturally as equal a copious portion of the calcareous earth as of the artificial one; but I have, in regard to its effects, for which it has been most valued by Glauber, ranked all the less considerable varieties of this neutral salt, when natural, under the name of *sal mirabile*.

SECT. CXXVII.

B. Acid of common or sea-salt, *Acidum salis communis*.

This acid, considered in that state in which it can be had, viz. in mixture with water, has the following qualities.

1. It does not alter the fluidity of water, nor considerably augment its heaviness, as the vitriolic acid does.
2. It is somewhat less corrosive and sour than the said vitriolic acid.
3. It strongly attracts the alkaline salts; but, however, is forced to quit them to the vitriolic acid, when that is added.
4. It dissolves the calcareous earth, and makes with it a substance, called *sal ammoniacum fixum*.
5. When exposed to the fire, combined with a phlogiston, it burns with a yellowish green flame.
6. When highly concentrated and pure, as when it is distilled from common salt mixed with pipe clay, it dissolves tin and lead:
but

but less pure, it dissolves copper, iron, zink, and the regulus of antimony: the copper is however more easily dissolved, when it is in form of a calx, as the calces of quicksilver and cobalt likewise are.

7. It unites with silver dissolved in aquafortis, and with lead dissolved in aqua-regia, falling with them to the bottom, in form of a white spongy mass. This precipitation, exposed to the fire, still retains the acid, and melts with it into a glassy substance, which does not dissolve in water.
8. It is apt to attract the humidity of the air, and to promote the decaying of those dry substances, with which it has been united.
9. Mixed with the spirit of nitre, it makes the so called aqua-regia, which is the true liquid menstruum for gold.

This acid seems also, on certain occasions, to have got loose from those substances, with which it has been originally united in the earth: the *sal ammoniacum naturale* at Solfatara in Italy, and the horn silver ore (clxxvii.) appear to be proofs of this, as they seem to be the products of time.

S E C T. CXXVIII.

1. Mixed or satiated acid of sea-salt, *Acidum salis heterogeneis saturatum.*

A. With earths, *Terris saturatum.*

1. With a calcareous earth, *Terrâ calcareâ saturatum: Sal ammoniacum fixum.*

This somewhat decays or attracts the humidity of the air: it is found in abundance

abundance in the sea-water. See the calcareous kind, Sect. xxi.

S E C T. CXXIX.

B. With alkaline salts, *Salibus alcalinis saturatum*.

1. With the fixed mineral alkali, or sea alkali, common salt, or sea-salt, *Sal commune*.

This shoots into cubical crystals during the very evaporation, it crackles in the fire, and attracts the humidity of the air,

a. Rock salt, fossil salt, *Sal montanum*.

Occurs in form of solid strata in the earth.

1. With scaly and irregular particles, *Sal montanum particulis indeterminatis*.

a. Grey, and

b. White. These are the most common, but the following are scarcer.

c. Red,

d. Blue, and

e. Yellow, from Cracow in Poland, England, Salzberg, and Tirol.

2. Crystallised rock salt, *Sal montanum crystallisatum. Sal gemmæ*.

a. Transparent, from Cracow in Poland, &c.

S E C T. CXXX.

b. Sea Salt, *Sal marinum*.

Is produced from sea-water, or from the water of salt lakes, by evaporation in the sun, or by boiling.

The

The seas contain this salt, though more or less in different parts. In Siberia and Tartary there are lakes that contain great quantities of salt.

S E C T. CXXXI.

c. Spring salt, *Sal fontanum*.

Is produced by boiling the water of the fountains near Halle in Germany, and other places. Near the city of Lidköping, in the province of Westergottland, and in the province of Dal, salt-springs are found, but they contain very little salt: and such weak water is called *solen* by the Swedes *.

S E C T. CXXXII.

2. Saturated with a volatile alcali, *Acidum salis communis alcali volatili saturatum*. Native sal ammoniac, *Sal ammoniacum naturale*.

This is of a yellowish colour, and is sublimed from the flaming fents or crevices at the Solfatara near Naples. See Sect. cxli.

* This division of the natural common salts is generally adopted, and not without reason, since the taste of all differs a little from one another, which depends on the less or greater mixture with heterogeneous substances. For out of the purest of these salts, a little of an earthy substance may still be precipitated, which dissolves in acids, and seems to be of a calcareous nature. The naturalists have troubled themselves a great deal to find out, how common salt is produced in the earth, and from whence the great store of it in the ocean is supplied: but they have proposed nothing but conjectures, without any wise illustrating the main question.

S E C T. CXXXIII.

C. United with phlogiston, *Acidum salis communis phlogisto saturatum*. Amber, *Succinum*. See Sect. cxlvi. *

S E C T. CXXXIV.

D. United with metals, *Acidum salis metallis saturatum*.

1. With silver, *Acidum salis communis argento saturatum*. *Minera argenti cornea*, Horn silver ore. The *Hornertz* of the Germans. See Sect. clxxvii.

S E C T. CXXXV.

The SECOND ORDER.

Alcaline Mineral Salts, *Alcalia Mineralia*.

These are known by their action on the above-mentioned acids, when they are joined together, whereby a fermentation arises, and a precipitation ensues of such bodies as either of them had before kept in dissolution;

* The dry volatile salt of amber, which discovers itself to possess the qualities of an acid, is, according to Mr. Bourdelin's experiments, communicated to the French Academy, compounded of the acid of common salt, and a phlogiston, both which substances are said likewise to make out the constituent parts of the yellow amber itself, though in different proportion than in the salt: for this reason, and until this opinion is refuted by other experiments, the salt of amber cannot be considered as a mineral salt, that is different from the others, and consequently existent by itself; nor can the vitriolic acid be said to coagulate the yellow amber.

uniting at the same time together, by which new compositions are made, that are called neutral salts, or *salia neutra*.

These alkaline salts are,

S E C T. CXXXVI.

- I. Fixed in the fire, *Alcalia mineralia fixa*.
 - A. Alkali of the sea, or common salt, *Alcali salis communis, propriè minerale dictum*.
 - I. Pure, *Purum*.

This has nearly the same qualities with the lixivious salt, which is prepared from the ashes of burnt vegetables; it is the same with the *sal sodæ*, or kelp, because the kelp is nothing else than the ashes remaining after the burning of certain herbs that abound in common salt; but which common salt, during the burning of those vegetables, has quitted its acid.

This,

1. Ferments with acids, and unites with them.
2. Turns the syrup of violets to a green colour.
3. Precipitates sublimate mercury in an orange-coloured powder.
4. Unites with fat substances to make soap.
5. Dissolves the siliceous earth in the fire, and makes glass with it, &c. It distinguishes itself from the salt of the pot-ashes, by the following properties: that,
6. It shoots easily into prismatical crystals, that

7. Fall

7. Fall to powder in the air, which is effected by nothing else, than that they easily lose their humidity.
8. Mixed with the vitriolic acid, it makes the *sal mirabile*.
9. It melts easier, and is fitter for producing the *sal commune regeneratum*, *nitrum cubicum*, &c. Perhaps it is also more conveniently applied in the preparation of several medicines.
10. It is somewhat volatile in the fire*.

S E C T. CXXXVII.

2. Mixed with a small quantity of the calcareous earth, *Alcali salis communis terræ calcareæ parvâ portione combinatum. A-phronitrum.*

* This salt is not met with pure in Europe, but it is said to be found in both the Indies, not only in great quantity, but likewise of a tolerable purity: it is there collected in form of an efflorescence in the extensive deserts, a profitable trade being carried on in it for the making of soap and gla's: and therefore it is very probable, that the antients meant this salt by their *natron*, or Baurach. The calcareous earth is suspected either to contain this salt in its own composition, or else to be able to generate it from itself: but this hypothesis cannot be demonstrated. It is more probable, that the heat of the sun under the equator, and in the countries on both sides of it, evaporates the humidity, and afterwards expels the acid out of some common salt, which either is naturally mixed with the earth, or else has been deposited there through the means of certain decayed vegetables, that always attract this salt; because an earth from Palestine, which Dr. Hasselquist some years ago sent to Sweden, as a matrix of the *natron*, did upon trial yield nothing but a common salt: and it might, perhaps, have been taken at such a great depth, that it had not yet suffered any decomposition. But this matter wants to be more illustrated by observations, which might be best made in the East-Indies, where the greatest quantity is to be had, and also by some farther analyses of the substance.

This

This is so strongly united with the calcareous earth, that the latter enters with it into the very crystals of the salt: though by repeated solutions the earth is by degrees separated from it, and falls to the bottom after every solution. It grows in form of white frost on walls, and under vaults, and in places where it cannot be washed away by the rain. When it contains any considerable quantity of the calcareous earth, its crystals become rhomboidal, a figure which the calcareous earth often assumes in shooting into crystals: but when it is purer, the crystals shoot into a prismatical figure. This is a circumstance which necessarily must confuse those who know the salts only by their figure, and shews, at the same time, how little certainty such external marks afford in a true distinction of things. This salt is therefore very often confounded with the *sal mirabile*.

S E C T. CXXXVIII.

3. Saturated with mineral acids, *Alcali salis communis acidis mineralibus ad saturitatem mixtum*. Neutral salts, *Salia media, salia neutra*.
- a. With the acid of sea-salt, common salt, sea-salt, *Sal commune*. Sect. cxxix.
- b. With the vitriolic acid, *Sal mirabile*. Sect. cxxvi.

S E C T. CXXXIX.

B. Borax.

This is a peculiar alkaline salt, which is supposed to belong to the mineral kingdom; and cannot be otherwise described, than that it is either some unknown alkali, united with an earth, which is dissoluble in water, and vitrescible; or an alkaline salt, which is fixed in the fire, and melts to a glass, which glass is afterwards dissoluble in water.

Many experiments have been made with it, in order to discover its origin and constituent parts, and therefore it is amply treated of in chemical books; and its following qualities are to be observed.

1. It swells and froths in the fire, as long as any humidity remains in it, but melts afterwards very easily to a transparent glass, which, as it has no attraction to the phlogiston, keeps itself in the form of a pearl on the charcoal, when melted with the blowpipe.
2. It changes the syrup of violets into green; and precipitates the solution of allum, and that of metals, made with acids.
3. It unites with mineral acids to a neutral salt, which shoots into very fine and subtile hair-like crystals, and is called *sal sedativum*. In a certain composition it is volatile; and mixed with *litmus*, or *succus heliotropii*, and the syrup of violets, it discovers marks both of an alkali and an acid.
4. When it has been united with the vitriolic acid and a phlogiston, no *bezar sulphuris* is produced.

5. After being refined, it shoots into irregular figures: but the crystals, which form themselves after the first operation, and are called *Tincal*, consist of flat octagonal prisms, flat at the extremities, and with their angles cut off or truncated*.

* It is yet unknown of what substance the East-Indians and Chinese prepare the borax. The unrefined, which is brought to Europe under the name of *tincal*, looks like soft soap, is fat, and covers or encrusts the borax crystals. The mine-master Mr. Swab, who has had an opportunity of making experiments upon this *tincal*, has published them in the Acts of the Royal Academy of Sciences at Stockholm for 1756. He says, that he has found in it a martial earth, and a fat substance, which, to smell and other circumstances, comes nearest to a mineral fat: as likewise, that pure borax does not yield any *hepar sulphuris*, when united with a phlogiston and a vitriolic acid; from which he concludes, that borax is prepared from its own particular mineral substance.

Professor Pott and Mr. d'Henouville have very carefully examined the refined borax; and from their experiments, which have been published, it is evident, that it is of a particular alkaline nature: however, there yet remains to know for certain, from what it is prepared by the Indians: for, if it is produced from a mineral substance, as is very probable, there must exist other mixtures and compositions, which are yet unknown to the learned world.

I have also found in the *tincal* small bits of leather, bones and small pebbles, whence there is no certainty to be concluded on from its examination; but, if it should happen, that it is prepared from animal substances, it must be allowed, that nature has formed an alkaline salt in the animal kingdom, which answers to the fixed acid salt in the human urine, called *sal fusibile microcosmicum*, and which has been first accurately described by Mr. Margraff, in the Memoirs of the Academy of Berlin.

Some years ago a report was propagated from Saxony, that somebody had there discovered a substance out of which borax could be made, and also the art of preparing it: but nothing more has ever transpired since, than that the author shewed it in secret to his friends, and gave a description of it, which only was intended to mislead them, if he really did possess the art.

S E C T. CXL.

2. Volatile alkali, *Alcali minerale volatile*.

This perfectly resembles that salt which is extracted from animals and vegetables, under the name of *alcali volatile*, or *sal urinosum*, and is commonly considered as not belonging to the mineral kingdom; but since it is discovered not only in most part of the clays, but likewise in the sublimations at Solfatara near Naples, it cannot possibly be quite excluded from the mineral kingdom.

Its principal qualities are that,

- a. In the fire it rises in *forma sicca*, and volatilises in the air, in form of corrosive vapours, which are offensive to the eyes and nose.
 - b. It precipitates the solution of the mercurial sublimate into a white powder.
 - c. It also precipitates gold out of *aqua regia*, and detonates with it, because
 - d. It has a reaction in regard to the acids, though not so strongly as other alcalies.
 - e. It tinges the solution of copper blue, and dissolves this metal afresh, if a great quantity is added.
 - f. It deflagrates with nitre, which proves that it contains a phlogiston.
- It is never found pure, but

S E C T. CXLI.

A. Mixed with

- 1. Salts, *Alcali minerale volatile salibus mixtum*.

- a. With the acid of common salt, *Alcali minerale volatile acido salis unitum*. Native sal ammoniac, *Sal ammoniacum nativum*, Sect. cxxxii*.

S E C T. CXLII.

2. With earths.

- a. Clay, *Alcali minerale volatile argillâ mixtum*.

The greatest part of the clays contain a volatile alcali, which discovers itself in the distillation of the spirit of sea-salt, &c. †

* If that hypothesis could be proved true, which holds that volcanos and subterranean fires arise from slates, formed from vegetables, animals, and the *humus ater* or mould, mixed together, (Sect. cxxiv.) the origin of the sal ammoniac at Solfatara would easily be acknowledged; since we know that petrifications discover a principle within them, which contains the *sal urinosum*.

† In case some of the clays are produced from the mould or *humus ater* (Sect. xci.) it is not difficult to see the reason of the presence of this alcali in them; but, though it would be both useful and curious to know all the changes of minerals, yet it is much better to take and employ them in their present state, than to lead the mind into perplexities by examining the combinations of these things by other means than by what the external senses shew, and by rational experiments.

A German author has lately asserted, that metals, according to his experiments, have been found dissolved or mineralised by a volatile alcali; but, besides that some subjects mentioned by him; for instance, the *Sinople*, or Red Chalk; the *Hungarian Gilben*, or Vein Stones; and the *Horn Silver ore*; do not shew the least mark of it; there is also wanted a description of the experiments he has made, and of the phœnomena which have presented themselves to him, during the examination of the other ores which he has mentioned: for these reasons his opinion cannot yet be admitted.

S E C T. CXLIII.

O B S E R V A T I O N S O N S A L T S.

The perfect knowledge of these bodies must be had from chemical books and practical chemistry, being almost the chief subject of that science. From thence we likewise learn why the acids are considered as salts, though a certain figure neither is found, nor can reasonably be expected in them. We are farther taught, that the angular figure, which is supposed to be essential to salts, and by its varieties to mark out their different species, depends on an alkali, earth, and metals, united with more or less water: for else, if this was not so, the crystal of alum and vitriol ought to be of the same figure, no *nitrum cubicum* would exist, nor could any crystallisation happen in such cases, where the acids necessarily must be parted (Sect. xi.).

Salts are contained in all the three kingdoms of nature; and as it is not yet known how the changes happen, and how far the varieties depend on one another, we cannot attribute to the mineral kingdom any other salts than those which are found truly changed in the earth.

The use of the salts in medicine and in common life is so great, that it would require a separate treatise, if it were to be fully discussed. Mean while, every one who applies himself to the study of mineralogy, in order to learn the use to which the mineral bodies can be employed in common life, I mean in particular mines, must endeavour to discover where salts may be found, and how they must be prepared, so as to be best fit for use. But the preparation of salts is not the subject of

this work ; they are here only described, such as they are naturally found, *viz.* entangled in certain heterogeneous bodies, of which they require but very little for their saturation.

S E C T. CXLIV.

The T H I R D C L A S S.

MINERAL INFLAMMABLE SUBSTANCES,

Phlogista Mineralia.

To this class belong all those subterraneous bodies that are dissoluble in oils, but not in water, which they repel; catch flame in the fire; and are electrical.

It is difficult to determine what constitutes the difference between the purer sorts of this class, since they all must be tried by fire, in which they all yield the same product; but those which in the fire shew their differences by containing different substances, are here considered as being mixed with heterogeneous bodies: that small quantity of earthy substance, which all phlogista leave behind in the fire, is, however, not attended to.

S E C T. CXLV.

1. Amber grise, *Ambra grisea.*

Is commonly reckoned to belong to the mineral kingdom, although it is said to have doubtful marks of its origin.

a. It has an agreeable smell, chiefly when burnt.

b. It is consumed in an open fire.

c. It

- c. It softens in a common degree of heat, so as to stick to the teeth like pitch.
- d. It is of a black or grey colour, and of a dull and fine-grained texture. The grey is reckoned the best, and is sold very dear.

This drug is brought to Europe from the Indies; it is employed in medicine, and as a perfume.

S E C T. CXLVI.

- 2. Amber, *Ambra flava*; *Succinum*, *Electrum*.

This is a substance which is dug out of the earth, and found on the sea-coasts. According to the experiments of Mr. Bourdelin, it consists of an inflammable substance, united with the acid of common salt, which seems to have given it its hardness. It is supposed to be of vegetable origin, since it is said to be found together with wood in the earth. By distillation it yields water, oil, and a volatile salt, which the abovementioned author has found to be the acid of common salt, united with a little of the phlogiston. There are often found fish, insects, and vegetables included in it, which testify its once having been liquid. It is more transparent than most part of the other bitumens, and is doubtless that substance which first gave rise to electrical experiments.

Its varieties are reckoned from the colour and transparency: it is found

A. Opaque, *Succinum opacum*.

- a. Brown.
- b. White.
- c. Blackish.

L 4

B. Trans-

B. Transparent, *Succinum diaphanum*.

a. Colourless.

b. Yellow.

The greatest quantity of European amber is found in Prussia; but it is, besides, collected on the sea-coast of the province of Skone, and at Biorke, in the Lake Malaren, in the province of Upland; as also in France and in Siberia. It is chiefly employed in medicines, and for making varnishes.

S E C T. CXLVII.

3. Rock-oil, *Petroleum*.

It is an inflammable mineral, of a light-brown colour, which cannot be decomposed, but is often rendered impure by heterogeneous admixtures. In length of time, it hardens in the open air, like a vegetable resin, and then becomes of a black colour, whether it is pure, or mixed with other bodies. It is likewise found in the earth

A. Liquid.

1. Naphta, *Naphta*.

This is said to be of a very fragrant smell, transparent, extremely inflammable, and attracts gold. It is gathered from the surface of the water in some wells in Persia.

S E C T. CXLVIII.

2. Rock-oil, *Petroleum, propriè sic dictum*.

This smells like the oil of amber, though more agreeable, and is likewise very ready to take fire. It is collected

in the same manner as the Naphta, from some wells in Italy, and in a deserted mine at Osmundsberget in the province of Dalarne: at this last-mentioned place it is found in small hollows in the limestone, as resin is in the wood of the pines.

S E C T. CXLIX.

B. Thick and pitchy Rock-oil, or Barbadoes Tar, *Petroleum tenax, Maltha.*

This resembles soft pitch.

It is found in Mossgrufvan, at Norberg, in the province of Westmanland, and at the Dead Sea in the Holy Land.

S E C T. CL.

C. Hardened Rock-oil, *Petroleum induratum.*
Fossil Pitch, *Pix montana.*

1. Pure, *Asphaltum.*

This leaves no ash or earthy substance when it is burnt.

It is found at Finnberget, in the parish of Grythytta, in Westmanland.

From this or the preceding substance, it is probable, the asphaltum was prepared that the Egyptians used in embalming their dead bodies, and which is now called *Mummiæ*.

2. Impure, *Pix montana impura.*

This contains a great quantity of earthy matter, which is left in the retort after distillation, or upon the piece of charcoal, if burnt in an open fire; it coheres like a slag, and is of the colour of black lead: but in a calcining heat
this

this earth quickly volatilises; so that the nature of it is not yet known.

It is found in Mossgrufvan at Norberg, and in Grengierberget, both in the province of Westmanland, and also in other places*.

S E C T. CLI.

4. Mineral Phlogiston, or Bitumen, united with the vitriolic acid, *Phlogiston minerale acido vitrioli junctum*. Sulphur or Brimstone, *Sulphur*.

This is very common in the earth, and discovers itself in many and various forms. It is found,

A. Native Sulphur, *Sulphur nativum*.

In this the two constituent parts are mixed in due proportion in regard to each other, according to the rules of that attraction which is between them; it is easily known,

1. By its inflammability, and by its flame.
2. By its smell, when burnt; and,
3. By its producing a liver of sulphur, when mixed with a fixed alkali, like that made from artificial sulphur.

It is found

- a. Pellucid, of a deep yellow colour.
- b. Opake, white and greyish.

These are found in Siberia, at Bevieux in Switzerland, and at Solfatara near Naples. It is often found on limestone, which the vitriolic acid has left untouched, having a stronger attraction to

* The substance which rises, and then falls into the receiver during the distillation of this fossil pitch, is entirely the same as the common natural liquid rock-oil, Sect. cxlviii.

the phlogiston, and therefore wholly uniting with that.

S E C T. CLII.

B. Sulphur that has dissolved, or is saturated with metals, *Sulphur metallis saturatum*.

1. With iron, *Sulphur marte saturatum*.
Pyrites, or Copperas-stone, *Pyrites*.

This is the substance from which most sulphur is prepared, and is therefore ranked here with all its varieties. It is hard, and of a metallic shining colour.

a. Pale yellow Pyrites, *Pyrites subflavus*.
Marcasite.

This is very common, and contains a proportionable quantity of sulphur with respect to the iron; when once thoroughly inflamed, it burns by itself.

1. Of a compact texture, *Texturâ æquali*: *Polita Piedra del Ynca, Hispanorum*.

2. Steel-grained, *Texturâ chalybeâ*.

3. Coarse-grained, *Texturâ granulatâ*.

4. Crystallised, *Christallisatus*.

It shoots mostly into cubical and octoedral figures, though it also crystallises into innumerable other forms.

S E C T. CLIII.

b. Liver-coloured Marcasite, *Pyrites colore rubescente*.

Its colour cannot be described, being betwixt that of the preceding marcasite, and the azure copper ore.

When

A SYSTEM OF

When it is of a light colour, it is called in Swedish *Tennbett*, or *Wattnkies*, but *Lefverflag* when it is of a deeper colour.

The iron prevails in this kind; it is therefore less fit to have sulphur extracted from it, and also for the smelting of copper ores. It is found

1. Of a compact texture, from Nya Kopparberget in the province of Westmanland.
2. Steel-grained, from Stollberget in Westmanland.
3. Coarse-grained, from Westersilfverberget in Westmanland.

S E C T. CLIV.

2. Iron and Tin, *Sulphur ferro & stannosaturatum*. Black Lead, or Wadd, *Molybdæna*.

If by such a mixture as this the iron and tin be not rendered too volatile, it must be supposed that the great loss the Black Lead sustains in the calcining heat is occasioned from the sulphur, and that the sulphur consequently makes out the greatest part of the black lead. It is found,

- a. Lamellar and shining, of the same colour as the potters lead ore, *Molybdæna membranacea nitens*.

From Bispergs Klack in the province of Dalarna, Bastnas-grufva at Riddarshyttan in Westmanland, Altenburg in Saxony.

The

The variety from Bispergs Klack has been examined by Mr. Quist, and has, by its volatilising under the muffle, in form of a white fibrous sublimate, induced that gentleman to examine the black lead more particularly; and he has published some very remarkable experiments on it in the Transactions of the Academy of Sciences at Stockholm, for the year 1754.

- b. Of a steel-grained and dull texture, *Texturâ chalybeâ*. It is naturally black, but when rubbed it gives a dark lead colour.
- c. Of a fine scaly and coarse-grained texture, *Texturâ micaceâ & granulâtâ*. Coarse Black Lead.

It has at the same time a scaly and a granulated appearance.

From Gran in the province of Upland, and from Tavastehuslan in Finland*.

* Professor Pott has examined the black lead in covered vessels, and Mr. Quist in an open fire, from which difference in the method of treating it, different notions have arose: because the black lead is nearly unalterable when exposed to the fire in covered vessels, or when immediately put into a strong charcoal fire, but it is almost wholly volatile in a calcining heat. This is the case with several others of the mineral phlogistons; and from this we may in general learn, how necessary it is to examine the mineral bodies by many and different methods, and to endeavour to multiply the experiments more than what has been hitherto done. Pencils are made from the black lead; as also the black lead crucibles.

S E C T. CLV.

3. Sulphur with iron and copper, yellow or marcasitical copper ore. See Sect. cxcviii.
4. Sulphur with iron and lead, Potters lead ore. See Sect. clxxxix.
5. Sulphur with iron and zinc, mock lead, black jack, or blende. See Sect. ccxxxix.
6. Sulphur with iron and arsenic, arsenical pyrites. Sect. ccxliii.
7. Sulphur with iron and cobalt. Sect. ccl.
8. Sulphur with iron and bismuth. Sect. ccxxv.
9. Sulphur with iron and nickel. Sect. cclvi.
10. Sulphur with iron and gold, pyritical gold ore. Sect. clxvi.

S E C T. CLVI.

11. Sulphur with silver, glass silver ore. Sect. clxix.
12. Sulphur with copper, grey or vitreous copper ore. Sect. cxcvii.
13. Sulphur with lead, Potters lead ore. Sect. clxxxvii.
14. Sulphur with bismuth. Sect. ccxxiv.
15. Sulphur with quicksilver, cinnabar. Sect. ccxviii.
16. Sulphur with arsenic, Orpiment, Realgar. Sect. ccxli.

SECT. CLVII.

5. Mineral phlogiston united with earths,
Phlogiston minerale terris imbutum.
- A. With a calcareous earth, *Phlogiston minerale terrâ calcareâ imbutum.*
1. With pure calcareous earth, the fœtid or swine spar, Sect. xxiii.
 2. With the calcareous earth and vitriolic acid, the Leberstein or Liverstone of the Swedes, Sect. xxiv.

SECT. CLVIII.

- B. With an argillaceous earth, *Phlogiston argillâ mixtum.*
1. With a small quantity of argillaceous earth and vitriolic acid: Coal: Lithantrax.

It is of a black colour, and of a shining texture; it burns, and is mostly consumed in the fire; but leaves however a small quantity of ashes.

a. Solid coal.

b. Slatty coal

Found in England, and at Boserup in the province of Skone.

SECT. CLIX.

2. With a greater quantity of argillaceous earth and vitriolic acid, the Kolm of the Swedes. This is of the same appearance with the former, though of a more dull texture; it burns with a flame, and yet is not consumed, but leaves behind a slag
of

A SYSTEM OF

of the same bulk or volume as the coal was.

From England, and among the alum rock at Moltorp and Billingen in the province of Westergottland.

S E C T. CLX.

3. With abundance of argillaceous earth, Stone coal. It burns with a flame by itself, otherwise it looks like other flates.

It is found at Gullerasen, in the parish of Rettwik, in the province of Dalarna, and also with the coals at Boserup in Skone*.

S E C T. CLXI.

6. Mineral phlogiston mixed with metallic earths, *Phlogiston minerale metallis impregnatum*.

This is not found in any great quantity: in regard to its external appearance, it resembles pit-coal; and the fat substance contained in it, at times partly burns to coal, and partly volatilizes in a calcining heat.

The only known varieties of this kind are,
A. Minera cupri phlogistica.

When it has been inflamed, it retains the fire, and at last burns to ashes, out of which

* This last mentioned kind has induced me to believe, that the earth of the pit-coals is an argillaceous one, but is not so easy to be discovered after its being burnt. The pit-coals contain more or less of the vitriolic acid, for which reason the smoak arising from them attacks silver in the same manner as sulphur does; though the coals be ever so free from marcasite, which however is often found imbedded or mixed with them.

pure copper can be smelted. It is found in Sladkierr's Grufva in the province of Dal, and at Bispergs Klack, in the province of Dalarne.

B. *Minera ferri phlogistica.*

This is not very different in its appearance from the pit-coal or fossil pitch; but it is somewhat harder to the touch: there are two varieties of this species:

1. Fixt in the fire, *Minera ferri phlogistica fixa.*

Exposed to a calcining heat, it burns with a very languid though quick flame, it preserves its bulk, and loses only a little of its weight. It yields above 30 per cent. of iron.

a. Solid, resembles black sealing-wax.

It is found in the liver-coloured marcasite, (Sect. cliii.) in Waskberget, at Norrberke, in Westmanland.

b. Cracked, and friable, from Finnberget, at Grythyttan, in Westmanland.

2. Volatile in the fire, *Minera ferri phlogistica volatilis.*

This is unalterable in an open fire, either of charcoal, or even upon a piece of charcoal before the flame of the blow-pipe: but under a muffle the greatest part of it volatilises, so that only a small quantity of calx of iron remains. It is found,

a. Solid, from Kronprints Shurff, at Kongsberg, in Norway.

b. Cracked, from the parish of Quistbro, in the province of Nerike.

This last kind leaves more ashes: these ashes, when farther exposed to

the fire, become first yellowish green, and afterwards reddish brown, when, besides iron, they then also discover some marks of copper; it has however not been possible to extract any metallic substance from them, the effects of the loadstone, and the colour communicated to the glass of borax, having only given occasion to this suspicion (conf. Sect. cl. & cliv.).

S E C T. CLXII.

OBSERVATION ON THE BITUMENS.

That substance which the chemists call Phlogiston, or an inflammable principle, exists in most of the mineral bodies, though often in so small a quantity as not to be perceived; and therefore I have here only enumerated those kinds in which it exists as a principal character; for instance, in the foetid spar or swine-stone, &c.

I do not myself know the substance in its simple state which I call a mineral phlogiston, since the ambergrise and the rock-oil can be nothing else than compositions which cannot be perfectly decomposed; and besides, they are not to be extracted from coal, sulphur, &c. which yet contain an inflammable substance. It seems as if a great part of this class were originally generated from the animal and vegetable kingdoms; so that they first have been an *humus ater* or mould, with which a vitriolic acid has afterwards been mixed; and that they have been best able to retain this phlogiston, when they have been covered and joined together by another earth: the coal, coal ore, and pitch tuff, (Sect. ccxciii.) give some hints or reasons

reasons for this supposition. The generation of sulphur and marcasite requires no preferable phlogiston out of any of the kingdoms of Nature, for the phlogistons throughout all nature are equally alike fit for it.

It is a sublime subject for philosophers to enquire how far fire, phlogiston, and electricity, have an affinity with, or dependance on, one another; but as they yet want that light in this matter which they wish to have, I hope to be excused for not mentioning any theories on the subject.

This class is of great use in medicine; for instance, the ambergrise, the salt of the yellow amber, the rock-oil, the asphaltum, and the sulphur. The rock-oil and sulphur are used in fireworks, the asphaltum by the watchmakers, and the yellow amber is used by the varnishers and painters*.

SECT. CLXIII.

The FOURTH CLASS.

METALS, *METALLA*,

Are those mineral bodies which, with respect to their volume, are the heaviest of all hitherto-known bodies; they are not only malleable, but they may also be decomposed, and in a melting heat be brought again to their former state,

* The coals, however, are of the greatest consequence for their economical use; and happy therefore are those countries which have a sufficient quantity of them, since they may be employed as fuel to almost every purpose, which is plainly proved in England. E.

by the addition of the phlogiston they had lost in their decomposition *

S E C T. CLXIV.

The FIRST ORDER.

METALS, *Metalla.*

I. Gold, *Aurum, Sol Chymicorum.*

This is by mankind esteemed as the principal and first among the metals; and that partly for its scarcity, but chiefly for its following qualities.

1. It is of a yellow shining colour.
2. It is the heaviest of all known bodies, its specific gravity to water being as 19,640 to 1000.
3. It is the most tough and ductile of all metals; because one grain of it may be stretched out so as to cover a silver wire of

* Those metals which in a calcining heat lose their phlogiston, and consequently with that the former coherency of their particles, are called *imperfect*, as tin, lead, copper, and iron, and all the semi-metals (of which more hereafter): notwithstanding which they may be malleable. But those which cannot be destroyed in the fire alone are called *perfect*, as gold, silver, and platina del pinto. Nevertheless, the metals have commonly been considered more with regard to their malleability than to their fixity in the fire, and are therefore divided into,

A. Malleable, which are called *metals*; and

B. Brittle, which are called *semi-metals*.

The zinc is, however, as a medium between these two divisions, just as the quicksilver is between the perfect and imperfect metals, because the quicksilver may indeed be so far destroyed in the fire, that its particles are separated during their volatilisation; but every one of them, even the minutest, retains however the phlogiston united with it.

the length of ninety-eight yards, by which means $\frac{1}{705600}$ grain becomes visible to the naked eye.

4. Its softness comes nearest to that of lead, and consequently it is but very little elastic.
5. It is fixed and unalterable in air, water, and fire, because it does not easily quit its phlogiston; its liquid menstruum (7°) being only made by art.

It has, however, according to Homberg's experiments, when exposed to Tschirnhausen's burning-glass, been found partly to volatilise in form of smoke, and partly to scorify: But this wants to be farther examined. It is also said, that gold in certain circumstances, and by means of certain artifices in electrical experiments, may be forced into glass; and that on this occasion it becomes white, leaving a black dust behind it; which, if so, confirms certain other chemical experiments; viz. That gold can, together with its colour, lose something of its phlogiston, and yet retain its heaviness, ductility, &c.

6. When melted, it reflects a blueish green colour from its surface.
7. It dissolves in aqua regia, which is composed of the acids of sea-salt and nitre; but not in either alone, nor in any other solution of salt or acid whatsoever.
8. When mixed with a volatile alkali and a little of the acid of nitre, by means of precipitation out of aqua regia, it burns off quickly, in the least degree of heat, with a strong fulmination.

9. It is dissolved, *in formâ siccâ*, by the liver of sulphur, and also somewhat by the glass of bismuth.
10. It is not carried away by the antimony during the volatilisation of that semi-metal, and is therefore conveniently separated from other metals by the help of crude antimony, in which process the other metals are partly made volatile, and fly off with the antimony, and partly unite with the sulphur, to which the gold has no attraction, unless by means of some uniting body, or by a long digestion.
11. The phosphorus is said to have ingress into gold.
12. If mixed with a less portion of silver, platina, copper, iron, and zinc, it preserves tolerably well its ductility; but,
13. When mixed with tin it becomes very brittle; and it attracts likewise the smoke of that metal, so as to be spoiled, if melted in an hearth where tin has been lately melted: And this is perhaps the reason why gold becomes brittle, and of a paler colour, when melted in a new black lead crucible (Sect. cliv.)
14. It requires a strong heat before it melts, nearly as much, or a little more than copper.
15. It mixes or amalgamates readily with quicksilver.
16. It is not dissolved by the glass of lead, and therefore remains on the cuppel.

In consequence of these its principal qualities, it seems as if it could never be found in the earth but in a native or pure state;

state; there are, however, several instances that it has been found dissolved or mineralised.

S E C T. CLXV.

A. Native Gold, *Aurum nativum*,

Is in its metallic form commonly pure : And in this state most part of this metal used in the world is found. With respect to either the figure or the quantity in which it is found in one place, it is by miners divided into,

1. Thin superficial plated or leaved gold, which consists of very thin plates or leaves, like paper.
2. Solid or massive, is found in form of thick pieces.
3. Crystallised, consists of an angular or crystalline figure.
4. Wash Gold, or Gold Dust, is washed out of sands, wherein it lies in form of loose grains and lumps*.

* The gold is in general more frequently imbedded and mixed with quartz, than with any other kind of stone; and the quartz in which the gold is found in the Hungarian gold mines is of a peculiar appearance. All other sorts of stones, however, are not to be excluded, since gold is likewise found in some of them; for instance, in limestone (Sect. ix.) in Adolph Fredrik's Grufva at Adelfors, in the province of Smoland; in Hornblende (Sect. lxxxviii.), in Bassas Grufva at Riddarshyttan, in the province of Westmanland; not to mention several foreign gold mines.

The greatest quantity of gold is imported into Europe from Chili and Peru, in America; and a little from China, and the coast of Africa. The chief European gold mines are those of Hungary, and next to them those at Saltzburg. Besides these, there are some others of less consequence; among which the gold mines at Adelfors in Smoland deserve to be taken much notice of, not only on account of the veins already worked, but also in regard to the vast tract of land, within which new

S E C T. CLXVI.

B. Mineralised Gold, *Aurum mineralisatum*.

This is an ore in which the gold is so far mineralised, or so entangled in other bodies, as not to be dissolved by the aqua regia.

I. Mineralised with sulphur, *Aurum sulphure mineralisatum*.**a.** Mineralised by means of iron, *Aurum sulphure mineralisatum mediante ferro*.

Marcasitical gold ore, *Pyrites aureus*.

It is found at Adelfors, in the province of Smoland, and contains an ounce of gold, or less, in an hundred pounds.

b. Mineralised by means of quicksilver, *Aurum sulphure mineralisatum mediante mercurio*.

It is found in Hungary.

c. Mineralised by means of zink and iron, *Aurum sulphure mineralisatum mediante zinco & ferro, aut argento*. The Schemnitz blende.

At Schemnitz in Hungary are found zink ores, which contain a great deal of silver, and this silver is very rich in gold (Sect. clxxv.) *.

veins are daily discovered. The silver from the mines at Oster-silverberget, in the province of Dalarna, contains about a fourth part of an ounce of gold in every pound of silver. Some native gold has likewise been found in Swappawari, above Tornea in Lapland, and in Bastnas, near Riddarshyttan in Westmanland.

* Since gold and sulphur have no immiscible power or attraction to one another, many have insisted that gold never could be found in marcasite, or those ores which contain sulphur: But since we know by experience, that gold can be melted

S E C T. CLXVII.

2. Silver, *Argentum, Luna*; which is,
- a. Of a white shining colour.
 - b. Its specific gravity to water is 11,091 to 1000.
 - c. It is very tough or ductile, so that a grain of it may be stretched out to three yards in length, and two inches in breadth.

melted out of the above-mentioned ores, altho' they have been previously digested in aqua regia; and that gold likewise mixes and dissolves into a regulus; there is the greatest reason to believe that a third substance, which here is a metal, must necessarily have by its admixture enabled the sulphur to unite with a certain quantity of gold. Scheffer has given upon this subject some very curious and useful observations, in his History of the Refining of Metals, inserted in the Transactions of the Academy of Sciences at Stockholm. It is very remarkable that the Mine-Master Henckel, in his excellent Treatise *de Appropriatione*, should be so obstinate in denying that marcasite could contain a dissolved gold.

It is, however, by no means hereby intended to confirm the credulous in their opinion, that the marcasites in general contain more gold than what true metallurgists have asserted; because fraud might then perhaps become too common. It is only meant to indicate, that, as no gold is to be expected from marcasites, where no native gold is found in the neighbourhood, in the same manner no marcasites ought to be despised, which are found in tracks where gold ores are dug; but at the same time care must be taken not to be deluded by the mention of volatile gold, as it is a notion really contradictory and suspicious, and then there can be no fear of being misled.

I am not perfectly clear, if the gold is really dissolved and indurated, or, if I may so express myself, vitrified in the Shirls (Schirkornern), provided by this mineral body is meant a garnet substance (Sect. lxxiii.) But I have seen a piece of what is called *Shirl*, whose texture was exactly like the Schemnitz blende; and in this case it might perhaps hold the same contents (Sect. clxxv.) For the other gold ores, I have not had an opportunity of seeing any from those places where gold is searched for and really found.

d. It

- d. It is unalterable in air, water, and fire.
- e. It dissolves in the acid of nitre, and also by boiling in the acid of vitriol.
- f. If precipitated out of the acid of nitre with the common salt, or with its acid, it unites so strongly with this last acid, that it does not part from it, even in the fire itself, but melts with it into a mass like glass, which is called *luna cornea*.
- g. It does not unite with the semi-metal nickel, during the fusion.
- h. It amalgamates easily with quicksilver.
- i. It is in the dry way dissolved by the liver of sulphur.
- k. It has a strong attraction to sulphur, so as readily to take a reddish yellow or black colour, when it is exposed to sulphureous vapours.
- l. It has no attraction to arsenic; whence when the red arsenical silver ore, or *Rothgulden Ertz* of the Germans, is put into the fire, the arsenic flies off, and leaves the sulphur (which in this compound was the *medium uniens*) behind, united with the silver in form of the glass silver ore, or glass ertz.
- m. It is not dissolved by the glass of lead, and consequently it remains on the cuppel.
- n. It is exhaled or carried off by volatile metals and acids, as by the vapours of antimony, zink, and the acid of common salt.
- o. It melts easier than copper.

S E C T. CLXVIII.

Silver is found,

A. Native or pure, *Argentum purum nativum*.

Native silver most generally is nearly of sixteen carats standard.

1. Thin superficial plated or leaved silver.
2. It is also found in form,
 - a. Of snaggs, and coarse fibres.
 - b. Of fine fibres. Capillary silver.
 - c. Arboreſcent. From Potosi in America, and Kongsberg in Norway.
 - d. Criftalline, or figured. This is very ſcarce to be met with: it has diſtinct figures, with ſhining ſurfaces; it is, however, ſometimes found at Kongsberg.

The ſilver from America is ſaid to be found for the moſt part native; ſo it is likewiſe at Kongsberg in Norway, but it is not commonly ſo in the other European mines. In Sweden it is found native in a very ſmall quantity, in the mines of Salberg in Weſtmanland, of Lofafen in Dalarne, of Hevaſſwik and Sladkierr in the province of Dal, of Sunnerſkog in the province of Smoland, and in the Iſland Utoen in the Lake Malaren. It was once found in pretty large lumps in a vein of clay in one of the iron mines at Normark, in the province of Wermeland. It was there mixed with nickel, which was partly decayed or withered; and under this circumſtance it formed the compound ore called the *Stercus Anſerinum*, or Goofe-dung Ore. At this place the
argilla

argillaceous vein crosses the veins of the iron ore, and will perhaps be found to have more of these riches, even in several other places, if well searched, as is done in other countries, oftentimes not on such evident marks or signs.

S E C T. CLXIX.

B. Dissolved and mineralised, *Argentum mineralisatum*.

1. With sulphur alone, *Argentum sulphure mineralisatum*. Glass silver ore, *Minera argenti vitrea*.

This is ductile, and of the same colour as lead; but, however, becomes blacker in the air. It has, therefore, very undeservedly got the name of glass ore, for that name rather belongs to the *minera argenti cornea*, or horn silver ore, if indeed any silver ore can be considered as glassy.

It is found in the same manner as native gold; viz.

1. In crusts, plates, or leaves.
2. Grown into,
 - a. Snaggs, and,
 - b. Crystalline figures.

It is generally either of a lamellar or a grained texture, and is found at Kongsberg and in the Saxon mines.

The glass silver ore is the richest of all silver ores; since the sulphur, which is united with the silver in this ore, makes out but a very small quantity of its weight.

SECT. CLXX.

2. With sulphur and arsenic, *Argentum sulphure & arsenico mineralisatum*. *Minera argenti rubra*, The red or ruby-like silver ore. The *Rothguldén* of the Germans.

The colour of this ore varies as the proportion of each of these ingredients varies in the mixture; viz. from dark grey to deep red: but when it is rubbed or pounded, it always gives a red colour. When put in the fire, it crackles and breaks; and when the crackling ceases, it melts easily, the arsenic at the same time exhaling in smoke.

- a. Grey arsenical silver ore; which is either,
1. Plated, crufted, or leaved, and,
 2. Solid.
- b. The red arsenical silver ore.
1. Plated, crufted, or leaved.
 2. Solid or scaly, and,
 3. Criftallited.

In this last form it fhews the moft beautiful red colour, and is often femi-transparent. It contains about fixty per cent in silver; and is found in the greateft quantity at Andreafberg in the Hartz.

SECT. CLXXI.

3. With fuphurated arsenic and copper, *Argentum arsenico & cupro fuphurato mineralisatum*. *Minera argenti albi*, The *Weiffguldén* of the Germans.

This, in its folid form, is of a light grey colour, and of a dull and fteel-grained texture.

ture. The more copper it contains, the darker is the colour. It often holds seven pounds of silver per cent. It is,

- a. Friable, withered, or decayed, of a black or sooty colour, and is therefore by the Germans called *Silber-Schwartz*, or *Ruffigtes-Ertz*.
- b. Solid, of a light-grey colour, and is that sort properly so called *Weissgulden*.

It is found at St. Mary of the mines in Alfatia, the Saxon mines, and at St. Andreasberg in the Hartz.

S E C T. CLXXII.

4. With sulphurated arsenic and iron, *Argentum ferro & arsenico sulphurato mineralisatum*, The *Weisertz*, or white silver ore, of the Germans.

This is an arsenical pyrites, which contains silver; it occurs in the Saxon mines, and so exactly resembles the common arsenical pyrites as not to be distinguished from it by sight alone, or without other means. The silver it contains may perhaps consist of very subtile capillary silver mixed in it. However, I have not had an opportunity to examine this circumstance.

S E C T. CLXXIII.

5. With sulphurated antimony, *Argentum antimonio sulphurato mineralisatum*.
 - a. Of a dark-grey and somewhat brownish colour. The *Leberertz*, from Braunsdorff in Saxony.
 - b. Of a blackish blue colour.

1. In form of capillary crystals, *Minera argenti antimonialis capillaris*. *Federertz*, or plumose silver ore.

It is found in Saxony, and contains only two or four ounces of silver per cent.

S E C T. CLXXIV.

6. With sulphurated copper and antimony, *Argentum cupro & antimonio sulphurato mineralisatum*. The *Dal Falertz*.

This resembles, both in colour and texture, the dark-coloured *Weißgulden*, or *Falertz*. When rubbed, it gives a red powder.

a. Solid.

- b. Crystallised, is found in the parish of *Aminskog*, in the province of *Dal*; and at that place has been for several years melted by a method invented for the different mixture of the ores; which process must be very troublesome to those who are not perfectly well versed in metallurgy.

It contains thirteen ounces of silver, and twenty-four per cent. of copper.

S E C T. CLXXV.

7. With sulphurated zink, *Argentum zinco sulphurato mineralisatum*. The *Peebblende* of the Germans.

This is a zink ore, mock lead, or blende, which contains silver, and is found among rich silver and gold ores; for instance, in the Hungarian and Saxon mines.

a. Of

- a.* Of a metallic changeable colour.
1. Solid, and with fine scales.
 2. In form of balls. The *Kugel-ertz*; or ball ore.
It is found at Schemnitz, and contains also gold. Its yield of silver is twenty-four ounces per cent. and thirty per cent. of zinc.
- b.* Black mock lead, or blende, found in Saxony. This is also found,
1. Solid, and with fine scales;
 2. And in form of balls.

S E C T. CLXXVI.

8. With fulphurated lead, Potter's ore, *Ga-lena*, *Bleyglanz*. See Sect. clxxxviii.
9. With fulphurated lead and antimony, called *Striperz*. See Sect. cxc.
10. With fulphurated iron, *Argentum ferro sulphurato mineralisatum*. *Silberhaltiger kies*, Marcasite holding silver.

At Kongberg in Norway, it is said, a liver-coloured marcasite is often found, particularly at the mine called Fraulein Christiana, &c. This marcasite contains of silver from three to three ounces and an half per cent.

S E C T. CLXXVII.

11. With the acid of common salt, *Argentum acido salis solutum & mineralisatum*. *Minera argenti cornea*. *Hornertz*, or horn silver ore.

This is the scarcest silver ore; it is of a white or pearl colour, changeable or varying on the surface, semi-transparent, and

and somewhat ductile, both when crude, and when melted. It cannot be decomposed without some admixture of such substances as attract the acid of the sea-salt. It is found in very thin worked or wrought leaves or crusts, at Johan Georgenstadt, in Saxony.

S E C T. CLXXVIII.

OBSERVATIONS ON THE SILVER ORES.

Silver may, perhaps, be found mineralised in the like manner with other metals than these here enumerated, such as with cobalt and bismuth; but having no certain knowledge of such mineralisations, I omit them here. It would be worthy examining, if in those mine countries where gold and silver are found in quantity, other ores do not contain a little of those metals, more especially when the particles of silver and gold have not been able to extricate themselves from the other minerals, and lie separate from them in the fissures, veins, and shakes or wranks, that is hollow places, in the mines.

Those silver ores which are named from earth or stones, wherein the silver is found; as, for instance, in the Goose-dung silver ore, and the *Leberertz*; ought no more to be considered in a natural system than other distinctions which are used at mineral works, and are only names given to the ores, according to the several changes they undergo to make them fit for the melting process.

In this our time a mineralisation of silver with alkali has been mentioned: it is said to have been found at Annaberg in Austria: But this discovery, which is made by a mine-master, Mr. Von Justi,

requires an explanation, since the author in his description does not observe the necessary distinction between alkali and lime; and quotes the horn silver ore, and the *luna cornea*, as proofs of his opinion; by which, however, his opinion seems rather weakened than confirmed.

S E C T. CLXXIX.

3. Platina del Pinto, Platina di Pinto, *Juan blanca*.

This metal is a recent discovery of our times, and is described with great accuracy by Scheffer, in the Acts of the Royal Academy of Sciences at Stockholm, for the year 1752; as also by Dr. Lewis, in the Philosophical Transactions for the year 1754, vol. xlviii. And though these two gentlemen agree in the principal circumstances relating to this metal, yet it is very plain by their descriptions, that neither of them knew any thing of the other's experiments. By these descriptions we are convinced of the resemblance this metal bears to gold; and therefore we must allow it to be called *white gold*, though, both theoretically and practically, it may be distinguished from gold by the following qualities.

1. It is of a white colour.
2. It is so refractory in the fire, that there is no degree of heat yet found by which it can be brought into fusion by itself, the burning-glass excepted, which has not yet been tried. But, when mixed with other metals, and semi-metals, it melts very easily, and especially with arsenic, both in
its

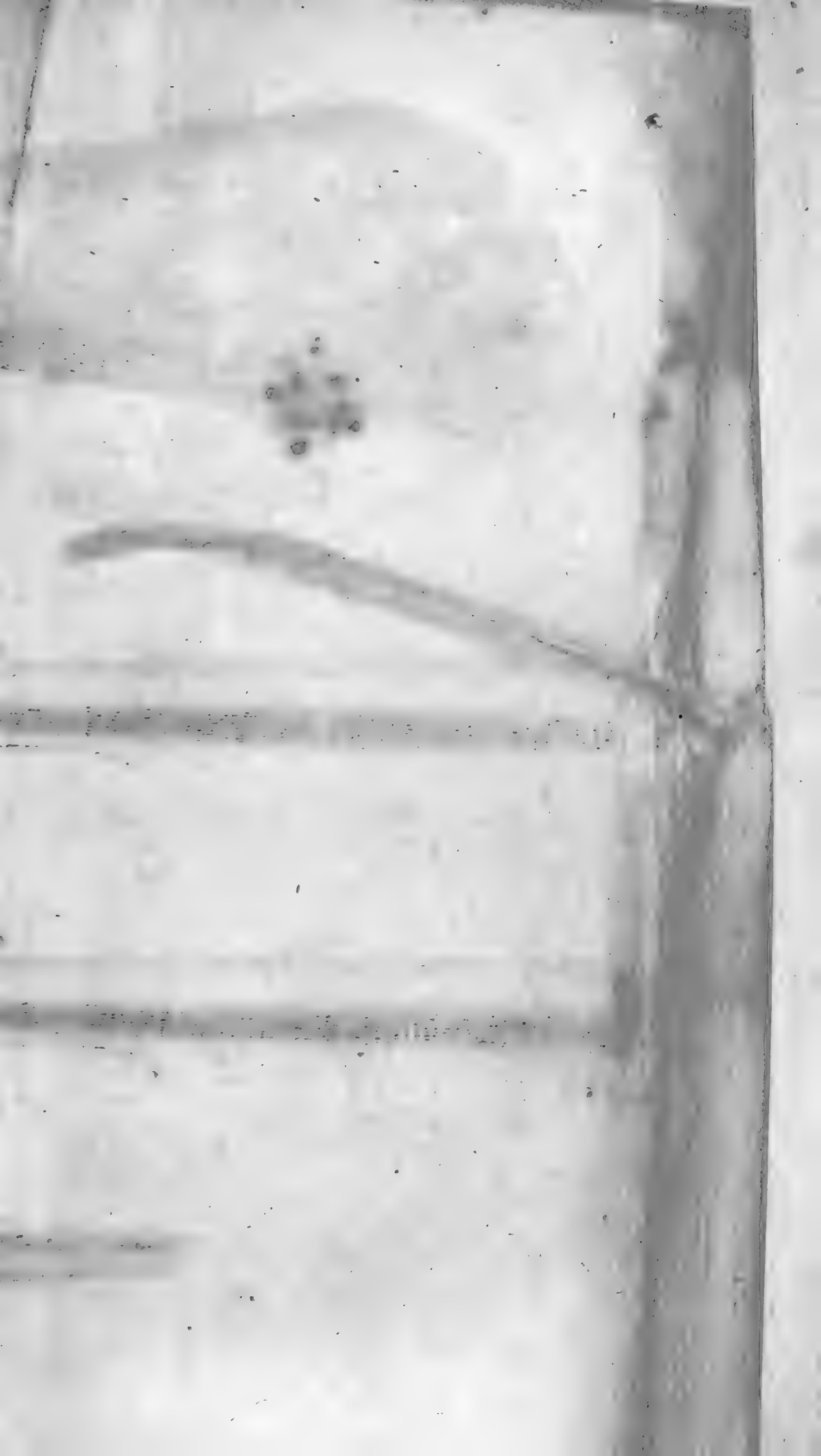


fig. 4.

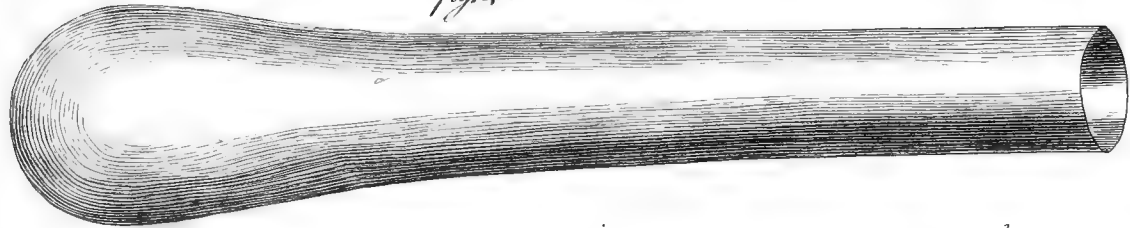


fig. 3.

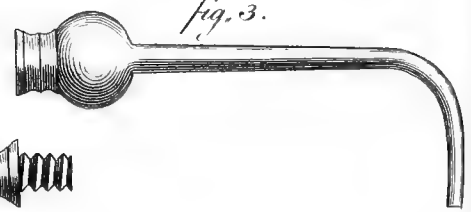


fig. 2.



fig. 1.



fig. 5.



1

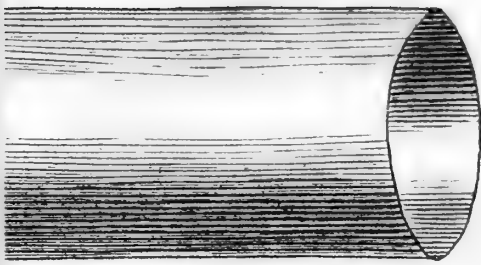
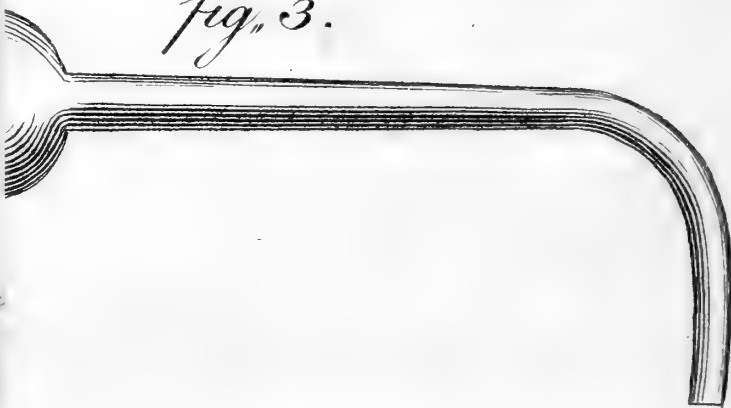


fig. 3.



its metallic form, and in form of a calx or glass.

3. It does not amalgamate with quicksilver by itself, but only by means of the acid of common salt after a long trituration. This metal is therefore really separated from gold by amalgamation, at those places where it is found; and without this quality, it would be very difficult to separate it.
4. It is harder and less coherent than gold.
5. It is heavier than gold; and therefore the heaviest of all bodies hitherto discovered: For though the specific gravity of platina, in the hydrostatical experiments made by Dr. Lewis, is found to be to water only as 17,000 to 1000; yet, when melted with other certain metals, its specific gravity has, by an exact calculation, been found to be considerably augmented, even so much as to 22,000.
6. Dissolved in aqua regia, and precipitated with tin, or with a solution of that metal, it yields no *purpura mineralis*.

Except these, this metal has the same qualities as gold; but it cannot, on account of its refractoriness in the fire, be worked off pure on the cuppel, nor likewise can it be worked with antimony; because, before it is rendered perfectly pure, it cools, grows hard, and retains always some part of the added metals. It is brought to us only in its native state, in small, irregular, rugged grains; and it is yet uncertain whether it is found naturally mineralised. The Platina is brought to

Europe from the Rio de Pinto, in the Spanish West-Indies.

S E C T. CLXXX.

4. Tin, *Stannum*, *Jupiter*.

This is distinguished from the other metals by its following characters and qualities.

- a.* Of a white colour, which verges more to the blue than that of silver.
- b.* It is the most fusible of all metals; and,
- c.* The least ductile; that is, it cannot be extended or hammered out so much as the others.
- d.* In breaking or bending it makes a crackling noise.
- e.* It has a smell particular to itself, and which cannot be described.
- f.* In the fire it is easily calcined to white ashes, which are twenty-five per cent. heavier than the metal itself. During this operation, the phlogiston is seen to burn off in form of small sparkles among the ashes, or calx.
- g.* This calx is very refractory; but may, however, with a very strong degree of heat, be brought to a glass of the colour of hard resin. But this calx is easily mixed in glass compositions, and makes with them the white enamel.
- h.* It unites with all metals and semi-metals; but renders most of them very brittle, except lead, bismuth, and zink.
- i.* It amalgamates easily with quicksilver.
- j.* It dissolves in aqua regia, the spirit of sea-salt, and the vitriolic acid; but it is only corroded

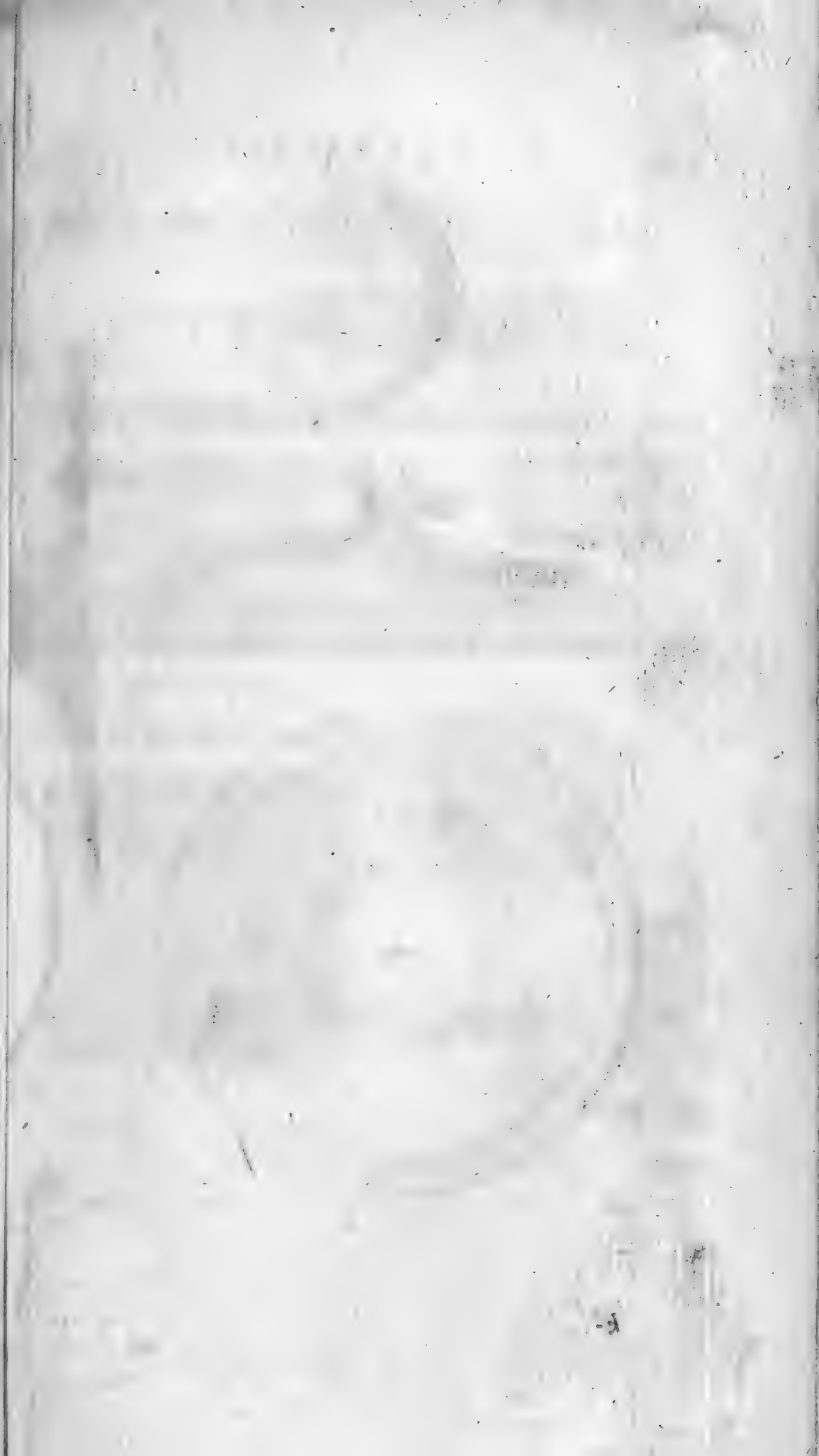


fig. 1.

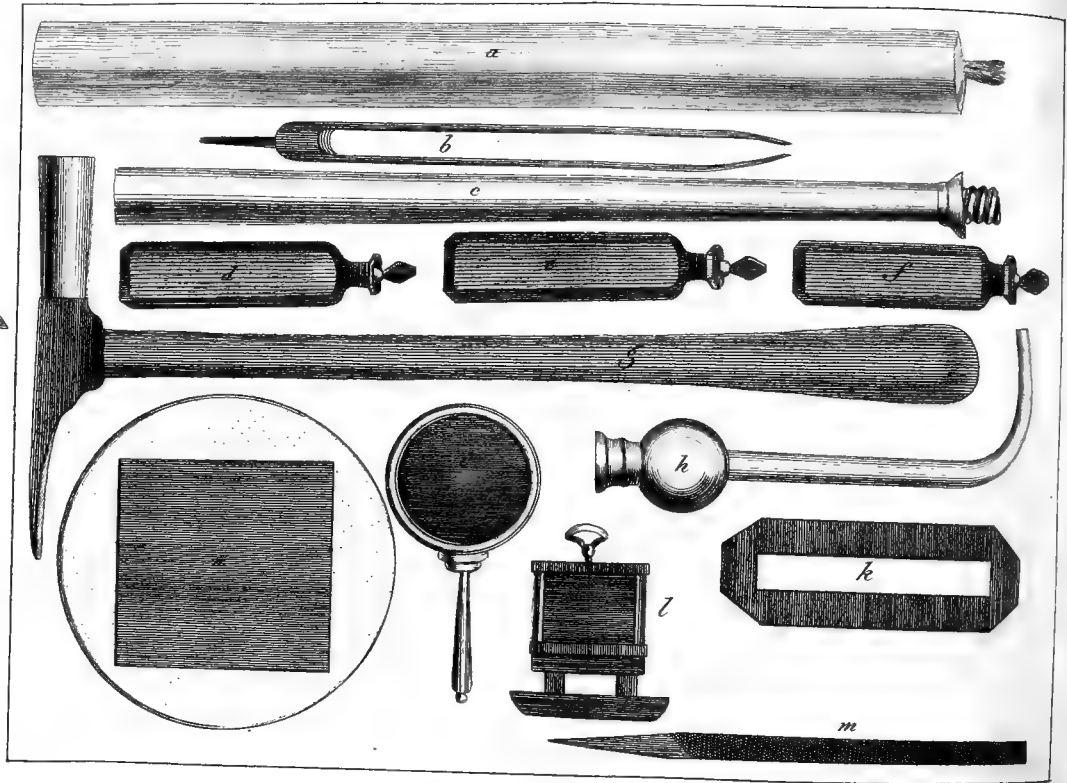


fig. 4.



fig. 3.

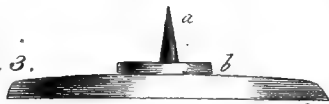
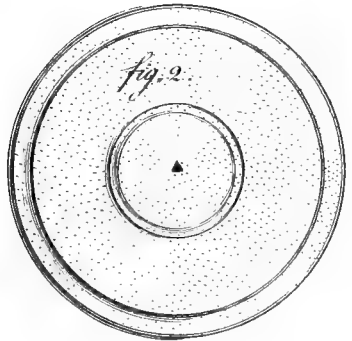
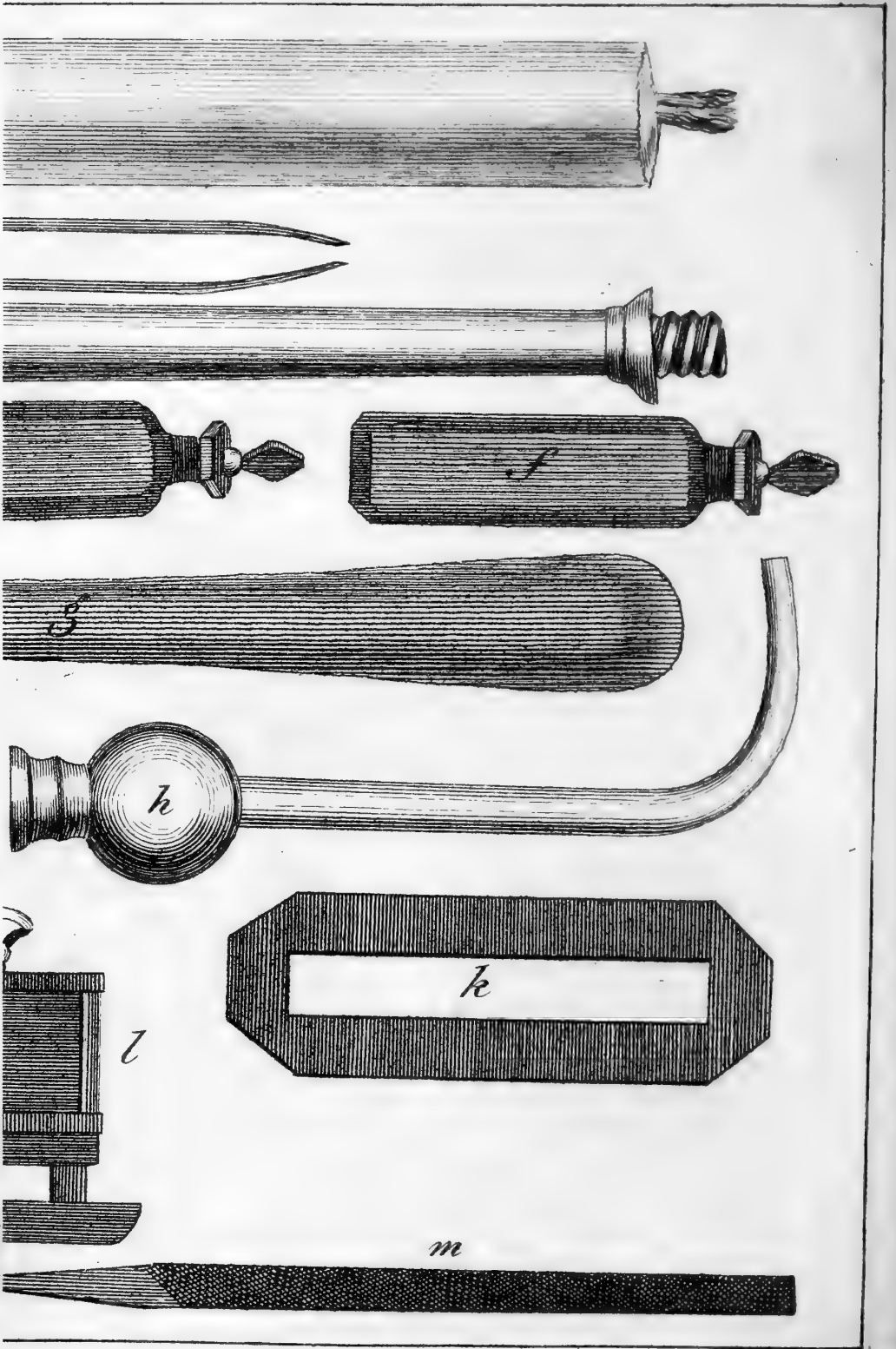


fig. 2.







to face Page 181.

corroded into a white powder by the spirit of nitre.

The vegetable acid, soaps, and pure alkaline salts, also corrode this metal by degrees.

- l. Its specific gravity to water is as 7400 to 1000, or as 7321 to 1000.
- m. Dissolved in aqua regia, which for this purpose ought to consist of equal parts of the spirit of nitre and sea-salt, it heightens the colour of the cochineal, and makes it deeper; for otherwise that dye would be violet.

SECT. CLXXXI.

Tin is not found naturally in the earth in any other state than,

- i. In form of a calx, *Stannum calciforme*.
 - A. Indurated, or vitrified, *Induratum*.
 1. Mixed with a little of the calx of arsenic, *Minera stanni vitrea arsenicalis*.
 - a. Solid tin ore, without any determinate figure, Tin-stone.

It resembles a garnet of a blackish brown colour, but is a great deal heavier; and has been considered at the English tin-mines as a stone, containing no metal, until some years ago it began to be smelted to great advantage.
 - b. Crystallised, *Crystallisatum*, Tin-grains.

Is like the garnets, of a spherical polygonal figure, but looks more unctuous on the surface.

A SYSTEM OF

1. In larger grains; and,
2. In smaller grains.

S E C T. CLXXXII.

2. Tin mixed with the calx of iron. Sect. lxx.
3. Tin mixed with the manganese. Sect. cxvii.
4. Tin mineralised with sulphur and iron, black lead. Sect. cliv.

S E C T. CLXXXIII.

O B S E R V A T I O N S O N T I N.

It has indeed been asserted by some, that Tin is found native in the earth; but, for my own part, like many others, I doubt much of it, having never seen a single specimen that could be called native tin. It is, however, remarkable that tin is so scarce, and is not found in any considerable quantity or purity in any other places in Europe than in England and Saxony. It is likewise worthy observation, that when its ore is profitable, or to be worked to any advantage, it is always in form of an indurated calx, which answers to those glasses that are prepared from metallic calces in our laboratories: Therefore, in regard to this resemblance, as well as to what this Mineralogical Essay requires from its readers, I have used the term *calx*, in describing the metals; by which word is understood the same as the chemists call a *crocus*, or *terra metallorum phlogisto privata*.

The tin must, however, be mineralised with sulphur in the black lead; but the question is, whether that would have happened if the iron
had

had not been present? This compound, or black lead, and many more, in which the iron and tin are united, are not easily to be examined by the common docimaftical means: However, eafier proceffes may poffibly, fome time or other, be difcovered, and employed for fuch fubftances.

S E C T. CLXXXIV.

5. Lead, *Plumbum, Saturnus*. It is
- a. Of a blueifh white colour when fresh broke, but foon dulls or fullies in the air.
 - b. Is very heavy; viz. to water as 11,325 to 1000.
 - c. Is foftest next to gold, but has no great tenacity, and is not in the leaft fonorous.
 - d. It is eafily calcined; and, by a certain art in managing the degrees of the fire, its calx becomes white, yellow, and red.
 - e. This calx melts eafier than any other metallic calx to a glafs, which becomes of a yellow colour, and femi-transparent. This glafs brings other bodies, and the imperfect metals, into fufion with it.
 - f. It diffolves, 1ft, in the fpirit of nitre; 2dly, in a diluted oil of vitriol, by way of digeftion; 3dly, in the vegetable acid; 4thly, in alkaline folutions; and 5thly, in expreffed oils, both in the form of metal and of calx.
 - g. It gives a fweet tafte to all folutions.
 - b. It amalgamates with quickfilver.
 - i. With the fpirit of fea-falt it has the fame effect as filver, whereby is produced a *ſaturnus corneus*.
 - k. It does not unite with iron, when it is alone added to it in the fire.

- l. It works on the cuppel, which signifies that its glass enters into certain porous bodies, destitute of phlogiston, and alkaline salts.
- m. It melts in the fire before it is made red-hot, almost as easily as the tin.
- n. Its calx or glass may be reduced to its metallic state by pot-ashes.

S E C T. CLXXXV.

Lead is found,

- A. In form of a calx, *Minera plumbi calciformis*.
 - 1. Pure, *Minera plumbi calciformis pura*.
 - a. Friable, lead ochre, *Cerussa nativa*, Native cerufs, is found at Kristiersberget in Westmanland, on the surface of the potter's ore.
 - b. Indurated, Lead spar, or spatose lead ore, *Spatum plumbi*.
 - 1. Radiated, or fibrous.
 - a. White, from Mendip-Hills, in England.
 - 2. Crystallised into a prismatical figure.
 - a. White, from Norrgrufva in Westmanland.
 - b. Yellowish green, from Zchopau in Saxony.

S E C T. CLXXXVI.

- 2. Mixed, *Minera plumbi calciformis mixta*.
 - a. With the calx of arsenic, Arsenic lead-spar.
 - 1. Indurated.
 - a. White. I have tried such an ore from an unknown place in Germany, and found that no metallic lead

lead could be melted from it by means of the blowpipe, as can be done out of other lead spars; but it must be performed in a crucible, and then that part of the arsenic which did not fly off in smoke, during the experiment, was likewise reduced, and found in form of grains dispersed, and forced into the lead. Another ore of this kind, which likewise was not easily reduced by means of the blowpipe, did always after being melted, and during the cooling, hastily shoot into polygonal, but mostly hexagonal crystals, with shining surfaces. Can this crystallisation be owing to salts, which are said not to act in this manner, but when they are dissolved in water?

b. With a calcareous earth *. See Sect. xxxvii.

* The abovementioned lead ores are very rich in lead, and easy to be tried; because most of them, being slowly heated, may be reduced to lead by means of the blowpipe on a piece of charcoal. The calx of the lead in these ores has, perhaps, first been dissolved by sulphur and arsenic, and has afterwards, when these two have weathered away or decayed, and parted from it, assumed this form; in the same manner as we see it really happens during the calcination, with rich lead ores, or such regulæ as contain lead. The same, very likely, is the case with other metals; for which reason their ores, when they occur in form of a calx, often contain a little sulphur, and more especially arsenic.

S E C T. CLXXXVII.

B. Mineralised, *Plumbum mineralisatum*.

1. With sulphur alone, *Plumbum sulphure mineralisatum*: The *Bley-Schweiff*, or *Bleyglanz*, of the Germans.

a. Steel-grained lead ore, from the mines at Hellefors, in the province of Westmanland.

b. Radiated, or antimoniated lead ore.

c. Tessellated, or potters lead ore.

At Villach in Austria there is said to be found a potters lead ore, which contains not the least portion of silver.

S E C T. CLXXXVIII.

2. With sulphurated silver, *Plumbum argento sulphurato mineralisatum*. *Galena*; also called *Bleyglanz* by the Germans.

a. Steel-grained, is found in the mines of Salberg and Hellefors, in the province of Westmanland; and in the Dorothea-mine, in the Hartz in Germany.

b. With small scales, is found at Salberg, and is there particularly called *Blyschweif*.

c. Fine-grained, found at Salberg.

d. Of a fine cubical texture; and,

e. Of coarse cubes. These two varieties are found in all the Swedish silver mines.

f. Crystallised, from Gislöf in the province of Skone*.

* The steel-grained and scaly ores are of a dim and dull appearance when they are broke, and their particles have no determined angular figure: They are therefore in Swedish commonly called *Blyschweif*, in opposition to the cubical ores, which are called *Bleyglanz*. But, in my opinion, the ores ought to

S E C T. CLXXXIX.

3. With sulphurated iron and silver, *Plumbum ferro & argento sulphurato mineralisatum*, is found,
- a. Fine-grained.
 - b. Fine cubical,
 - c. Coarse cubical. These are found at Westersilfverberget, in Westmanland.

When this ore is scorified, it yields a black slag; whereas the preceding lead ores yield a yellow one, because they do not contain any iron.

S E C T. CXC.

4. With sulphurated antimony and silver, *Plumbum antimonio & argento sulphurato mineralisatum*. Antimoniated or radiated lead ore. This has the colour of a *Blyglanz*, but is of a radiated texture.

It is found,

- a. Of fine rays or fibres, and,
- b. Of coarse rays or fibres.

And is got in Maklos Schacht and Fierde-Bottn, in the mine of Salberg in Westmanland. The lead in this ore prevents any use being made of the an-

to be denominated and distinguished from one another according to their metallic contents. No ore ought, by virtue of the most received notion, to be called *Blyschweif*, but that which contains only lead and sulphur. The most part of the ores called *Blyglanz* contain silver, even to twenty-four ounces percent. of which we have instances in the mines of Salberg, where it has been observed that the coarse cubical lead ores are generally the richest in silver, contrary to what is commonly taught in books; the reason of which may perhaps be, that, in making the essays on these two ores, the coarse cubical can be chosen purer or freer from the rock, than the fine cubical ores.

timony

timony to advantage; and the antimony likewise in a great measure hinders the extracting of the silver.

S E C T. CXCI.

OBSERVATIONS ON LEAD ORES.

I know of no native lead; and all which has been said on that subject is liable to remarkable restrictions.

Such of the potters ores as do not contain any silver are very scarce; yet they are often found so poor in silver, that it does not answer the expences of extracting. These, when they are free from mixtures of the rock, are, without any previous fusion, employed to glaze earthen-ware; and a great trade is carried on in the Mediterranean with such ores, from the lead-mines of Sardinia and France.

S E C T. CXCII.

6. Copper, *Cuprum, Venus, As.*

This metal is,

- a. Of a red colour.
- b. The specific gravity of the Japan copper is 9000, and of the Swedish 8784 or 8843, to 1000.
- c. It is pretty soft and tough.
- d. The calx of copper being dissolved by acids becomes green, and by alcalies blue.
- e. It is easily calcined in the fire into a blackish blue substance, which, when rubbed to a fine powder, is red; when melted together with glass, it tinges it first reddish

reddish brown, and afterwards of a transparent green or sea-green colour.

- f.* It dissolves in all the acids; viz. The acids of vitriol, sea-salt, nitre, and the vegetable; and likewise in all alkaline solutions. That it becomes rusty, and tarnishes in the air (a consequence of a former solution), depends very much on some vitriolic acid which is left in the copper in the refining of it. This metal is easier dissolved when in form of a calx than in a metallic state, especially by the acids of vitriol and sea-salt, and the vegetable acid.
- g.* Vitriol of copper is of a deep blue colour, but the vegetable acid produces with the copper a green salt, which is verdigrise.
- b.* It can be precipitated out of the solutions in a metallic state; and this is the origin of the precipitated copper of the mines, called Ziment copper.
- i.* It is not easily amalgamated with quicksilver; but requires for this purpose a very strong trituration, or the admixture of the acid of nitre.
- k.* It becomes yellow when mixed with zink, which has a strong attraction to it, and makes brass, pinchbeck, &c.
- l.* It is easily dissolved by lead glass, which last is coloured green by it.
- m.* When this metal is exposed to the fire, it gives a green colour to the flame in the moment it begins to melt, and continues to do so afterwards, without losing any thing considerable of its weight.
- n.* It requires a strong degree of heat before it melts, yet is it a lesser degree than for iron.

S E C T. CXCIII.

Copper is found in the earth,

A. Native, or in a metallic state; Virgin or native copper, *Cuprum nativum*.

1. Solid, *Solidum*, is found in the iron mine of Hefslekulla, in the province of Nerike, and at Sunnerskog, in the province of Smoland; also in the Russian Carelia, and in other foreign places.
2. Friable, in form of small, and somewhat coherent grains, *Cuprum nativum particulis conglomeratis distinctis*. Precipitated or Ziment Copper. It is found at Riddarshyttan in Westmanland, at Fahlun in Dalarne, and in Hungary.

It has been observed, that both copper and silver glass ore, being precipitated from water, become friable and granulated, but that they in time grow solid and ductile: whence the dispute about the distinction between native and precipitated copper may cease, the rather as native copper will scarcely be found in other places, and in any other kinds of stones, than through which the ziment or vitriolic waters have circulated; altho' the fissures thro' which it has run may afterwards be filled with a stony substance.

S E C T. CXCIV.

B. In form of a calx, *Minera cupri calciformis*.

1. Pure, *Minera cupri calciformis pura*.
 - a.* Loose or friable, *Oebra veneris*.
 1. Blue, *Cæruleum montanum*.

Is very seldom found perfectly free from a calcareous substance.

2. Green, *Viride montanum*.

Both these colours depend on menstrua, which often areedulcorated or washed away.

3. Red. This is an efflorescence of the glass copper ore. It is found in the province of Dal, and at Ostanberg, in the province of Dalarne.

S E C T. CXC V.

- b.* Indurated, *Indurata*. Glass copper ore.

- a.* Red, *Minera cupri calciformis pura & indurata, colore rubro*.

This is sometimes as red as sealing-wax, and sometimes of a more liver-brown colour. It is found in Sandbacken, at Norberg in Westmanland, at Ordal in Norway, in Siberia, and in Suabia in Germany.

This ore is always found along with native copper, and seems to have lost its phlogiston by way of efflorescence, and to be changed into this form. It is likewise found along with the sulphurated copper, and is commonly, though very improperly, called Glass copper ore.

S E C T. CXC VI.

2. Mixed, *Minera cupri calciformis impura*.

- a.* Loose or friable, *Ochra veneris friabilis impura*.

A SYSTEM OF

1. Mixed with a calcareous substance; *Ochra veneris terrâ calcareâ mixta. Cæruleum montanum.* In this state copper blue is mostly found. It ferments during the solution in aqua fortis. See Sect. xxxiv.
2. Mixed with iron. Black. It is the decomposition of the Fahlun copper ore. Sect. cxcviii. a.
- b. Indurated, *Minera cupri calciformis impura indurata.*
 1. Mixed with gypsum, or plaster. Green. Is found at Ordal in Norway, and there called Malachites.
 2. Mixed with quartz. Red. From Sunnerskog, in the province of Smoland. Sect. liii. B.
 3. Mixed with lime. Blue. This is the *lapis armenus*, according to the accounts given of it by authors.

S E C T. CXC VII.

C. Dissolved and mineralised, *Cuprum mineralisatum.*

1. With sulphur alone, *Cuprum sulphure mineralisatum.* Grey copper ore. Is improperly also called Glass copper ore.

a. Solid, without any certain texture, *Minera cupri sulphurata solida texturâ indeterminatâ.* This is very soft, so that it can be cut with a knife, almost as easily as black lead.

b. Fine cubical, *Minera cupri sulphurata tessulis constans minoribus.*

Both these varieties are found at Sunnerskog, in Smoland; where the last is sometimes

sometimes found decomposed or weathered, and changed into a deep mountain blue. Sect. cxciv.

S E C T. CXCVIII.

2. With sulphurated iron, *Minera cupri pyritacea*: Yellow copper ore. Marcasitical copper ore, *Pyrites cupri*.

This is various both in regard to colour, and in regard to the different proportion of each of the contained metals; for instance:

- a. Blackish grey, inclining a little to yellow, *Pyrites cupri griseus*.

When decayed or weathered, it is of a black colour; is the richest of all the varieties of this kind of copper ore, yielding between 50 and 60 per cent. and is found in Spain and Germany.

- b. Reddish yellow, or liver brown, with a blue coat on the surface, *Minera cupri lazurea*.

This ore yields between 40 and 50 per cent. of copper, and is commonly said to be blue, though it is as red when fresh broke, as a rich copper regulus.

- c. Yellowish green, *Pyrites cupri flavo viridescens*.

This is the most common in the north part of Europe; and is, in regard to its texture, found

1. Solid, and of a shining texture, from Ostanberg, in the province of Dalarne.
2. Steel-grained, of a dim texture, from the same place, and Falun in Dalarne.
3. Coarse-grained, is of an uneven and shining texture. It occurs in most of

A SYSTEM OF

the Swedish and Norwegian copper mines.

4. Crystallised marcasitical copper ore.
 a. Of long octoëdric crystals.

This is found at Hevassvik, in the province of Dal, and in Lovisagrufva, in Westmanland; notwithstanding its existence is denied by Henckel, and his followers.

- d. Pale yellow, *Pyrites cupri pallidè flavus*.

This cannot be described but as a marcasite, though an experienced eye will easily discover some difference between them. It is found at Tunaberg, in the province of Sodermanland, and yields 22 per cent. of copper.

- e. Liver-coloured.

This is found at Falun, in Dalarna, where it contains copper; though at most other places, where it occurs, it does not contain any copper, but is only a martial marcasite.

S E C T. CXCIX.

3. With sulphurated arsenic and iron; *Cuprum ferro ex arsenico sulphurato mineralisatum*.
 White copper ore.

It is said to be found in the Hartz, in Germany, and to resemble an arsenical pyrites; but I have never met with this kind.

However, most of the pyritical copper ores, as well as the marcasites, contain a little arsenic, though it is in too small a quantity to be observable.

S E C T. CC.

4. Dissolved by the vitriolic acid, *Cuprum acido vitrioli solutum* : *Vitriolum Veneris*. See Sect. cxxii.
5. With phlogiston. Copper coal ore. See Sect. clxi.

S E C T. CCI.

7. Iron, *Ferrum*, *Mars*. It is
 - a. Of a blackish blue shining colour.
 - b. It becomes ductile by repeated heating between coals, and hammering.
 - c. It is attracted by the loadstone, which is an iron ore; and the metal itself may also be rendered magnetical.
 - d. Its specific gravity to water is as 7,645, or 8000 : : 1000.
 - e. It calcines easily to a black scaly calx, which, when pounded, is of a deep red colour.
 - f. When this calx is melted in great quantity with glass compositions, it gives a blackish brown colour to the glass; but in a small quantity a greenish colour, which at last vanishes, if forced by a strong degree of heat.
 - g. It is dissolved by all salts, by water, and likewise by their vapours. The calx of iron is dissolved by the spirit of sea-salt, and by aqua regia.
 - h. The calx of the dissolved metal becomes yellow, or yellowish brown; and in a certain degree of heat, it turns red.

- i. The same calx, when precipitated from acids, by means of the fixed alcali, is of a greenish colour; but it becomes blue, when precipitated by means of an alcali united with phlogiston, in which last circumstance the phlogiston unites with the iron: These two precipitates lose their colour in the fire, and turn brown.
- k. The vitriol of iron is green.
- l. It is the most common metal in nature, and at the same time the most useful in common life; notwithstanding which, its qualities are perhaps very little known.

S E C T. CCII.

Iron is found,

A. In form of calx, *Minera ferri calciformis pura*.

1. Pure.

a. Loose and friable, *Minera ferri calciformis pura friabilis*. Martial ochre, *Minera ochracea*.

1. Powdry, *Ochra ferri*, is commonly yellow or red, and is iron which has been dissolved by the vitriolic acid.

2. Concreted. Bog-ore.

a. In form of round porous balls.

b. More solid balls.

c. In small flat pieces, like cakes, or pieces of money.

d. In small grains.

e. In lumps of an indeterminate figure.

All these are of a blackish brown, or a light brown colour. They are found in lakes in the province of Smoland;

Smoland; and in marshes at Fiellryggen, a chain of rocks which separates Sweden from Norway.

S E C T. CCIII.

b. Indurated, *Minera ferri calciformis pura indurata*. The bloodstone, *Hæmatites*.

1. Of an iron colour, *Hæmatites carulefcens*.

This is of a blueish grey colour; it is not attracted by the loadstone, yields a red powder when rubbed, and is hard.

a. Solid, and of a dim appearance when broken.

b. Cubical, and of a shining appearance when broken.

c. Fibrous, is the most common *Torrsten* of Sweden.

d. Scaly; the *Eisenman* of the Germans,

This is for the most part as if it were micaceous, though the scales go across the strata of the stone. It is found at Jobsbo, in Norrberne in Dalarne, and Reka Klitt, in the province of Helsingland.

1. Black, from Gellebeck, in Norway.

2. Blueish grey, from Reka Klitt.

When this is found along with marcasite, as at Sandswar, in Norway, it is not only attracted by the loadstone, but is of itself really a loadstone Sect. ccxi.

c. Crystallised.

1. In octoëdric crystals.
2. In polyëdric crystals.
3. In a cellular form, from Mofsgrufvan, at Norberg in Westmanland.

These varieties are the most common in Sweden, and are very seldom blended with marcasite, or any other heterogeneous substance, except their different beds. It is remarkable, that, when these ores are found along with marcasite, those particles, which have laid nearest to the marcasite, are attracted by the loadstone, although they yield a red or reddish brown powder, like those which are not attracted by the loadstone: It is likewise worth observation, that they generally contain a little sulphur, if they are imbedded in a lime-stone rock, which however very seldom happens in Sweden; but I know only one such instance, viz. at Billfio, in Soderberke, in the province of Dalarne. Sect. ccxiii.

S E C T. CCIV.

2. Blackish brown bloodstone, *Hematites nigrescens*. Kidney ore.

This yields a red or brown powder when it is rubbed; it is very hard, and is attracted by the loadstone.

- a. Solid, with a glassy texture, from Westerfilfverberget, in the province of Westmanland.
- b. Radiated.
- c. Crystallised.

1. In form of cones, from Siberia.
2. In form of concentrick balls, with a facettèd surface.

These are very common in Germany, but very scarce in Sweden.

S E C T. CCV.

3. Red bloodstone, *Hæmatites ruber*. Red kidney ore.
 - a. Solid, and dim in its texture, from Westersilfverberget, in Westmanland.
 - b. Scaly. The *Eisenman* of the Germans. This is commonly found along with the iron-coloured iron glimmer, (Sect. cciii. 1. d.) and smears the hands.
 - c. Crystallised.
 1. In concentrick balls, with a flat or facettèd surface.

S E C T. CCVI.

4. Yellow bloodstone, *Hæmatites flavus*.
 - a. Solid.
 - b. Fibrous, from Lammerhof, in Bohemia*.

S E C T. CCVII.

2. Iron in form of calx, mixed with heterogeneous substances, *Minera ferri calciformis heterogeneis mixta*.
 - a. With

* The varieties of the colours in the bloodstone are the same with those produced in the calces of iron, made by dry or liquid menstrua, and afterwards exposed to different degrees of heat.

- a. With a calcareous earth, White spathose iron ore. The *Stablstein* of the Germans. See Sect. xxx.
- b. With a filiceous earth. The Martial Jasper or Sinople. Sect. lxxv.
- c. With a garnet earth. Garnet and coccle or shirl. Sect. lxxix.
- d. With an argillaceous earth. The bole. Sect. lxxxvi.
- e. With a micaceous earth. Mica. Sect. xc.
- f. With manganese. Sect. cxvi.

S E C T. CCVIII.

- g. With an alcali and phlogiston, *Calx martialis phlogisto juncta, et alcali precipitata*. Blue martial earth. Native Prussian-like blue.
 - 1. Loose or powdery, found among the turf in the levels of the province of Skone: Also in Sax Weiffenfels, and at Norvlanden in Norway, &c.

S E C T. CCIX.

- b. With an unknown earth, which hardens in water, *Calx martis terrâ incognitâ aquâ indurescente mixta*. Tarras, *Cementum*.
 - 1. Loose or granulated, *Terra Puzzolana*, from Naples and Civita Vecchia in Italy. This is of a reddish brown colour, is rich in iron, and is pretty fusible.
 - 2. Indurated, *Cementum induratum*, from Cologne,

This

This is of a whitish yellow colour, contains likewise a great deal of iron, and has the same quality with the former, to harden soon in water, when mixed with mortar. This quality cannot be owing to the iron alone, but rather to some particular modification of it, occasioned by some accidental causes, because these varieties rarely happen at any other places, except where volcanos have been, or are yet in the neighbourhood.

S E C T. CCX.

- i. Calx of iron, united with another unknown earth, *Ferrum calciforme terrâ quâdam incognitâ intimè mixtum*. The *Tungsten* of the Swedes.

This is also, though improperly, called White Tingrains. Sect. clxxxii.

This resembles the garnet-stone, (Sect. lxix.) and the tin-grains; is nearly as heavy as pure tin; very refractory in the fire, and excessively difficult to reduce to metal. Iron has, however, been melted out of it to more than 30 per cent. It is very difficultly dissolved by borax and alkaline salts, but melts very easily with the microcosmic salt, giving a black slag: And for this reason, this last mentioned salt must be employed in the experiments on this stone. It is found,

1 Solid and fine-grained.

a. Reddish or flesh-coloured.

b. Yellow.

- b.* Yellow, from Bastnaſgrufva at Riddarshyttan in the province of Westmanland.
- 2. Spathoſe, and with an unctuous ſurface.
 - a.* White, from Marienberg and Altenberg, in Saxony.
 - b.* Pearl-coloured, from Biſpberg Klack, in the province of Dalarne*.

S E C T. CCXI.

B. Diſſolved or mineraliſed iron, *Ferrum mineraliſatum*.

1. With ſulphur alone.

a. Perfectly ſaturated with ſulphur, *Ferrum ſulphure ſaturatum*. Marcasite. See Sulphur, Sect. clii.

b. With very little ſulphur. Black iron ore. Iron ſtone. *Minera ferri atra*.

This is either attracted by the loadſtone, or is a loadſtone itſelf, attracting iron; it reſembles iron, and yields a black powder when rubbed.

1. Magnetic iron ore, *Minera ferri attractoria*. The Loadſtone, *Magnes*.

a. Steel-grained, of a dim texture, from Hogberget, in the pariſh of

* This kind of ſtone is very ſeldom met with, but in ſuch places where black lead is common in the neighbourhood; and the hiſtory of the black lead, inſerted in the Memoirs of the Swediſh Academy of Sciences, has induced me to believe, that this may contain ſome tin, which merits further examination. Mr. Cronſtedt has in the ſaid Memoirs communicated his experiments upon this kind of ſtone from Riddarshyttan, and Biſpberget in Westmanland; as has alſo Mr. Rinman, on a great number of other martial earths. See the ſaid Memoirs for the years 1751 and 1754.

Gagnœf in Dalarne: It is found at that place almost to the day, and is of as great strength as any natural loadstones were ever commonly found.

- b. Fine-grained, from Saxony.
- c. Coarse-grained, from Spetalsgrufvan, at Norberg, and Kierrgrufvan, both in the province of Westmanland. This loses very soon its magnetical virtue.
- d. With coarse scales, found at Sandfwœr in Norway. This is a pyritical *Eisenman*, and yields a red powder when rubbed. Sect. cciii.

S E C T. CCXII.

2. Refractory iron ore, *Minera ferri retractoria*. This in its crude state is attracted by the loadstone.

- a. Giving a black powder when rubbed, *Tritura atra*. Of this kind are,
 - 1. Steel-grained, from Adelfors, in the province of Smoland.
 - 2. Fine-grained, from Dannemora, in the province of Upland.
 - 3. Coarse-grained, from Kierrgrufvan, in the province of Westmanland.

This kind is found in great quantities in all the Swedish iron mines; and of this most part of the fusible ores consist, because it is commonly found in such kinds of rocks as are very fusible:

And

A SYSTEM OF

And it is as seldom met with in quartz, as the hæmatites is met with in limestone.

S E C T. CCXIII.

b. Rubbing into a red powder, *Tritura rubra*.

These are real hæmatites, that are so far modified by sulphur or lime, as to be attracted by the loadstone.

1. Steel-grained, found in a deserted mine at Billsto, in the parish of Soderberke in Dalarne.
2. Fine-grained. Emery. This is imported from the Levant: It is mixed with mica, is strongly attracted by the loadstone, and smells of sulphur when put to the fire.
3. Of large shining cubes, from Thomfensgrube at Arendal in Norway.
4. Coarse, scaly. The *Eisenglimmer* or *Eisenman* from Gellebeck in Norway*.

S E C T. CCIV.

2. With arsenic, *Ferrum arsenico mineralisatum*. Called Mispickel by the Germans, and Plate Mundic in Cornwall.
3. With sulphurated arsenic. (Sect. ccxliii.) Arsenical Pyrites.

* These are very scarce in Sweden, most part of the Swedish bloodstones being pure, as has already (Sect. cciii.) been said, and form that very profitable ore in Swedish called *Torrsten*.

4. With vitriolic acid. Martial vitriol; Sect. cxxii.
5. With phlogiston. Martial coal ore. Sect. clxi.
6. With other fulphurated and arsenicated metals. See these in their respective arrangements.

S E C T. CCXV.

O B S E R V A T I O N S O N I R O N.

This metal enters into so many compositions, that they cannot all be possibly enumerated; it must therefore suffice to mention only those, in which it makes out the predominant part. This metal is found in animals and vegetables; and certain iron ores seem to be of service to the vegetable kingdom, as is manifestly seen on the ground round, and under the heaps of loose stones laid up in separating the ore from the rock, at those iron mines, where the ores are mixed with limestone.

With respect to oeconomic effects, iron is divided into cold-short, red-short, and tough; and the ores into refractory, fusible, and those that do not want any admixture; which depends on accidental circumstances, and the method of working.

Although iron is commonly mixed in the different kinds of earth, yet it cannot be asserted with Becher, that iron may be melted out of every earth, by adding only a phlogiston; since in that case this metal might also be got out of Muscovy glass, pure quartz, chalk, white transparent fluor, &c. which very likely has never yet been done.

Nature has bestowed on Sweden an immense store of iron ores; so that whole mountains, in Tornea and Lappmark in Lapland, consist solely
of

of a pure, and a very rich iron ore : Large veins of the same ore are likewise found in almost every province of that kingdom of such a nature, that few countries can produce better or richer.

The magnetical power, with respect to its principles and origin, is no better understood than electricity, yet somewhat more with respect to its effects. Though both these qualities are now considered as different powers, they may perhaps in time be regarded as something nearer allied to each other.

The magnetical power is not innate in the iron, but is collected into it by degrees, which is verified by experiments ; it may be expelled, it may vanish and gather again, as it were out of the air, since the natural loadstones for the most part occur in small veins to the day, whilst deeper, only refractory iron ores are found. There is the same difference between an artificial magnet of Dr. Knight's, and a bar of steel, whether of the same shape or not, as between a natural loadstone, and a blackish blue iron ore ; whence it is ridiculous to insist with a certain author, that no iron ore can be attracted by the loadstone, but what of itself contains some magnetical virtue.

S E C T. CCXVI.

The SECOND ORDER:

S E M I-M E T A L S.

There are but seven semi-metals yet discovered.
viz.

1. Quicksilver, Mercury, *Argentum vivum*,
Mercurius, *Hydrargyrum*.

This distinguishes itself from all metals, by the following qualities. a. Its

- a. Its colour is white and shining; a little darker than that of silver.
- b. It is fluid in the cold, and divisible by the least force; but, as it only sticks to a few bodies, to which it has an attraction, it is said that it does not wet.
- c. It is volatile in the fire.
- d. Its weight is next to that of the gold, viz. to water, as 13,593 : : 1000.
- e. It attracts the other semi-metals and metals, and unites with them all, except cobalt and nickel, with which it cannot by any means yet known be made to mix. This union is called an amalgamation. This amalgamation, or mixtion of metallic bodies, according to the readiness with which they unite or mix, is in the following progression, viz. gold, silver, lead, tin, zink, bismuth, copper, iron, and the regulus of antimony: But the three latter however do not very readily amalgamate. The iron requires a solution of the vitriol of iron, as a medium to promote the union.
- f. It dissolves in the spirit of nitre, out of which it is precipitated by a volatile alkali, and the common salt, in form of a white powder; but if a fixed alkali is used, into a yellow powder or calx.
- g. It dissolves in the oil of vitriol by a strong boiling.
- h. It is not affected by the acid of common salt, unless it be previously dissolved by other acids; in which case only they unite with one another, and may be sublimed together, the which sublimation is a strong poison.

i. It

- i. It unites with sulphur by grinding, and then produces a black powder, called *æthiops mineralis*, which sublimes into a red striated body, called factitious cinnabar.
- k. The sulphur is again separated from the quicksilver, by adding iron or lime, to which the sulphur attaches itself, leaving the quicksilver to be distilled over in a metallic form; but if a fixed alkali is added to it, some part of the quicksilver will remain in the residuum, and in that case makes a liver of sulphur.

S E C T. CCXVII.

Quicksilver is found,

- A. Native, or in a metallic state, *Mercurius nativus, virgineus*.

This is found in the quicksilver mines at Idria in Friuli, or the Lower Austria, in clay, or in a black stony lapis ollaris, out of which it runs, either spontaneously, or by being warmed even in the hands. It has several times been found at Herr Sten's Botten, in the mines of Salberg, in Westmanland, and sometimes also amalgamated with native silver.

S E C T. CCXVIII.

- B. Mineralised, *Mercurius mineralisatus*.

- i. With sulphur, *Mercurius sulphure mineralisatus*. Cinnabar, *Cinnabaris nativa*.

This is of a red colour, and its specific gravity to water is as 7500 :: 1000.

- a. Loose or friable cinnabar, *Cinnabaris friabilis*, looks like red ochre.

It is found in the duchy of Zweybruck or Deuxponte, in Germany.

- b. Indurated, *Minera Mercurii indurata*;
Solid cinnabar. Is of a deep red colour, and, with respect to its texture, is either,
1. Steel-grained, from Siebenburgen;
 2. Radiated;
 3. Composed of small cubes, or scaly, from Idria and Hungary; or
 4. Crystallised,
 - a. In a cubical form; it is transparent, and deep red as a ruby, from Mutschlansberg in Zweybruck*.

S E C T. CCXIX.

2. Mineralised with sulphur and copper, *Mercurius cupro sulphurato mineralisatus*. This is blackish grey, of a glassy texture, and brittle; crackles and splits excessively in the fire; and when the quicksilver and sulphur are evaporated, the copper is discovered by its common opaque red colour in the glass of borax, which, when farther forced in the fire, or diluted, becomes green and transparent. It is found at Mutschlansberg in Zweybruck.

S E C T. CCXX.

OBSERVATIONS ON QUICKSILVER.

The divisibility of quicksilver in the cold, might occasion some doubt, whether it really deserves to be called a metal, if it had not a right to it from

* It is said, that there is also found in Idria a black cinnabar, that retains its colour in the sublimation, which seems to indicate an abundant phlogiston in the sulphur; but this requires, however, a farther examination.

the earliest times, being then reckoned among the metals, when even they were named after the planets, the number of both being thought equal.

The opinion, which has a long time prevailed, that the quicksilver is a necessary ingredient, and constituent part in all metals, is not so generally received now as heretofore; since those processes, which have been advanced as proofs of it, and which have, however, but seldom been repeated, do by no means succeed, at least not in all places; it is rather supposed, that by the mercurial earth the ancients have understood an earth, which may, by addition of phlogiston, be reduced in the fire to a metallic state; and this appears to be so much the more reasonable, as the quicksilver only attracts the metals in their substances, and not in their burnt calces.

SECT. CCXXI.

2. Bismuth, Tinglass, *Vismutum*, *Bismutum*, *Marcasita officinalis*. It is
 - a. Of a whitish yellow colour.
 - b. Of a laminated texture, soft under the hammer, and nevertheless very brittle.
 - c. Its specific gravity to water is, as 9,700 : : 1000.
 - d. It is very fusible, calcines and scorifies like lead, if not rather easier, and therefore it works on the cuppel. It is pretty volatile in the fire.
 - e. Its glass or slag becomes yellowish brown, and has the quality of retaining some part of the gold, if that metal has been melted, calcined, and vitrified with it.
 - f. It may be mixed with the other metals, except cobalt and zink, making them white and brittle.
 - g. It

- g. It dissolves in aqua-fortis, without imparting to it any colour; but to the aqua-regia it gives a red colour, and may be precipitated out of both these solutions with pure water, into a white powder, which is called *Spanish white*. It is also precipitated by the acid of sea-salt, which last unites with it, and makes the *Vismutum corneum*.
- b. It amalgamates easily with quicksilver. Other metals are so far attenuated by the bismuth, when mixed with it, as to be strained or forced along with the quicksilver through skins or leather.

S E C T. CCXXII.

Bismuth is found in the earth.

A. Native, *Vismutum nativum*.

This resembles a regulus of bismuth, but consists of smaller scales or plates.

1. Superficial, or in crusts.
2. Solid, and composed of small cubes.

This is found in, and with, the cobalt ore, at Schneeberg in Saxony, and other foreign places: Likewise along with the copper ore, at Nyberget, in the parish of Stora Skedwi, in the province of Dalarne.

S E C T. CCXXIII.

B. In form of calx, *Vismutum calciforme*.

1. Powdery or friable, *Ochra vismuti*.

This is of a whitish yellow colour; it is found in form of an efflorescence, to the day, at Los, in the province of Helsingland.

It has been customary to give the name of Flowers of Bismuth to the pale red calx

of cobalt, but it is wrong; because neither the calx of bismuth, nor its solutions, become red, this being a quality belonging to the cobalt.

I have seen a radiated cristallisation of a metallic appearance, which was found at Schneeberg, and was likewise called Bismuth Flowers; but in the small trial I was permitted to make on it, it did not discover the least marks of bismuth, but answered rather to zink, if zink may be supposed to exist in a native state.

S E C T. CCXXIV.

C. Mineralised bismuth, *Vismutum mineralisatum*:

This is, with respect to colour and appearance, like the coarse tessellated potter's lead ore; but it consists of very thin square plates or flakes, from which it receives a radiated appearance, when broken crosswise.

1. With sulphur, *Vismutum sulphure mineralisatum*.

a. With large plates or flakes, from Bastnas at Riddarshyttan, Balringe and Stripas in Westmanland.

b. With fine or small scales, from Jacobsgrufvan at Riddarshyttan, and the mines at Los, in the parish of Farila, in Helplingland.

S E C T. CCXXV.

2. With sulphurated iron, *Vismutum ferro sulphurato mineralisatum*.

a. Of

4. Of coarse, wedge-like scales, from Kongruben, at Gellebeck in Norway*.

S E C T. CCXXVI.

O B S E R V A T I O N S O N B I S M U T H.

Although Mr. Pott has, in a separate treatise on bismuth, shewn, that it is dissolved without giving any colour to the solution, and that it is precipitated with pure water; and, though the mine-master Mr. Brandt has likewise, in the *Acta Upsaliensia* for the year 1735, given an accurate history of the cobalt, we find nevertheless in some new authors such a definition of bismuth, as includes at the same time the principal characters of the cobalt, viz that of giving to glass a blue colour, and to tinge solutions red. This confusion proceeds from the bismuth being commonly found among cobalt ores, and that it cannot be separated from it but by the way of eliquation; during which the cobalt, as being less fusible, remains, and is by the workmen called *Vismut graupe*, or Bismuth grains.

This error is excusable in those who do not pretend to maintain and vindicate their ignorance, it having been the fate of the semi-metals to be but very little examined. If the alchemists had not thought the quicksilver, antimony, and zink, fit for their purposes, we should very likely have still wanted many of those advantages which they af-

* This mineralised bismuth ore yields a fine radiated regulus; for which reason it has been ranked among the antimonial ores, by those who have not taken proper care to melt a pure regulus or destitute of sulphur from it; while others, who make no difference between regulus and pure metals, have still more positively asserted it to be only an antimonial ore.

ford both in medicine and common life. The bismuth, it is true, has likewise in its time been in some favour with adepts; but it soon lost its credit, and was left to those who contented themselves with less prospects than of making gold and the universal medicine; as to pewterers, tin-workers, and other tradesmen, who find their advantage in the fusibility of this semi-metal, and its giving colour and hardness to tin and lead.

S E C T. CCXXVII.

3. Zink, Speltre, *Zincum*.

- a. Its colour comes nearest to that of lead, but it does not so easily tarnish.
- b. It shews a texture, when it is broken, as if it were compounded of flat pyramids.
- c. Its specific gravity to water is, as 6,900 or 7000 :: 1000.
- d. It melts in the fire before it has acquired a glowing heat; but when it has gained that degree of heat, it burns with a flame of a changeable colour, between blue and yellow; and if in an open fire, the calx rises in form of soft white flowers; but if in a covered vessel, with the addition of some inflammable, it is distilled in a metallic form; in which operation, however, part of it is sometimes found vitrified.
- e. It unites with all the metals, except bismuth, and makes them volatile. It is however not easy to unite it with iron without the addition of sulphur. It has the strongest attraction to gold and copper, and this last metal acquires a yellow colour by it; which has occasioned many experiments

ments to be made to produce new metallic compositions.

- f.* It is dissolved by all the acids; of these the vitriolic acid has the strongest attraction to it, yet it does not dissolve it, if it is not previously diluted with much water. The abundance of phlogiston in this semi-metal is perhaps the reason of its strong attraction to the vitriolic acid.
- g.* Quicksilver amalgamates easier with zink than with copper, by which means it is separated from compositions made with copper.
- b.* It seems to become electrical by friction, and then its smaller particles are attracted by the loadstone; which effects are not yet perfectly investigated; but they may excite philosophers to make farther experiments, in order to discover whether the electrical power shews itself in the metals, by being attracted by the loadstone, or whether the magnetic power can be exerted on other metals than iron.

S E C T. CCXXVIII.

Zink is found,

A. In form of calx, *Zincum calciforme naturale.*

1. Pure, *Minera zinci calciformis pura.*

a. Indurated, *Indurata.*

1. Solid.

2. Crystallised.

This is of a whitish grey colour, and its external appearance is like that of a lead spar; it cannot be described, but is easily known by an experienced eye. It looks very like an artificial

glass of zink, and is found among other calamines at Namur, and in England.

2. Mixed, *Minera zinci calciformis impura*.
 - a. With a martial ochre, *Ochra sive calx zinci martialis*.
 1. Half indurated, *Ochra zinci indurata*.
Calamine, *Lapis calaminaris*.
 - a. Whitish yellow, from Tarnovitz, in Silesia, England, and Aix-la-Chapelle.
 - b. Reddish brown, Poland and Namur.
This seems to be a mouldered or weathered blende.
 - b. With a martial clay or bole, from Hollberget in Norberke, in Westmanland. Sect. lxxxvi. d.
 - c. With a lead ochre and iron, England.

SECTION CCXXIX.

- B.** Mineralised zink, *Zincum mineralisatum*.
1. With sulphurated iron, *Zincum ferro sulphurato mineralisatum*. Blende, Mocklead, Black jack, Mock ore, *Pseudogalena* and Blende of the Germans.
 - a. Mineralised zink in a metallic form, *Zincum formâ metallicâ sulphuratum*. Zink ore.
This is of a metallic blueish grey colour, neither perfectly clear as a potter's ore, nor so dark as the Swedish iron ores.
 1. Of a fine cubical or scaly texture, from China, Kongsberg, and Jarlsberg in Norway.

2. Steel-grained, from Bowallen and Skienshyttan, in the parish of Tuna, in Dalarne.

S E C T. CCXXX.

b. In form of calx, *Zincum calciforme cum ferro sulphuratum*. Blende. Mocklead, *Sterile nigrum*. *Pseudogalena*. This is found,

1. With coarse scales,

a. Yellow, semi-transparent, from Scharffenberg in Misnia, Schemnitz and Kongsberg.

b. Greenish, from Kongsberg.

c. Black, *Pechblende* or *Pitch Blende* of the Germans, from Salberg and Falun in Sweden, and from Saxony.

d. Blackish brown, from Storfallsberget in Tuna in Dalarne.

2. With fine scales,

a. White, from Silfberget in the parish of Rettwik in Dalarne.

b. Whitish yellow, from Rettwik.

c. Reddish brown, from Salberg, Silfverberget, and Hellefors in Westmanland.

3. Fine and sparkling; at Goslar called *Braun Bleyertz*.

a. Dark Brown, from the Rammelsberg in the Hartz, and Salberg in Westmanland*.

S E C T.

* The zink, in these last kinds of blendes, is as it were in form of a calx or glass, so that they are often transparent: On the contrary, in the zink ore, (Sect. ccxxix. *a.*) it seems rather to be in a metallic form, or like most other metals, mineralised

SECT. CCXXXI.

OBSERVATIONS ON ZINK.

It does not seem just to conclude from old coins and other antiquities, that it is evidently proved that the making of brass was known in the most antient times, and that it was their *Æs Corinthia-*

neralised with sulphur. The sulphur, nevertheless, exists in the different kinds of blende, equally as in the zink ore; and this remarkable difference in their appearance must be accounted for from another principle than the quantity of the zink which they contain; because the yellow and white blendes are often found richer than the zink ores, but the zink ores are however more easy to melt, and consequently more profitable. Perhaps it is because the blende does not contain a sufficient quantity of the phlogiston of the sulphur, to prevent the calcination of the zink.

It is no matter whether a calcined blende is called calamine or not, provided it has such properties that it may be employed to the same purposes. and with the same advantage as that calamine which nature has freed from its sulphur by its weathering or decaying. This may be done with some kinds of blende, and Mr. Von Swab has given evident and excellent proofs of it in Sweden; insomuch that it would demonstrate a want of experience to insist that sulphur cannot be expelled by calcination, without destroying the zink itself, and that flowers of zink may be produced from zink ores in a calcining heat, without addition of any phlogiston.

Mr. Justi however avers, that he has found an ore of this quality, which in his Mineralogy he calls *Zinkspat*; but there is great reason to doubt if it really contains any zink, until it is proved whether the author added any phlogiston during the calcination, or reduced the zink out of it; because, although the flowers of zink may not always be perfectly well calcined, yet there is no instance of a natural zink ore being discovered, which by itself yields those flowers during the calcination: And it requires, besides, a strong heat to produce these flowers from a perfect calx or glass of this semi-metal, either natural or artificial, though mixed with a phlogiston; for it could not have been a native zink, since it resembled a spar, and such a one very likely is not to be found in nature.

cum which contained copper and zink : But, however, it is not long since this semi-metal was discovered to lie concealed in calamine, and that calamine was its particular ore, and also a body of distinct qualities, prepared by nature, equal to that which is got tolerably pure at the furnaces of Goslar, or that is imported from China, under the name of *Tutanague*. Mr. Brandt removed a great many doubts about the origin of zink, and the metallic earth of the calamine, by having, in the year 1734, a favourable opportunity of examining the calamines, and different kinds of blends, from Rettwik in the province of Dalarne. He then proved, in his history of the semi-metals, that blends and calamines are ores of zink, and that the clear alum-like vitriol, called *Galitzenstein* by the Germans, (Sect. cxxii.) was its vitriol. Soon after, the blueish grey zink ore was discovered by Mr. Von Swab at Bowallen, who in the year 1738 prepared calamine from it, and erected a work for distilling zink at large from it, at Westerwiken in Dalarne; which manufacture, however, afterwards was laid aside for other intervening business. Thus these first discoverers might perhaps have given Messieurs Pott and Margraff the opportunity to write the history of zink, then more known to the world; the former in his Treatise *De Pseudogalenâ*, in the year 1741; and the latter in the Memoirs of the Academy of Berlin; though this notice is by no means intended to prejudice these ingenious gentlemen of the honour they merit, to have of themselves had the same opinion, and purposed the same experiments.

The zink ore from Ramelsberg in the Hartz, is, like most of the lead and copper ores from the same mines, of a very fine-grained texture; and

it is likewise so often equally mixed with the said copper and lead ores, as not to be easily perceived, if one is not previously acquainted with them. It seems, nevertheless, reasonable, that a true mineralist ought rather to suspect the ore called *Braunbleyertz* (Sect. ccxxx.) to be a zink ore, than to suppose this semi-metal to be a product of lead, copper, and iron.

S E C T. CCXXXII.

4. Antimony, *Antimonium*. *Stibium*. This semi-metal is
- a. Of a white colour almost like silver.
 - b. Brittle; and in regard to its texture, it consists of shining planes, of greater length than breadth.
 - c. In the fire it is volatile, and volatilises part of the other metals along with it, except gold and platina. It may, however, in a moderate fire be calcined into a light grey calx, which is pretty refractory in the fire, but melts at last to a glass of a reddish brown colour.
 - d. It dissolves in spirit of sea-salt and aqua regia, but is only corroded by the spirit of nitre into a white calx; it is precipitated out of the aqua regia by water.
 - e. It has an emetic quality when its calx, glass, or metal, is dissolved in an acid, except when in the spirit of nitre, which has not this effect.
 - f. It amalgamates with quicksilver, if the regulus, when fused, is put to it; but the quicksilver ought for this purpose to be covered with warm water; It amalgamates with

with it likewise, if the regulus of antimony be previously melted with an addition of lime.

S E C T. CCXXXIII.

Antimony is found in the earth.

A. Native, *Antimonium nativum*, *five*, *Regulus Antimonii nativus*.

This is of a silver colour, and its texture is composed of pretty large shining planes.

This kind was found in Carls Ort, in the mine of Salberg, about the end of the last century; and specimens thereof have been preserved in collections under the name of an arsenical pyrites, until the mine-master Mr. Von Swab discovered its real nature, in a treatise he communicated to the Royal Academy of Sciences at Stockholm, in the year 1748. Among other remarkable observations in this treatise, it is said, first, That this native antimony easily amalgamated with quicksilver; doubtless, because it was imbedded in a limestone; since, according to Mr. Pott's experiments, an artificial regulus of antimony may, by means of lime, be disposed to an amalgamation: Secondly, That when brought in form of a calx, it shot into crystals during the cooling*.

* Since native antimony, or, as it is commonly called, regulus of antimony, was never before described, the possibility of its existence has been denied; and when this here mentioned was discovered, somebody published some doubts of the truth of the whole affair, upon no better foundation than that the specimens were very small for making experiments, and that it was uncertain if ever mineralised antimony had been found in the mine of Salberg: but those reasons are not sufficient to refute experiments, because men of experience

S E C T. CCXXXIV.

B. Mineralised Antimony, *Antimonium mineralisatum*.

1. With sulphur, *Antimonium sulphure mineralisatum*. *antimonium propriè sic dictum*.

This is commonly of a radiated texture, composed of long wedge-like flakes or plates; it is nearly of a lead colour, and rough to the touch.

a. Of coarse fibres.

b. Of small fibres.

c. Steel-grained, from Saxony and Hungary.

d. Crystallised, from Hungary.

1. Of a prismatical, or of a pointed pyramidal figure, in which last circumstance the points are concentrical.

I have seen a specimen of this, in which the crystals were covered with very minute crystals of quartz, except at the extremities, where there was always a little hole: This specimen was given for a *flos ferri spar*.

are always able to make true experiments on small pieces of native metals, nor is there any necessity that mineralised metals should always be found along with the native ores of the same species; but this really happens with this antimony in the mine of Salberg. We ought to be contented with conclusions drawn from experiments, until the fallaciousness of such experiments is demonstrated: And it were to be wished, that all pretended discoveries were supported by experiments, and an enumeration of the phenomena which happen in them; we should then not contradict things, which perhaps may be true, though, for want of this precaution, they seem scarce credible; as, for instance, the native tin, lead, and iron, the zink spar, and an unknown semi-metal in the mica.

S E C T. CCXXXV.

2. With sulphur and arsenic, *Antimonium auripigmento mineralisatum*. Red antimony ore, *Antimonium solare*.

This is of a red colour, and has the same texture with the preceding, though its fibres are not so coarse.

a. With small fibres.

b. With abrupt broken fibres, from Braunsdorff in Saxony, and from Hungary.

All antimonial ores are somewhat arsenical, but this is more so than the preceding kinds.

S E C T. CCXXXVI.

- C. With sulphurated silver. Plumose silver ore. Sect. clxxiii.
- D. With sulphurated silver, copper and arsenic. Sect. clxxiv.
- E. With sulphurated lead. Sect. cxc.

S E C T. CCXXXVII.

OBSERVATIONS ON ANTIMONY.

By the name of Antimony is commonly understood the crude antimony, (which is compounded of the metallic part and sulphur) as it is melted out of the ore (Sect. ccxxxiv.); and by the name of Regulus, the pure semi-metal; although this last begins now to be better distinguished from the other metals.

The alchemists have very much employed antimony in their experiments; some of them chiefly
on

on account that it is found in the Hungarian gold mines : Yet still we know no more of the constituent parts of this semi-metal than the others, notwithstanding all that has been wrote on the subject. Some say that its earth is not vitrifiable, because it is volatile, which is perfectly contrary to experience : And if volatility is the characteristic of a mercurial earth, the pipe clay from Cologne ought to be of the same nature. Perhaps it is better to say that the calx of antimony is volatile, and is incapable of being reduced into a metallic state with phlogiston alone, but may be melted into glass ; and such is its nature, though we do not know the reason of it.

S E C T. CCXXXVIII.

5. Arsenic, *Arsenicum*. This is
- a. In its metallic form nearly of the same colour as lead, but brittle, and changes sooner its shining colour in the air, first to yellow, and afterwards to black.
 - b. It appears laminated in its fractures, or where broken.
 - c. Is very volatile in the fire, burns with a small flame, and gives a very disagreeable smell, like garlick.
 - d. It is, by reason of its volatility, very difficult to be reduced, unless it is mixed with other metals : However, a regulus may be got from the white arsenic, if it is quickly melted with equal parts of pot-ashes and soap ; but this regulus contains generally some cobalt, most of the white arsenic being produced from the cobalt ores during their calcination. The white arsenic, mixed with a phlogiston, sublimes like-

- likewise into octoëdral crystals of a metallic appearance, whose specific gravity is 8,308.
- e. The calx of arsenic, which always, on account of its volatility, must be got as a sublimation, is white, and easily melts to a glass, whose specific gravity is 5,000. When sulphur is blended in this calx, it becomes of a yellow, orange, or red colour; and according to the degrees of colour is called Orpiment or yellow arsenic, Sandarach, Realgar or red arsenic, and also *Rubinus Arsenici*.
- f. This calx and glass are dissoluble in water; and in all liquids; though not in all with the same facility. In this circumstance arsenic resembles the salts, for which reason it also might be ranked in that class. Sect. cxix.
- g. The regulus of arsenic dissolves in spirit of nitre; but as it is very difficult to have it perfectly free from other metals, it is yet very little examined in various menstrua.
- h. It is poisonous, especially in form of a pure calx or glass: But probably it is less dangerous when mixed with sulphur, since it is proved by experience, that the men at mineral works are not so much affected by the smok of this mixture, as by the smok of lead; and that some certain nations make use of the red arsenic in small doses as a medicine.
- i. It unites with all metals, and is likewise much used by nature itself to dissolve, or, as we term it, to mineralise the metals, to which its volatility, and dissolubility in water, must greatly contribute. It is likewise most generally mixed with sulphur.

k. It absorbs or expels the phlogiston, which has coloured glasses, if mixed with them in the fire.

S E C T. CCXXXIX.

Arsenic is found,

1. Native, *Arsenicum nativum*; called *Scherbencobolt* and *Fliegenstein* by the Germans.

It is of a lead colour when fresh broken, and may be cut with a knife, like black lead, but soon blackens in the air. It burns with a small flame, and goes off in smoak.

A. Solid and testaceous, *Arsenicum nativum particulis impalpabilibus testaceum*. *Scherbencobolt*.

This is found in the mines of Saxony, the Hartz, and Hungary.

B. Scaly, *Particulis micaceis*, from Winorn at Kongberg in Norway.

C. Friable and porous, *Friabile et porosum*. *Fliegenstein*.

1. With shining fissures, *Fissuris nitentibus*, from Annaberg in Saxony.

This is by some called *Spigel Cobolt*, (*Minera cobalti specularis*) according to their notions of the affinity of these metals to one another. However, there always remains after the volatilisation of the Scherbencobolt, some calx, either of cobalt or bismuth, and some silver, though in too small a quantity to deserve any notice.

S E C T. CCXL.

2. In form of a calx, *Arsenicum calciforme*.

A. Pure, or free from heterogeneous substances, *Calx arsenici nativa pura*.

1. Loose

1. Loose or powdry. This sort is found at Giesshubel in Saxony, but is collected in a much purer state on the sides of the rock in some mines.
2. Indurated or hardened. This is found in form of white semi-transparent crystals, in small cavities within the Scherbencobolt, at Andreasberg in the Hartz, and in Saxony, but is very scarce.

S E C T. CCXLI.

B. Mixed with sulphur, *Calx arsenici sulphure mixta.*

1. Hardened.

- a. Yellow. Orpiment, *Auripigmentum*, from Hungary.
- b. Red. Native Realgar or Sandarach, from Hungary, Andreasberg in the Hartz, Saxony, and Rotendal in Elfdalen in Sweden*.

S E C T. CCXLII.

- C. Mixed with the calx of tin, in the tin-grains. Sect. clxxxii.
- D. With sulphur and silver, in the Rothguldén, or red silver ore. Sect. clxxx.
- E. With calx of lead, in the lead-spar. Sect. clxxxvi.
- F. With calx of cobalt, in the efflorescence of cobalt. Sect. ccxlviii.

* The orpiment may perhaps be found naturally in loose staly powder, as it is sometimes met with in the shops; However, I have only seen the hardened sort in collections.

S E C T. CCXLIII.

3. Mineralised arsenic, *Arsenicum mineralisatum*.
 A. With sulphur and iron, *Arsenicum ferro sulphurato mineralisatum*. Arsenical pyrites or marcasite*.

This alone produces red arsenic, when calcined, and is found in great quantities in the mines of Lofas in the province of Dalarna: It is of a deeper colour than the following.

- B. With iron only, *Arsenicum metalliforme ferro mixtum*. *Misspickel*. This differs with regard to its particles, being
1. Steel-grained;
 2. Coarse-grained, from Westersilfverberget;
 3. Crystallised.
 - a. In an octoëdral figure. This is the most common kind.
 - b. Prismatical, from the mines of Salberg, Westersilfverberget, and Hellefors in Westmanland, and in many places of foreign countries †.

S E C T. CCXLIV.

- C. With cobalt, almost in all cobalt ores. Sect. ccxlviii.
 D. With silver. Sect. clxxi. clxxii.
 E. With copper. Sect. cxcix.
 F. With antimony. Sect. ccxxxv.

* These kinds in Cornwall are called Silvery or White Mundics, and Plate Mundics. D. C.

† The sulphureous marcasite is added to this kind, when red arsenic is to be made; but in Sweden it is scarcer than the sulphureous arsenical pyrites.

SECT. CCXLV.

OBSERVATIONS ON ARSENIC.

Such ores as consist of arsenic united solely with iron, or with iron and sulphur, cannot be employed to any other use than to the preparation of arsenical products; for which reason they ought to be ranged among the arsenic ores. Some have indeed denied this difference between the arsenical pyritæ; but it is however necessary to make some difference, with respect to the presence or absence of sulphur, although the greatest quantity of arsenic is got from the calcination of the cobalt ores, and that the true arsenical pyritæ do not deserve to be separately employed.

Although it is difficult to reduce the arsenic by way of precipitation, one cannot for that reason deny it to be of a metallic nature; for the same way of reasoning might have been used against the zink in the calamine, before the method to extract that semi-metal in its metallic state, now known, was discovered: But those who know that metals only can be mixed with metals, so as to preserve the solidity and some ductility in the compound, and who at the same time are ignorant of any metallic earth, which cannot be reduced to its metallic state again, could never entertain such notions.

It is indeed true, that sulphur, in regard to the brittleness which it produces in metals, is of no worse effect than arsenic; but this last may by itself, and mixed only with a pure phlogiston, be sublimed into a metallic form, which is more plainly seen in the Scherbencobolt (Sect. ccxxxix.). I easily perceive that it may be objected by those,

who deny arsenic to be a semi-metal, that it may as well be a salt of a peculiar nature; as, for instance, the vitriolic acid; and that it may, like sulphur, dissolve the metals in form of a kind of regulus; and farther, that its assuming a metallic appearance, when it is united with an inflammable substance, is of no consequence, since there are fish and insects who have a shining metallic colour: But all this does not deserve an answer, since it has been already agreed, that systems must not be too severely criticised.

S E C T. CCXLVI.

6. Cobalt, *Cobaltum*.

This semi-metal is,

- a. Of a whitish grey colour, nearly as fine tempered steel.
- b. Is hard and brittle, and of a fine grained texture; hence it is of a dusky, or not shining appearance.
- c. Its specific gravity to water is 6000 :: 1000,
- d. It is fixt in the fire, and becomes black by calcination; it then gives to glasses a blue colour, inclining a little to violet, which colour, of all others, is the most fixed in fire.
- e. The concentrated oil of vitriol, aqua fortis, and aqua regia, dissolve it; and the solutions become red. The cobalt calx is likewise dissolved by the same menstrua, and also by the volatile alcali, and the spirit of sea-salt.
- f. When united with the calx of arsenic in a slow (not a brisk) calcining heat, it assumes a red colour: The same colour is naturally produced by way of efflorescence, and is then

then called the *bloom* or *flowers of cobalt*. When cobalt and arsenic are melted together in an open fire, they produce a blue flame.

- g. It does not amalgamate with quicksilver by any means hitherto known.
- b. Nor does it mix with bismuth, when melted with it, without addition of some medium to promote their union.

S E C T. CCXLVII.

The cobalt is most commonly found in the earth mixed with iron.

A. In form of a calx, *Cobaltum calciforme*.

1. With iron without arsenic, *Martiale absque arsenico*.

a. Loose or friable, *Minera cobalti calciformis pulverulenta*. Cobalt ochre, *Ochra cobalti nigra*. It is black, and like the artificial zaffre.

b. Indurated, *Minera cobalti calciformis indurata*. *Minera cobalti vitrea*, the *schlacken* or slag cobalt.

This is likewise of a black colour, but of a glassy texture, and seems to have lost that substance which mineralised it, by being decayed or weathered. It is often confounded with the Scherbencobolt, for it is seldom quite free from arsenic; and there may perhaps exist a progressive series from the Schlacken kind to the Scherbencobolt kind.

S E C T. CCXLVIII.

2. With the calx of arsenic, *Minera cobalti calciformis calce arsenici mixta*. Cobalt-blut. *Ochra cobalti rubra*, Bloom, Flowers, or Efflorescence of cobalt.

a. Loose or friable, *Ochra cobalti pulverulenta*. This is often found of a red colour like other earths, spread very thin on the cobalt ores, and is, when of a pale colour, erroneously called Flowers of Bismuth.

b. Indurated, *Ochra cobalti rubra indurata*. Hardened Flowers of Cobalt.

This is commonly cristallised in form of deep red semi-transparent rays or radiations: It is found at Schneeberg in Saxony*.

S E C T. CCXLIX.

B. Mineralised, *Cobaltum mineralisatum*.

1. With arsenic and iron in a metallic form, *Cobaltum ferro & arsenico metalliformis mineralisatum*; vulgò *Cobaltum dictum*.

This is of a dim colour when broken, and not unlike steel. It is found

a. Steel-grained, from Loos in the parish of Farila, in the province of Helsingeland, and at Schneeberg in Saxony.

b. Fine-grained, from Loos.

* A white cobalt-earth, or ochre, is said to have been found. It has been seen and examined by a celebrated mineralist, who has found it in every respect, except the colour, to resemble the cobalt flowers; and it is very possible, that those cobalt flowers might in length of time have lost their red colour, and become white.

c. Coarse-grained.

d. Crystallised.

1. In a dendritical or arborescent form, from Schneeberg.
2. Polyëdral, with shining surfaces; the *Glanz kobolt* of the Germans, from Schneeberg.
3. In radiated nodules, from Kongberg in Norway.

S E C T. CCL.

2. With sulphurated iron, *Cobaltum ferro sulphurato mineralisatum*.

This is of a lighter colour than the preceding, nearly like to tin or silver. It is found

a. Crystallised.

1. In a polygonal form.

a. Of a slaggy texture.

b. Coarse-grained.

This kind is found in Bastnasgrufva at Riddarshyttan in Westmanland, and discovers not the least mark of arsenic. The coarse-grained becomes slimy in the fire, and sticks to the stirring hook during the calcination, in the same manner as many regulæ do; and is a kind of regulæ prepared by nature.

That sort of a slaggy texture is very martial, and is described by the mine-master Mr. Brandt, in the Acts of the Swedish Academy of Sciences for the year 1746. Both these give a beautiful colour.

S E C T. CCLI.

3. With sulphur, arsenic, and iron, *Cobaltum cum ferro sulphurato et arsenicato mineralisatum.*

This resembles the arsenicated cobalt ore, being only rather of a whiter or lighter colour. It is found

- a. Coarse-grained.
- b. Crystallised.

1. In a polygonal figure, with shining surfaces, or *Glanzkobolt.*

It occurs at Tunaberg in the province of Sodermanland, partly of a white or light colour, and partly of a somewhat reddish yellow.

S E C T. CCLII.

4. With sulphurated and arsenicated nickel and iron; see *Kupfernickel*, Sect. cclvi.

S E C T. CCLIII.

OBSERVATIONS ON COBALT.

Since the glass of cobalt, which has been entirely freed from all arsenic in the calcination, and from the iron and the other metals by scorification, as when it is prepared from crystallised cobalt flowers, may by addition of phlogiston be melted to a true cobalt regulus, which differs in its qualities from all other metals; there can be no reason for denying the cobalt a place among the semi-metals, as many authors even at this time do, notwithstanding

withstanding the several reasons given, which might induce them to examine nearer into the subject.

It was the mine-master Mr. Brandt who first discovered this semi-metal, and described it in the abovementioned History of Semi-metals, in the *Acta Upsaliensia* for the year 1735.

The brittleness of the cobalt regulus is no proof against its being a semi-metal, that property being the basis on which the distinction between the semi-metals and metals is founded. The earth of cobalt is fixed and vitrifiable in the fire, as well as that of copper and iron; and the colour of its glass being so immutable in the fire, proves it to be a particular substance, distinct from other earths and metallic calces. The experiment of making a cobalt glass from iron or steel and arsenic, will certainly never succeed, unless the arsenic, employed for that purpose, has been made from a cobalt ore; but if the origin of the colour should be ascribed to an irreducible metallic earth, there is no occasion for this experiment, because a cobalt regulus may be prepared so as to be free both from arsenic and iron, the presence of this last metal being easily discovered by the loadstone. It is therefore now unnecessary and ridiculous to continue the old definitions of the cobalt, in which the Speise, which partly is a cobalt regulus, and partly a compound, consisting of nickel, cobalt, and bismuth, united with sulphur and arsenic, is either confounded with the semi-metal itself, or quoted as a proof, that a cobalt regulus cannot exist in any other manner than as a dead earth involved in heterogeneous substances; which is the same as to conclude, that no pure copper can be produced from the copper regulus or fusions, called *Trotten* or *Spursten*.

These

These false notions have, however, induced a new author to describe the cobalt as a mixture of iron, copper, lead, bismuth, and arsenic; but he has not at the same time published any experiments which might serve to confirm his opinion; amongst which, with great reason, such experiments are expected as imitate nature in this composition, which is pretended to consist of so many different things. It might then have been calculated, if it would be profitable to establish manufactures for making cobalt-glass, or zaffre, in any part of the world, where the above-mentioned ingredients can be had.

The word Cobalt in Germany, and especially at the mineral works in Saxony, is applied to the damps, the arsenic, its vapours, and their effects on man; which has induced the vulgar also to apply it to some pretended evil spirit, which is said to dwell in the mines: But time will abolish these superstitions, which have their origin from ignorance.

SECT. CCLIV.

7. Nickel, *Niccolum*.

This is the latest discovered semi-metal. It was first described by its discoverer Mr. Cronstedt in the Acts of the Royal Academy of Sciences at Stockholm, for the years 1751 and 1754, where it is said to have the following qualities: That

1. It is of a white colour, which however inclines somewhat to red.
2. Of a solid texture, and shining in its fractures.
3. Its specific gravity to water is as 8,500
:: 1000.

4. It

4. It is pretty fixt in the fire; but together with the sulphur and arsenic, with which its ore abounds, it is so far volatile, as to rise in form of hairs and branches, if in the calcination it is left without being stirred.
5. It calcines to a green calx:
6. This calx is not very fusible, but however tinges glass of a transparent reddish brown, or jacinth colour.
7. It dissolves in aqua fortis, aqua regia, and the spirit of sea-salt, but more difficultly in the vitriolic acid, tinging all these solutions of a deep green colour. Its vitriol is of the same colour; but the colcothar of this vitriol, as well as the precipitates from the solutions, become by calcination of a light green colour.
8. These precipitates are dissolved by the spirit of sal ammoniac, and the solution has a blue colour; but being evaporated, and the sediment reduced, there is no copper, but a nickel regulus is produced.
9. It has a strong attraction to sulphur; so that when its calx is mixed with it, and puts on a scorifying test under the muffle, it forms with the sulphur a regule: This regule resembles the yellow steel-grained copper-ores, and is hard and shining on its convex surface.
10. It unites with all the metals, except quicksilver and silver. When the nickel regulus is melted with the latter, it only adheres close to it, both the metals lying near one another on the same plane; but they are easily separated with a hammer. Cobalt has the strongest attraction to nickel,
after

after that to iron, and then to arsenic. The two former cannot be separated from one another but by their scorification, which is easily done, since

- II. This semi-metal retains its phlogiston a long time in the fire, and its calx is reduced by the help of a very small portion of inflammable matter: It requires, however, a red heat before it can be brought into fusion, and melts a little sooner, or almost as soon as copper or gold, consequently sooner than iron.

S E C T. CCLV.

The nickel is found.

A. In form of a calx, *Niccolum calciforme*. Nickel ochre, *Oebra niccoli*.

- I. Mixed with the calx of iron, *Oebra niccoli martialis*.

This is green, and is found in form of flowers on Kupfernichel. In Normarken in the province of Wermeland, this ochre was found without any visible nickel mixed in the clay, which contained a great quantity of native silver. Sect. clxviii.

S E C T. CCLVI.

B. Mineralised nickel, *Niccolum mineralisatum*.

- I. With sulphurated and arsenicated iron and cobalt, *Niccolum ferro & cobalto arsenicatis et sulphuratis mineralisatum*. *Cuprum nicolai seu niccoli*. Kupfernichel.

This is of a reddish yellow colour, and is found

a. Of a slaggy texture, in Saxony.

b. Fine-

- b. Fine-grained, and
 c. Scaly, in Loos cobalt mines in the province of Helsingeland; at which place it is of a lighter colour than the foreign ones. These two are often from their colour confounded with the liver-coloured marcasite. Sect. cliii.

S E C T. CCLVII.

2. With the acid of vitriol, *Niccolum acido vitrioli mineralisatum.*

This is of a beautiful green colour, and may be extracted out of the nickel ochre, (Sect. cclv.) or efflorescence of the Kupfernickel.

S E C T. CCLVIII.

O B S E R V A T I O N S O N N I C K E L.

The cobalt, bismuth, and nickel, are commonly found together in the same mines, by which it happens, that, when the first, as the most useful of them all, is to be made into glass, the adherent nickel, according to its nature, unites with the sulphur and arsenic, of which some portion remains after the calcination, and makes with them a regule. When these minerals (the sulphur and arsenic) are in greater quantity than is wanted for the nickel, they likewise reduce some part of the calces of the cobalt and bismuth; and in this case the nickel, as a medium, uniting the other two, otherwise not miscible semi-metals, incorporates them into the same regule. From hence arises a difference in the contents of different regules; and from this difference people, who
 have

have not sufficient experience, form to themselves false notions of the whole compound, and of each part contained in it: For which reason they chuse rather to retain that definition of the Kupfernickel which has received its sanction from the earliest authors, than to admit the conclusion to which Mr Cronstedt's experiments seem to lead.

For my own part, I have found myself obliged to follow the opinion of the latter, partly because I am tired with those common epithets given to unknown bodies; such as, *wild, refractory, rapacious, arsenical, irreducible, metallic earth, &c. &c.* which regard the effect alone and not its cause; and partly because I have not, besides the nickel, found any metal or metallic composition, which

1. Becomes green when calcined.
2. Yields a vitriol, whose colcothar also becomes green in the fire.
3. So easily unites with sulphur, and forms with it a regule of such a peculiar nature, as the nickel does in this circumstance; and that
4. Does not unite with silver, but only adheres or sticks close to it, when they have been melted together.

The nickel not having yet been found free from cobalt and iron, is the reason why it was not discovered. This was the case also with the cobalt. Platina del pinto perhaps, in the same manner, might for a long time have been mixed in the gold, at certain places, where it is said to be naturally paler than any where else in the world. But the existence of such things cannot any longer be denied, since the method is discovered to get them separate, and free from heterogeneous substances. It indeed would be the same thing, as if in a country where silver is never found but in the potter's lead ore, any person should deny the existence of either of these

these metals, or insist upon it, that one is produced from the other.

It is remarkable, that the precipitates of nickel give a blue colour to the spirit of sal ammoniac, when they are dissolved in it; without shewing besides any marks of copper, which, however, could not be concealed if there were any; for if a small quantity of copper is melted with the nickel, and kept in a strong fire with it, the copper soon separates, and scorifies, tinging the glass first of a reddish brown opaque colour, and, the fire being further forced, it then makes it transparent and green, as usual.

There is no danger attending the encreasing the number of the metals. Astrological influences are now in no repute among the learned, and we have already more metals than planets within our solar system. It would perhaps be more useful to discover more of these metals, than idly to lose our time in repeating the numberless experiments which have been made, in order to discover the constituent parts of the metals already known. In this persuasion, I have avoided to mention any hypotheses about the principles of the metals, the processes of mercurification, and other things of the like nature, with which, to tell the truth, I have never troubled myself.

A P P E N D I X.

S E C T. CCLIX.

I Have already in the Preface mentioned the reasons why the Saxa and Fossils commonly called Petrefactions, cannot be ranked in a mineral system: And I am almost persuaded, that the same reason which has prevailed on me, will likewise after mature consideration be approved by others. Mean while, since these bodies, especially the latter, occupy so considerable a place in most mineral collections, and the former must necessarily be taken notice of by the miners in the observations they make in the subterranean geography, I would not entirely omit them here, but have tried to put them in such an order as may answer that purpose, for which miners and mineralists pay any regard to them.

S E C T. CCLX.

The F I R S T O R D E R.

S A X A. P E T R Æ.

I divide these into two kinds.

I. Compound Saxa, *Saxa composita*,

Are such stones whose particles, consisting of different substances, are so exactly fitted and joined together, that no empty space, or even cement, can be perceived between them; which seems to indicate, that some, if not all, of

of these substances have been soft at the instant of their union.

2. Conglutinated stones, *Saxa conglutinata*,

Are such stones whose particles have been united by some cementitious substance, which, however, is seldom perceivable, and which often has not been sufficient to fill every space between the particles: In this case the particles seem to have been hard, worn off, and in loose, single, unfigured pieces, before they were united.

S E C T. ' CCLXI.

1. Compound Saxa, *Saxa composita*.

A. Opbites. Scaly limestone with kernels or bits of serpentine stone in it, *Saxum compositum particulis calcareis et argillaceis*.

1. *Kolnord's marble.* It is white and green.

2. *Serpentino antico*, is white, with round pieces of black steatites in it. This must not be confounded with the *Serpentino verde antico*. Sect. cclxvi.

3. The *Haraldsio marble*. White, with quadrangular pieces of a black steatites.

4. The *Marmor Pozzevera di Genova*. Dark green marble, with white veins.

This kind receives its fine polish and appearance from the serpentine stone.

S E C T. CCLXII.

B. Stelsten or *Gestelstein*, *Saxum compositum particulis quartzosis & micaceis*.

1. Of distinct particles, *Particulis distinctis*.

This is found at Garpenberg in the province of Dalarne. It is likewise met

with in the other mineral mountains of Sweden. In some of these the quartzose particles predominate, and in others, the micaceous: In the last case it is commonly flaty, and easy to split.

2. Of particles which are wrapt up in one another, *Particulis quartzosis micâ convolutis.*
 - a. Whitish grey, from Morthernberget in Norberke in Dalarne.
 - b. Greenish, at Salberg in Westmanland.
 - c. Reddish, from the parish of Malung in Dalarne.

Both these kinds of *Stellsten* are for their resistance to the fire employed in building furnaces; but the latter is the best, because it seems at the same time to contain a little of a refractory clayish substance: It however cracks very soon, if the flat side of the stratum, instead of the extremity, is turned towards the fire. It is also of great use in mills, if the other or fellow-stone is made of the mill-stone from Arfunde, which is a *Saxum* of the conglutinated kind, or a coarse sand-stone. It is lucky for œconomical purposes, that the plates of these stones are so thick, although thereby they are not so easily split.

S E C T. CCLXIII.

C. *Norrka.* *Murksten* of the Swedes. *Saxum compositum micâ, quartzo et granato.*

1. With distinct garnets or shirl, *Granatis distinctis crystallisatis.*
 - a. Light

- a. Light grey, from Selbo in Norway.
 - b. Dark grey, with very small garnets, from Quarnberget in the parish of Soderli in the province of Jemteland.
 - c. Dark grey, with prismatical, radiated, or fibrous cockle or whirl, from the village of Handol, in the parish of Are in Jemteland.
2. With kernels of garnet stone, *Particulis granatinis indeterminatis*.
- a. Of pale red garnet stone, from Stollberget in Norberke in Dalarne.

The first of this kind, whose slaty strata makes it commonly easy to be split, is employed for mill-stones, which without difficulty distinguish themselves for that purpose, if sand is first ground with them, because the sand wears away the micaceous particles on the surfaces, and leaves the garnets prominent, which renders the stone fitter for grinding the corn.

S E C T. CCLXIV.

D. The Whetstone, *Cos. Saxam compositum micâ, quartzo, et forsan argillâ martiali in nonnullis speciebus.*

- 1. Of coarse particles, *Particulis distinctis*.
 - a. White, from Wanga in the province of Skone.
 - b. Light grey, from Tellemarken in Norway.
- 2. Of fine particles, *Particulis minoribus*.
 - a. Liver brown colour, from Selbo in Norway.

- b. Blackish grey, from Lerwik at Hellefors in Westmanland, and from Cologne in Germany.
- c. Light grey, from Hellefors in Westmanland.
- d. Black. The table slate, or that kind used for large tables and for school-slates.

The naked eye, and the magnifying glass much better, discovers the micaceous particles in this kind to be as it were twisted in one another; some clay seems likewise to enter into the composition: However, it cannot yet be certainly asserted that it is real mica which has that appearance in this kind.

- 3. Of very minute and closely combined particles, *Cos particulis constans impalpabilibus durus.* The Turkey stone.

This is of an olive colour, and seems to be the finest mixture of the first species of this genus. It is found in loose stones at Biorkskoginas in the parish of Hellefors in Westmanland, though not perfectly free from cross veins of quartz, which always are in the surface of the rock, and spoil the whetstones. It is also said to be found in Tellemarken in Norway. The best of this sort come from the Levant, and are pretty dear. The whetstone kinds, when they split easily, and in thin plates, are very fit to cover houses with, though most of them are not used for that purpose.

S E C T. CCLXV.

E. The *Telgsten* of the Swedes. *Lapis ollaris. Saxum compositum steatite et micâ.*

a. Light grey, from Fahlun, and also Byxberget at Norberke.

b. Whitish yellow, from Sikfioberget in Norberke.

c. Dark grey, from Riddarshyttan.

d. Dark green, from Salvisto in the parish of Tamela in Finland.

This is employed with great advantage to build fire-places and furnaces, &c. and when it is slaty, the extremities of the strata must be turned towards the fire.

S E C T. CCLXVI.

F. Porphyry, *Porphyrites. Italorum Porfido. Saxum compositum jaspide et felspat, interdum micâ et basalte.*

a. Its colour is green, with light green felspat, *Serpentino verde antico.* It is said to have been brought from Egypt to Rome, from which latter place the specimens of it now come.

b. Deep red, with white felspat, from Italy, and Egern in Norway.

c. Black, with white and red felspat, from Klitten, in the parish of Elfdalen in Dalarna.

d. Reddish brown, with light-red and white felspat, from Hykieberget in Elfdalen, and Gustavstrom, in the parish of Gofborn in the province of Wermeland.

- e. Dark grey, with white grains of felspat also, from Gustavsstrom.

Many varieties of this kind, in regard to colour, are found in form of nodules or loose stones in Sweden; but I have only mentioned the hardest and finest of those which are found in the rocks; because, besides these, there are coarse porphyries found, which scarce admit of any polish. The dark red porphyry has been most employed for ornaments in building: yet it is not the only one known by the name of *Porfido*, the Italians applying the same name also to the black kind,

S E C T. CCLXVII.

- G. The *Trapp* of the Swedes. *Saxum compositum jaspide martiali molli, seu argillâ martiali induratâ, et - - -*

This kind of stone sometimes constitutes or forms whole mountains; as, for example, the mountain called Hunneberg, in the province of Westergottland, and at Drammen in Norway; but it is oftener found in form of veins in mountains of another kind, running commonly in a serpentine manner, contrary or across to the direction of the rock itself. It is not homogeneous, as may be plainly seen at those places where it is not pressed close together; but where it is pressed close, it seems to be perfectly free from heterogeneous substances. When this kind is very coarse, it is interspersed with felspat; but it is not known if the finer sorts likewise contain
any

any of it. Besides this, there are also some fibrous particles in it, and something that resembles a calcareous spar: This however does not ferment with acids, but melts as easy as the stone itself, which becomes a black solid glass in the fire. By calcination it becomes red, and yields in assays 12 or more per cent. of iron. No other sort of ore is to be found in it, unless now and then somewhat merely superficial lies in its fissures; for this stone is commonly, even to a great depth in the rock, cracked in acute angles, or in form of large rhomboidal dice. It is employed at the glass-houses, and added to the composition of which bottles are made. By the Germans it is called *Schwach* or *Schwartzstein*; at the Swedish glass-works, *Trappskiol*, *Tegelskiol*, or *Swartskiol*; and at Jarlsberg in Norway, *Blabest*. In the air it decays a little, leaving a powder of a brown colour; it cracks commonly in the fire, and becomes reddish brown if made red hot. It is found

1. Of coarse chaffy particles, *Particulis majoribus acerosis*.
 - a. Dark grey, from the top of Kinnekulle in the province of Westergottland.
 - b. Black, from Stallberget at Ostersilfverberget in the province of Dalarna.
2. Coarse-grained, *Particulis majoribus granulatis*.
 - a. Dark grey, from the uppermost stratum at Hunneberg in Westergottland.
 - b. Reddish, from Bragnas in Norway.
 - c. Deep brown, from Gello in Norway.

3. Of fine imperceptible particles, *Particulis impalpabilibus*.
- a. Black. The Touchstone, *Lapis Lydius*, from Salberg mine, Hellefors, Westerfilfverberget, and Norberg in Westmanland, and Osterfilfverberget in Dalarne, &c.
 - b. Blueish, from Osterfilfverberget.
 - c. Grey, from Dalwik in the parish of Sorberke in Dalarne.
 - d. Reddish, from Dalstugun in the parish of Rettwik in Dalarne *.

S E C T. CCLXVIII.

H. *Amygdaloides. Saxum basi jaspideâ martiali, cum fragmentis spati calcarei et serpentini, figurâ ellipticâ †.*

It is a martial jasper, in which elliptical kernels of calcareous spar and serpentine-stone are included.

- a. Red, with kernels of white limestone, and of a green steatites, from Gello and Gullo in Norway, and the Hartz in Germany.

This is of a particular appearance, and when calcined is attracted by the loadstone; it decays pretty much in the air, and has some affinity with the Trapp, (Sect. cclxvii.) and also with the Porphyry (Sect. cclxvi.). There are some-

* The black variety (3. a.) is sometimes found so compact and hard, as to take a polish like the black agat; it melts, however, in the fire to a black glass, and is, when calcined, attracted by the loadstone. Such a kind is found in the parish of Arla in the province of Sodermanland.

† The Carpelithi or Fruit-stone rocks of the Germans D. C. times

times found pieces of native copper in this stone at Gullo.

S E C T. CCLXIX.

I. The *Gronsten* of the Swedes. *Saxum compositum micâ et hornblende.* Sect. lxxxviii.

Its basis is hornblende, interspersed with mica. It is of a dark green colour, and is dug in several places in Smoland, where it is employed in the iron furnaces as a flux to the bog ore (Sect. ccii.). It is also found in other places, as at Rettwik in Dalarne, and in the neighbourhood of some of the iron mines.

S E C T. CCLXX.

K. The *Granites.* *Saxum compositum felspatomica et quartzo, quibus accidentaliter interdum hornblende, steatites, granatus et basaltites immixti sunt.*

Its principal constituent parts are felspat, or rhombic quartz, mica, and quartz: It is found

1. Loose or friable, *Particulis constans parum coherentibus.*

This is used at the brass works to cast the brass in, and comes from France.

2. Hard and compact, *Granites durus.*

a. Red.

1. Fine-grained, from Swappawari at Tornea in Lapland

2. Coarse-grained, from Bispbergs Klack, in the province of Dalarne.

b. Grey, with many and various colours, found on the coast round Stockholm and Norland. The

The Granites are seldom slaty or laminated, when their texture is close, and the harder particles, as the felspat or rhombic quartz, the quartz, and the shirl, predominate in it. They admit of a good polish, for which reason the Egyptians in former times, and the Italians now, work them into large pieces of ornamental architecture, for which purpose they are extremely fit, as they do not decay in the air.

S E C T. CCLXXI.

2. Conglutinated Saxa, *Saxa conglutinata*.

A. Of larger or broken pieces of stones of the same kinds conglutinated together, *Saxum conglutinatum fragmentis lapidum. Breccia.*

1. Of limestone cemented by lime, *Saxum constans fragmentis lapidis calcarei, calce conglutinatis.*

a. The calcareous Breccia, *Breccia calcarea*: The *Marmi Brecciati* of the Italians.

When these kinds have fine colours, they are polished and employed for ornaments in architecture, and other œconomical uses; they come from Italy.

b. The *Lumachella* of the Italians, or shell marbles. These are a compound of shells and corals, which are petrified or changed into lime, and conglutinated with a calcareous substance. When they have many colours, they are called

led Marbles, and employed for the same purposes as the preceding; likewise from Italy, from Bergen in Norway, and Offerdal in the province of Jemteland. In the island of Gottland there is found of this kind of one colour only, which on that account is not called Marble, or used as such. At Balsberget, in the province of Skone, is found a white and yellow shell limestone, of weak colours.

S E C T. CCLXXII.

2. Of kernels of jasper cemented by a jaspry substance, *Saxum fragmentis jaspidis materiâ jaspideâ conglutinatum*. *Breccia Jaspidea*. *Diaspro brecciato* of the Italians.

Of this kind specimens from Italy are seen in collections. A coarse Jasper Breccia is said to be found not far from Frejus in Provence in France.

S E C T. CCLXXIII.

3. Of siliceous pebbles, cemented by a jaspry substance, or something like it, *Saxum silicibus amorphis materiâ jaspideâ conglutinatis*. The plum-pudding stone of the English. *Breccia Silicea*.

Its basis, which at the same time is the cement, is yellow, wherein are contained single flinty or agaty pebbles, of a grey colour or variegated. This is of a very elegant appearance when cut and polished; it is found in England.

S E C T. CCLXXIV.

4. Of quartzose kernels combined with an unknown cement, *Saxum fragmentis quartzosis conglutinatis*. *Breccia quartzosa*. Found in the provinces of Jemteland and Smoland.

S E C T. CCLXXV.

5. Of kernels of several different kinds of stones, *Saxum fragmentis variorum saxorum conglutinatis*. *Breccia saxosa*.

a. Of kernels of porphyry, cemented by a porphyry or coarse jaspry substance, *Breccia porphyrea*, from Serna Fiell, and Hykieberget in the province of Dalarne.

b. Of kernels of several taxa, *Saxum fragmentis variorum saxorum compositorum conglutinatis*. *Breccia indeterminata*.

Is found in loose stones in Dalarne, and are originally broken from the Fiell tracts in Serna, which consist of nothing else but conglutinated stones.

c. Of conglutinated kernels of sandstone, *Saxum fragmentis constans saxorum conglutinatorum*. *Breccia arenacea*.

This kind consists of sandstone (Sect. cclxxvi.) kernels, which have been combined a second time together. This is also found in loose stones in Dalarne, and are perhaps originally broken

broken from the above-mentioned Fiell in Serna*.

S E C T. CCLXXVI.

B. Conglutinated stones of granules or sands of different kinds, *Saxum conglutinatum granulis seu arenâ variorum lapidum.* Sandstone, *Lapis arenaceus.*

In this division are reckoned those which consist of such minute particles, that all of them cannot easily be discovered by the naked eye. The greatest part, however, consist of quartz and mica, which substances are the most fit to be granulated, without being brought to a powder.

I think I have reason to consider this kind in regard to the substance which has served as a cement to combine them, although it is not always perfectly discernible.

1. Cemented by clay, *Lapis arenaceus glutine argillaceo.*

* The above mentioned Breccia of themselves must demand the distinctions here made between them, but which perhaps may seem to be carried too far, since their particles are so big and plain, as to be easily known from one another. These stones are a proof both of the subversions which the mountains in many centuries have undergone, and of some hidden means which Nature makes use of in thus cementing different kinds of stones together. Any certain bigness for the kernels or lumps in such compounds, before they deserve the name of Breccia, cannot be determined, because that depends on a comparison, which every one is at liberty to imagine. At one place in the mountain called Hykieberget, the kernels of porphyry have a diameter of six feet, while in other places they are not bigger than walnuts. At Massewala the kernels have a progressive size down to that of a fine sandstone. Most of this kind of stone is fit for ornaments, though the workmanship is very difficult and costly.

a. With

- a.* With an apyrus or refractory clay, *Argillâ porcellaneâ*.

It is found under the stratum of coal in the coal-mine at Boferup in Skone; is of a loose texture, but hardens, and is very refractory in the fire.

- b.* With common clay, *Argillâ communi*, from Burfwick in the island of Gottland.

2. With lime, *Lapis arenaceus glutine calcareo*; resembles mortar made with coarse sand.

- a.* Consisting of transparent and greenish grains of quartz and white limestone; from the island Ifo, near Beckaskog in Skone.

- b.* Of no visible particles, from France and Livonia. This is of a loose texture, and hardens in the air.

3. With an unknown cement, *Lapis arenaceus glutine incognito, forsan argillaceo*.

- a.* Loose, from Helsingberg in Skone.

- b.* Harder, from Roslagen, Orsa, and Kinnekulle.

- c.* Compact, from Gesle in the province of Gestrikeland, and the lake Malaren.

- d.* Very hard, from Serna Fiell or Fells in Dalarne; it is also found in great abundance in loose stones at Gustavsstrom, and at Siliamfors in the parish of Mora in Dalarne.

4. Cemented by the rust or ochre of iron, *Lapis arenaceus ochrâ martis conglutinatus*. Is found in form of loose stones at several places, and ought perhaps to be reckoned

among

among the *Mineræ Arenaceæ* or Sand-Ores; (Sect. cclxxvii.) at least when the martial ochre makes any considerable portion of the whole*.

S E C T. CCLXXVII.

C. Stones and ores cemented together, *Saxum fragmentis constans lapidum et minerarum conglutinatis. Mineræ Arenaceæ.*

1. Of larger fragments, *Fragmentis lapidum et minerarum majoribus.*

a. Mountain green, or *Viride Montanum Cupri*, and pebbles cemented together, from Siberia.

* Sandstones are of great use in œconomy, as materials for buildings which resist fire, air, and water, are made of them. Some of them are soft while in the quarry, but harden in the open air. The loose sandstones are the most useful; but the solid and hard ones, such as *c.* and *d.* crack in the fire, and take a polish when used as grindstones. However, though the Burfwik's stone, (*i. b.*) is pretty loose in its texture, it is nevertheless unfit for buildings which are exposed to fire or open air, because it breaks to pieces and melts in the fire, and in the air it attracts the moisture, decays in length of time, and cracks in the cold, which proceeds from the included kernels of clay expanding themselves when they grow wet; the sandstones ought therefore to be very nicely examined before they are employed to the usual purposes.

There are many quarries of sandstones in Sweden, but no enquiry has yet been made if any of them, and which, can be employed in the larger works, instead of the English, and in the smaller manufactories instead of the Bohemian sandstones. Such enquiries are of greater consequence, in proportion as those manufactures encrease wherein they are wanted. It must be remarked, that the working-masons or stone-cutters ought to wear a piece of frieze or baize before their mouth and nose, in order to preserve themselves from a premature death, which now-a-days unhappily is the case with them in the parish of Orsa in Dalarnæ, and in other places; but limestone is not found to have this bad effect.

A SYSTEM OF

- b. Potters lead ore, with limestone, slate-kernels and shells, from Gragrufvan at Boda in Rettwik, and in Dalarne.
- c. Yellow or marcasitical copper ore, with small pebbles.

S E C T. CCLXXVIII.

- 2. Of smaller pieces, *Granulis lapidum et minerarum*.
 - a. Potters lead ore with a quartzose sand, from Eiffelsfeldt near Cologn in Germany.
 - b. Mountain green with sand, from Siberia.
 - c. Cobalt ore with sand.
 - d. Martial ochre with sand*.

S E C T. CCLXXIX.

OBSERVATIONS ON THE SAXA OR STONES.

Besides the advantages which may accrue to œconomy by a perfect knowledge of the Saxa, the miners or subterranean geographers expect also

* The *Mineræ Arenaceæ* or Sand-ores, cannot reasonably be separated from the sand-stones, since they are produced in the same manner; besides, when they are poor in yield, they are also employed to the same purpose, because it is not easy to smelt the metal out of them. The sand-ores, besides, cannot be ranked in a mineral system as separate species of ores, because they would then be arranged with respect to the kind of stone in which the ore occurs, and not the ore itself, which case cannot be admitted here. It might be urged, that ores, mixed with the stones of the very load, and not in form of sand-ores, ought as well as them to be ranked among the compound saxa; but in that case there would be no end of species, nor could they ever be reduced into any order.

another

another future benefit from it, viz. that of concluding, from many observations, if all the *Saxa* are to be equally considered; for example, if in some of them veins or strata of ores may be expected, and if those are only of certain kinds; if others are every where found destitute of any ore whatsoever; if, and which of them are fit to form coats on the surface of the rock, which covers other kind of stones, and also veins and strata of ores, &c. If no general rules are to be deduced from such observations, there is a probability, at least, to gain some insights that may be particular to certain countries; and this opinion is already in some places confirmed by experience. Hence it may be concluded, how necessary it is to communicate all such observations which, for the above-mentioned purposes, ought to be made over the whole globe, and to agree on fixing certain names on the *Saxa*, in order to avoid too great a prolixity in their descriptions. It is with this intention I have here, as a trial, given specific names to those *Saxa* which are found in this northern country, and which *Saxa* I know; wishing at the same time to be acquainted with a method to distinguish them more easily and to better purpose.

This procedure will be found still more necessary and useful, as the world seems resolved soon to abolish the superstition of the Hazel Rod or *Virgula Divinatoria*, and that we have by means of observations already got too much experience to believe, that the strata of earths and stones are placed equally and in the same order and situation over the whole earth; which some, however, in these our times have even endeavoured to prove, while others have made a secret of it, in order by some way or other to enrich themselves.

S E C T. CCLXXX.

The S E C O N D O R D E R.

MINERAL-CHANGES, or the PETREFACTIONS.

Mineralia-Larvata, vulgò Petrefacta,

Are mineral bodies in the form of animals or vegetables, and for this reason no others belong to this order, than such as have been really changed from the subjects of the other two kingdoms of nature.

There is more difficulty to determine the first point, viz. from when these bodies are to be stiled petrefactions, than from when they cease to be such; meanwhile I have, in order to make a trial, considered them in the following manner.

S E C T. CCLXXXI.

1. Earthy Changes, *Terræ Larvatæ. Terrificata.*

A. Extraneous bodies changed into a lime substance, or calcareous changes, *Larvæ calcareæ.*

1. Loose or friable. Chalky changes, *Cretæ larvatæ.*

a. In form of vegetables.

b. In form of animals.

1. Calcined or mouldered shells, *Humus conchaceus*, from the province of Helsingeland, at Uddevalla in the province of Halland, and in the French strata of earth and chalk.

2. Indurated, *Petrefacta calcarea.*

a. Changed

- a. Changed and filled with solid limestone.
1. In form of animals.
 2. In form of vegetables.
Found in the island of Gottland.
- b. Changed into a calcareous spar, *Petrefacta calcarea spatosa*.
1. In form of animals.
The shells in Balsberget in the province of Skone.
 2. In form of vegetables*.

S E C T. CCLXXXII.

- B. Extraneous bodies changed into a flinty substance. Siliceous changes, *Larvæ siliceæ*. These are like the flint,
1. Indurated, *Petrefacta silicea*.
a. Changed into flints.

* Shells and corals are indeed composed of limy matter, even when their animals still dwell in them; nevertheless, although they are not changed in regard to their principle, yet are they reckoned among the petrefactions, as soon as the particles of the calcareous substance have got a new situation; for example, when they are become sparry, when they have been filled with a calcareous earth, either hardened or loose, or when they lie in the strata of the earth. These form the greatest part of fossil collections, which are so industriously made, often without any regard to the only and principal use they can be of, viz. that of enriching zoology. Mineralists are satisfied with seeing the possibility of the changes the limestone undergoes in regard to its particles, and also with receiving some insight into the alterations which the earth has been subject to, from the strata which are now found in it.

The calcined shells, or those which have been changed into limy and chalky matter, are fit to make lime, and are still more serviceable as a manure. The indurated serve only to make grottos. No gypseous petrefactions are known, if such are not found in the Persian alabaster; for Mr. Chardin says, that he has seen a lizard included in that stone:

A SYSTEM OF

1. Carnelians in form of shells, from the river Tomm in Siberia.
2. Agat in form of wood. Such a piece is said to be in the collection of Count Tessin.
3. Coralloids of white flint, (*Millepora*) found in Gottland.
4. Wood of yellow flint. Italy, Adrianople, and Loughneagh, a lake in Ireland.

S E C T. CCLXXXIII.

C. Extraneous bodies changed into clay.
Argillaceous changes, *Larvæ argillaceæ*.

a. Loose and friable.

1. Of porcellane clay.

a. In form of vegetables.

A piece of white porcellane clay from Japan, with all the marks of the root of a tree, has been observed in a certain collection.

b. Indurated.

1. In an unknown clay.

a. In form of vegetables. *Osteocolla*. It is said to be changed roots of the poplar tree, and not to consist of any calcareous substance. See the *Physikalische Belustigungen*.

A sort of fossil ivory is said to be found, which has the properties of a clay; but I do not know if it is rightly examined,

S E C T. CCLXXXIV.

2. Saline extraneous bodies, or such as are penetrated by mineral salts, *Corpora peregrina insalita. Larvæ insalitæ.*

A. With the vitriol of iron, *Vitriolo martis insalita.*

1. Animals.

a. Human bodies have been twice found in the mine at Falun in Dalarne; the last was kept a good many years in a glass case, but began at last to moulder and fall to pieces.

2. Vegetables.

a. Turf, and

b. Roots of trees.

These are found in water strongly impregnated with vitriol; for instance, in the moor at Ostersilfberget in Dalarne. They do not burn with a flame, but only like a coal in a strong fire; neither do they decay in the air.

S E C T. CCLXXXV.

3. Extraneous bodies penetrated by mineral inflammable substances, or mineral phlogiston, *Corpora peregrina phlogistis mineralibus impregnata.*

A. Penetrated by the substance of pit-coals, *Litbantrace impregnata.*

1. Vegetables, which commonly have been woods, or appertaining to them.

a. Fully saturated. *Gegas. Jet.*

A SYSTEM OF

The jet is of a solid shining texture. From England, Boserup in Skone, and the Black Sea.

- b. Not perfectly saturated. *Mumia vegetabilis*. Is loose, resembles umbre, and may be used as such. From Boserup.

S E C T. CCLXXXVI.

B. Penetrated by rock oil or asphaltum, *Corpora peregrina petroleo seu asphaltum impregnata*.

1. Vegetables.

a. Turf, in the province of Skone.

The Egyptian mummies cannot have any place here, since art alone is the occasion that those human bodies have in length of time been penetrated by the asphaltum, in the same manner as has happened naturally to the wood in pit-coal strata (Sect. cclxxxv. b).

S E C T. CCLXXXVII.

C. Penetrated by sulphur which has dissolved iron, or by marcasite and pyrites, *Pyrite impregnata. Petrefacta pyritacea*.

1. Human.

a. Bivalves,

b. Univalves, and

c. Insects.

In the alum slate at Andrarum in Skone.

S E C T. CCLXXXVIII.

4. Metals in the form of extraneous bodies,
Larvæ metalliferæ.

A. Silver, *Larvæ argentiferæ.*

1. Native.

a. On the surfaces of shells. England.

2. Mineralised with copper and sulphur.

a. Fahlertz or grey silver ore (Sect. clxxi.) in form of ears of corn, &c. and supposed to be vegetables, are found in argillaceous slate at Frankenberg and Tahlitteren in Hesse.

S E C T. CCLXXXIX.

B. Copper, *Larvæ cupriferæ.*

1. Copper in form of calx, *Cuprum calciforme corpora peregrina ingressum.*

a. In form of animals, or of parts belonging to them.

1. Ivory, and other bones of the elephant. The Turcois or Turkey stone: It is of a blueish green colour, and much valued in the East.

At Simore in Languedoc bones of animals are dug, which during the calcination assume a blue colour; but it is not probable that the blue colour is owing to copper.

S E C T. CCXC.

2. Mineralised copper, which impregnates extraneous bodies, *Cuprum mineralisatum corpora peregrina ingressum.*

A. With

A SYSTEM OF

A. With sulphur and iron. The yellow or marcasitical copper ore that impregnates

1. Animals.

a. Shells, from Hagatienns Schurff and Jarlsberg in Norway. These shells lye upon a loadstone,

b. In form of fish, from Eisleben, Mansfeld, and Oisterode, in Germany.

B. With sulphur and silver. Grey silver ore or Fahlertz, like ears of corn, from the slate quarries in Hesse (Sect. cclxxxviii.).

S E C T. CCXCI.

C. Changes into iron, *Larvæ ferriferae*.

1. Iron in form of calx, which has assumed the place or the shape of extraneous bodies, *Ferrum calciforme corpora peregrina ingressum*.

a. Loose, *Larvæ ochraceæ*.

1. Of vegetables.

Roots of trees, from the lake Langelma in Finland: See the Acts of the Swedish Academy of Sciences for the year 1742.

b. Indurated, *Larvæ hæmatiticæ*.

1. Of vegetables.

Wood, from Orbissau in Bohemia.

S E C T. CCXCII.

2. Iron mineralised, assuming the shape of extraneous bodies, *Ferrum mineralisatum*

mineralisatum corpora peregrina ingressum.

a. Mineralised with sulphur. Marcasite. *Larvæ Pyritaceæ.* Sect. cclxxxvii.

S E C T. CCXCIII.

5. Extraneous bodies decomposing, or in a way of destruction, *Corpora peregrina in gradibus destructionis considerata.* Mould, *Humus.* Turf, *Turba.*

A. From animals. Animal mould, *Humus animalis.*

1. Shells. *Humus conchaceus.*

2. Mould of other animals, *Humus diversorum animalium.*

B. Vegetable mould, *Humus vegetabilis.*

1. Turf, *Turba.*

a. Solid, and hardening in the air, *Turba solida aëre indurescens.* Is the best of this kind to be used for fuel, and comes nearest to the pit-coals. It often contains a little of the vitriolic acid.

b. Lamellated turf, *Turba foliata.* This is in the first degree of destruction.

2. Mould of lakes, *Humus lacustris.* This is a black mould which isedulcorated by water.

3. Black mould, *Humus ater.*

This is universally known, and covers the surface of that loose earth in which vegetables thrive best*.

* All the kinds of mould contain some of the inflammable substance, which has remained in them from the vegetables or animals; and they are more or less black, in proportion as they contain

S E C T. CCXCIV.

The T H I R D O R D E R.

N A T U R A L S L A G S,

Scoriæ Vulcanorum.

Slags are found in great abundance in many places in the world, not only where volcanos yet exist, but likewise where no subterraneous fire is now known: Yet, according to our opinion, they cannot be produced but by means of fire. These are not properly to be called natural, since they have marks of violence, and of the last change that mineral bodies can suffer without the destruction of the world; nor are they artificial, according to the universally received meaning of this word. When we perhaps in future times by new discovered means may be able to find out of what sort of earth stones are compounded, we shall still be forced to stop at the surface of them, and be contented with knowing that they contain a little iron. Mean while I cannot omit them here, since I have considered the petrefactions; and therefore I will enumerate some of them, according to their external marks.

contain more or less of this phlogiston. I have ranked them in this place, that they might not be totally excluded. They are esse a *medium uniens* between all the three kingdoms of nature: And it may reasonably be asked, if all sorts of earth do not in form of very minute particles enter into the composition of vegetables and animals, after which they exist for some time in form of mould, until the phlogiston is again separated.

S E C T. CCXCV.

A. Iceland agat, *Achates islandicus niger*.

It is black, solid, and of a glassy texture; but in thin pieces, it is greenish and semi-transparent like glass bottles, which contain much iron. The most remarkable is, that such large solid masses are found of it, that there is no possibility of producing the like in any glasshouse.

It is found in Iceland, and in the Island of Ascension: The jewellers employ it as an agat, though it is too soft to resist wear.

S E C T. CCXCVI.

B. Rhenish millstone, *Lapis molaris Rhenanus*.

Is blackish grey, porous, and perfectly resembles a sort of slag produced by Mount Vesuvius. If I am mistaken in this, I hope that somebody else will describe the constituent parts of this millstone.

S E C T. CCXCVII.

C. Pumice-stone, *Pumex*.

Is very porous and blistered, in consequence of which it is specifically very light. It resembles that froathy slag which is produced in our iron furnaces.

1. White.

2. Black.

The colour of the first is perhaps faded or bleached, because the second kind comes in that state from the laboratory itself, viz. the volcanos.

S E C T.

S E C T. CCXCVIII.

D. Pearl slag, *Scoriæ constantes globulis vitreis conglomeratis.*

Is compounded of white and greenish glass particles, which seem to have been conglutinated while yet soft, or in fusion. Found on the Isle of Ascension.

S E C T. CCXCIX.

E. Slag-sand or ashes, *Scoriæ pulverulentæ. Cineres Vulcanorum.*

This is thrown forth of the volcanos in form of larger or smaller grains. It may perhaps be the principle of the Terra Puzzolana (Sect. ccix. a.), because such an earth is said at this time to cover the ruins of Herculaneum near Naples, which history informs us was destroyed by a volcano during an earthquake.

S E C T. CCC.

OBSERVATIONS on the preceding SLAGS.

It seems as if we could not go any farther in the arrangement of bodies belonging to the mineral kingdom, than to the black mould (Sect. ccxciii.) and the slags, as being the extremes.

However, if these slags likewise decay, and in length of time become an earth, which possibly may happen; there is then a new substance beyond them, which however may return back and circulate again in some known form. It is obvious how the old heaps of slags from the iron furnaces

furnaces decay, and at last produce vegetables, which cannot be ascribed to a black mould alone carried thither by the wind. The same may perhaps happen with the natural slags in the open air; but we do not know if it is so, nor what different forms this and every other earth which circulates in animals and vegetables further assumes: However, in such circumstances, as their particles become or are already very minute, and most part of the phlogiston becomes volatile, when acted upon by heat or fire, it seems probable, that, by a slow separation of the phlogiston, or a union by means of salts, this earth is most apt to become a clay, provided it is not by any previous revolution laid in such places as to change it into slate, pit-coal, &c.

If at any time it should happen that a volcano should burst out of a mountain, whose strata we knew before, we could at least imagine some reasons for this wonderful effect: However, the learned would nevertheless, perhaps, want some knowledge about the substances of the strata, and the manner of their formation; since in this circumstance water and other obstacles have hindered people too much from making the due observations thereon.

Meanwhile, the more we consider, on the one part, all the modifications and alterations the earths undergo by means of fire and water, by the free or impeded access of the air, by the volatility and attraction of the acid salts, whereby are produced solution and hardening, composition and separation; and, on the other part, reflect on the shortness of a man's life, perhaps also dedicated to other business, on the difficulty of observing the subterraneous effects, and on several other things, which prevent the making discoveries, by which we might find out some easier means to attain true knowledge

knowledge by judicious experiments; the more we shall find, what is wanted to form mineral systems, and for this reason be apt to excuse the faults of those which have been hitherto published.

From those, who of themselves are susceptible of these sentiments, I suffer with pleasure that judgment, which I am myself ready to pronounce upon this Effay,

Transit cum ceteris.

E I N I S;



DESCRIP.

DESCRIPTION and USE

OF A

Mineralogical Pocket Laboratory ;

AND ESPECIALLY THE

USE of the BLOW-PIPE

IN

MINERALOGY.

By GUSTAV VON ENGESTROM.

T

REPORT OF THE

OF A

Mineralogical Laboratory

AND

USE OF THE MICROSCOPE

Public Good, in the

MINERALOGY

Mineralogy has long been a science of the laboratory, yet its progress has been slow. Some have thought that the microscope was the key to the solution of the problem, but only a few have taken advantage of it.

The present volume is a collection of papers read at the meeting of the Mineralogical Society, London, 1914. It is a valuable contribution to the knowledge of the microscope in mineralogy.

D E S C R I P T I O N

O F A

Mineralogical Pocket Laboratory, &c.

S E C T. I.

THAT Science which teaches us the properties of mineral bodies, and by which we learn how to characterize, distinguish, and class them into a proper order, is called *Mineralogy*. This, like all other sciences, when rightly cultivated, and employed to its proper end, (the Public Good) furnishes us with many useful discoveries, in proportion as it increases.

S E C T. II.

Mineralogy has been studied for several ages, yet its progress has been very slow.

Some learned men have, indeed, endeavoured to bring it into some systematical order: But as the passion for only collecting minerals and fossils has still predominated over that of diving into the nature of the subjects themselves, they have for the most part met with but very little success. Those who were *mere Collectors*, being superior in number to the *scientific ones*, or *Mineralists*, and

having more opportunities of getting new specimens, were most of them not so communicative to the latter as they ought to have been. Some of these, fond of the number, were wholly taken up in gathering together immense heaps of things, seeming almost resolved to get the whole of Nature into their cabinets, without having regard to any true order; while others, purposing to correct this inconveniency, would pretend to some interior knowledge, as if that had been a consequence of their collection; and by that fell into another still greater extravagancy.

All this certainly hindered the mineralists from improving much in the science; but, happily, those times are past. The world is grown more reasonable at present, and Mineralogy seems more and more to be encouraged.

The great utility of the mineral bodies already known, promises us a greater advantage from the study of this science, than only the pleasure of collecting. But, in order to come at this advantage, we ought to search into the very principles of these bodies, that we may be certain of not deceiving ourselves in our judgment about them.

S E C T. III.

As the principal end of cultivating Mineralogy is to find out the œconomical use of the minerals, it is necessary to know every occurrent mineral body in regard to all its effects; from them to determine the best use it might be put to. A System of Mineralogy thus founded on the effects of its subjects, must be more scientific, since it always has in view that real point, *their application to Common Life*: And since it is natural to the human mind to adapt every thing to its own advantage,

vantage, as far as possible, such a system must be more generally received, and at the same time the easier understood, as it includes the mineral bodies in a less number of classes, orders, &c. by which the memory is not so much clogged, as if only their surfaces had been described.

S E C T. IV.

This granted, let us consider what difficulties there are to be met with in examining mineral bodies. These are often like one another as to their external appearances, although their constituent parts are quite different, and consequently make them useful in different ways: Most part of them ought also to be changed from their natural form, and even often dissolved, before they can be made any use of. Their figure and colour, or, in short, their surfaces, are therefore not solely to be depended upon; we must penetrate into them; and they must be decomposed according to the principles of chemistry.

S E C T. V.

By examining the mineral kingdom in this manner, we may now and then find the subjects of our experiments (if even nearly the same) to differ in some of their effects, which is particularly owing to the difficulty of justly determining the degrees of the fire employed; a difficulty not yet removed, but which, however, ought not to hinder us from going as far as possibly we can, since we find by practice, that such obstacles often are remedied by repeated experiments; and of these we never can make too many, if judiciously performed.

S E C T. VI.

This way of studying Mineralogy has already some time ago been entered upon; but Mr. Pott, at Berlin, has brought it to a greater perfection; and after him Mr. Cronstedt, in Sweden, has extended it yet farther, submitting every mineral body, that came to his hands, to chemical experiments; in consequence of which he afterwards published his *Essay towards a System of Mineralogy*.

S E C T. VII.

Thus the greatest obstacle is removed; the best method to learn Mineralogy is laid open, in following which we are enabled to render this Science more and more perfect. To obtain this end, chemical experiments are without doubt necessary; but as a great deal of the mineral kingdom has already been examined in this manner, we do not want to repeat all those experiments in their whole extent, unless some new and particular phenomena should discover themselves in those things we are examining; else the tediousness of those processes might discourage some from going farther, and take up much of the time of others, that might be better employed. An easier way may therefore be made use of, which even for the most part is sufficient, and which though made in miniature, yet is as scientific as the common manner of proceeding in the laboratories, since it imitates that, and is founded upon the same principles. This consists in a *method of making experiments upon a piece of charcoal with the concentrated flame of a candle blown through a Blow-pipe*. The heat

heat occasioned by this, is very intense, and the mineral bodies may here be burnt, calcined, melted, or scorified, &c. as well as in any great works.

S E C T. VIII.

The Blow-pipe is in common use among jewelers, goldsmiths, some glass-blowers, &c. and has even been used a little by the chemists and mineralists; but, to the best of my knowledge, Mr. Cronstedt is the first who made such an improvement in its use, as to be employed in examining all mineral bodies. This gentleman invented some other apparatus, necessary in making the experiments, to go with the Blow-pipe, which all together make a neat little case, that, for its facility of being carried in the pocket, particularly on travels, might be called a *Pocket-Laboratory*: And as neither this Pocket Laboratory, nor even the extensive use of the Blow-pipe, is yet generally known, I think it will not be altogether useless, to give a description of it.

S E C T. IX.

The Blow-pipe is represented in its true figure and size, Tab. 1, fig. 1. The globe *a* is hollow, and made on purpose to condense the vapours, which always happen to be in the Blow-pipe when it has been used some time: If this globe was not there, the vapours would go directly with the wind out into the flame, and would thereby cool the assay.

The hole in the small end *b*. through which the wind comes out, ought not to be larger than the size of the finest wire. This hole may now and then be stopped up with something coming

into it, which hinders the force of the wind; one ought therefore to have a piece of the finest wire, to clear it with when required: And, in order to have this wire the better at hand, it may be fastened round the Blow-pipe, in such a manner as is represented in fig. 1. *c* is the wire, fastened round the Blow-pipe at *d*. and afterwards drawn through a small hole at *e*. made in the ring *f*. to keep it more steady.

S E C T. X.

The Blow-pipe is compounded of two parts, Tab. 1. fig. 2. and 3; and this for the facility both of making, carrying it along, and cleaning it on the inside when it is wanted.

In order to determine the most convenient proportions of this instrument, several Blow-pipes of different sizes, both bigger and smaller, have been tried: The former have required too much wind, and the latter being too soon filled with the wind, have returned it back again upon the lungs: Both these circumstances hindered greatly the experiments, and are perhaps even prejudicial to the health. This size, fig. 1, is found to answer best; and though the hole must be as small as before mentioned (Sect. ix.) yet the sides of the pipe at the point must not be thinner, nor the point narrower than here represented, else it will be too weak, and will not give so good a flame. It is also to be observed, that the canal throughout the pipe, but particularly the hole at the small end, must be made very smooth, so that there are no inequalities in it; the wind would else be divided, and consequently the flame made double. That Blow-pipe is to be reckoned the best, through which can be formed the longest and most pointed flame from off a
common-

common-sized candle. These Blow-pipes are commonly made of brass or silver.

S E C T. XI.

The whole Pocket-Laboratory is represented Tab. II. fig. 1, with the case, exactly of the form, bigness, and proportions as that I make use of myself: What alterations there may be wanted are easily found out by practice.

c b are the two parts of which the Blow-pipe consists, and which are already described.

a. a wax-candle, destined to be made use of, particularly in travels, when no other candle is to be had.

b. a pair of nippers, (*Korntong*) to handle so much the easier the things which are to be tried, because they are generally small particles: This serves also to touch and turn the subjects during the experiments, when they are hot, and could not be well handled with the fingers.

d. e. f. are three phials, to put the required fluxes in, viz. Borax, the Mineral Alkali (*Sal Sodæ*), and *sal fusibile microcosmicum*.

g. a hammer, to break any part of a stone, when it is to be tried: This serves also to pound things with.

i. A magnifying glass, necessary when the objects are too small to be seen by the naked eye.

k. a steel, to strike fire, by which the hardness or softness of the bodies is tried.

l. a loadstone, to discover the presence of iron.

m. a file, wherewith to distinguish natural gems, quartz-crystals, and artificial or coloured glasses from one another.

n. a thin square plate made of untempered steel, filed flat on one side, to pound things upon, and polished

polished on the other side, to hammer metals upon.

Above this steel plate *n.* and within the circle, drawn round about it, is the place for a candlestick. This candlestick is shewn in plan, fig. 2, and in profile, fig. 3, Tab. II. It consists of a round brass plate; the point *a.* and the ring *b.* round it, is instead of the socket in another candlestick, which would here take up too much room.

Fig. 4, (Tab. II.) is a thin iron ring, a sixth part of an inch high; within this ring the pounding and grinding of the things upon the steel plate fig. 1, *n.* is performed, that they may not be lost. In packing up, this ring is to be put loose upon the candlestick; and, as it is lower than the point of this, it does not take up much room in the case.

The whole case, thus made, with all the instruments in it, as I have described them, is no more than one and an eighth part of an inch high, and consequently not more troublesome to be carried in the pocket than a small book*.

* The *Pocket Laboratory* here described, and the *Box for the Acids*, mentioned in Sect. lxii. have been improved after the manner of Mr. Cronstedt, by a gentleman particularly acquainted with Mr. Engestrom, from whom he learned this method of making Mineralogical Experiments. The bulk of the first has been reduced nine and a half cubic inches; its length being diminished *one* sixteenth of an inch, the breadth *five* ditto, and the depth *two*; notwithstanding which, there is also added a piece of charcoal for trying the experiments, a flint, a piece of agaric tinder, and some matches for lighting the candle. The three phials *d e f* for the salts, are of different colours, to prevent any mistake. The candlestick *s* has different concentric grooves for keeping the results of the trials separate. The blow-pipe *c b* has a silver mouth-piece, and screws in the middle of the ball, in order to clean out the moisture with the greater ease; and the small wire [Sect. ix.] is more conveniently detached than fixed round it. The other box
for

S E C T. XII.

Whenever any thing is to be tried, one must not begin immediately with the Blow-pipe; some preliminary experiments ought to go before, by which those in the fire may afterwards be directed. For instance, a stone is not always homogeneous, or of the same kind throughout, although it may appear to the eye to be so: The magnifying-glass is therefore necessary, to discover the heterogeneous particles, if there be any; and these ought to be separated, and every thing tried by itself, that the effects of two different things, tried together, may not be attributed to one alone. This might happen with some of the finer *micae*, which are now and then found mixed with small particles of quartz, scarcely to be perceived by the eye. The Trapp, (in German *Schwartzstein*) is also sometimes mixed with very fine particles of Felspat (*spatum scintillans*) or of Calcareous Spar, &c. After this experiment follows that, to try the hardness of the stone in question with the steel. The Flint and Garnet-kinds are commonly known to strike fire with the steel; but there are also other stones, though very seldom, found so hard as to strike fire:

for the acids, mentioned Sect. lxii. is reduced to less than a fourth of its original bulk, being exactly of the same size with the above. It contains two small matrasses [Tab. I. fig. 4.] for making solutions; a trough [Tab. I. fig. 5.] for washing the ore after its being pounded; and the three small bottles with double stoppers, for the *nitrous*, *muratic*, and *vitriolic* Acids, have their respective initials cut on each.

Both these Pocket-Laboratories, made in the neatest manner by an ingenious artist, may be had ready furnished with the purest acids, &c. at the *General Office of Business, Arts and Trade*, opened for the present at No. 98, Wood-Street, Cheap-side, and only there, for very reasonable prices.

A kind of Trapp is found of that hardness, in which no particles of Felspat are to be seen. Coloured glasses resemble true gems; but as they are very soft in proportion to these, they are easily discovered by the means of the file: The common quartz-crystals are harder than coloured glasses, but softer than the gems. The loadstone discovers the presence of iron, when it is not mixed in too small a quantity in the stone, and often before the stone is roasted. Some kinds of *Hæmatites*, and particularly the *Cærulescens*, is very like some other iron ores, but distinguishes itself from these by a red colour, when pounded, the others giving a blackish powder, and so forth.

S E C T. XIII.

To manage the Blow-pipe with ease requires some practice. A beginner blows generally too strongly, which forces him to take breath very often, and then he draws the flame at the same time along into the Blow-pipe: This is troublesome for himself, and the experiment cools always a little at the same time. But the more experienced can breathe in, through the nose, and yet at the same time blow through the pipe, whereby a constant flame from the candle is kept up. The whole art consists in constantly taking in air through the nose, and with the tongue moderating its blowing out; so that the tongue performs nearly the office of a sucker in a pump; or rather, the action of the nose, lungs, and mouth, resembles here the action of bellows with double partitions. In this manner there is no need of blowing violently, but only with a moderate and equal force, and thus the breath can never fail the operator. The only inconveniency attending, is, that
the

the lips grow weak or tired, after having continued to blow for a while in one strain; but they soon recover their former strength, by ceasing to blow for some minutes.

S E C T. XIV.

The candle used for this purpose (Sect. vii.) ought to be snuffed often, but so, that the top of the wick may retain some fat in it, because the flame is not hot enough when the wick is almost burnt to ashes; but only the top must be snuffed off, because a low wick gives too small a flame. The blue flame is the hottest; this ought therefore to be forced out when a great heat is required, and only the point of the flame must be directed upon the subject which is to be assayed.

S E C T. XV.

The piece of charcoal made use of in these experiments (Sect. vii.), must not be of a disposition to crack. If this should happen, it must gradually be heated until it does not crack any more, before any assay is made upon it. If this is not observed, but the assay made immediately with a strong flame, small pieces of it will split off in the face and eyes of the assayer, and often throw along with them the matter that was to be assayed. Charcoal which is too much burnt consumes too quick during the experiment, leaving small holes in it, wherein the matter to be tried may be lost: And charcoal that is burnt too little catches flame from the candle, burning by itself like a piece of wood, which likewise hinders the process.

S E C T. XVI.

Of those things that are to be assayed, only a small piece must be broke off for that purpose, not bigger than that the flame of the candle (Sect. vii. xiv.) may be able to act upon it at once, if required; which is sometimes necessary; for instance, when the matter requires to be made red hot throughout. A piece of about an eighth part of an inch square is reckoned of a moderate size, and fittest for experiments; seldom more, but rather less. This proportion is only mentioned as a direction in regard to the quantity, the figure being of no consequence at all, a piece broke off from a stone seldom or never happening to be square. But here it is to be observed, that the piece ought to be broke as thin as possible, at least the edges: The advantage thereof is easily seen, the fire having then more influence upon the subject, and the experiment being quicker made. This is particularly necessary to be observed when such stones are to be assayed, which although in some respects fusible by themselves, yet resist considerably the action of the fire; because they may by these means be brought into fusion, at least at their edges, which else would have been very difficult if the piece had been thick.

S E C T. XVII.

Some of the mineral bodies are very difficult to keep steady upon the charcoal during the experiment, before they are made red hot; because, as soon as the flame begins to act upon them, they split asunder with violence, and disperse. Such
often

often are those which are of a soft consistence, or a particular figure, and which preserve the same figure in however minute particles they are broke; for instance, the Calcareous Spar, the Sparry Gypsum, Sparry Fluor, White Sparry Lead-ore, the Potters Ore, (*Galena tessellata*) the Tessellated Mock-lead or Blende, &c. even all the common fluors which have no determinate figure, and most of the *Mineræ metallorum calciformes crystallisatæ* or *spatosæ*: All these are not so compact as common hard stones; and therefore, when the flame is immediately pushed at them, the heat forces itself quickly through and into their clefts or pores, and causes this violent expansion and dispersion. Many of the clays are likewise apt to crack in the fire, which may be for the most part ascribed to the humidity, of which they always retain a portion. Besides these enumerated, there may be found now and then other mineral bodies of the same nature; but it is, however, not so common.

The only way of preventing this inconveniency, is to heat the body as slowly as possible. It is best, first of all, to heat that place of the charcoal, where the piece is intended to be put on, and afterwards lay it thereon; a little crackling will then ensue, but commonly of no great consequence. After that, the flame is to be blown very slowly towards it, in the beginning not directly upon, but somewhat above it, and so approaching nearer and nearer with the flame until it becomes red hot. This will do for the most part; but there are nevertheless some, which, notwithstanding all these precautions, it is almost impossible to keep on the charcoal. Thus the Fluors are generally the most difficult; and as one of their principal characters is discovered by their effects in the fire *per se*, (Sect. xviii. 6.) they ought necessarily

cessarily to be tried that way. To this purpose it is best to make a little hole in the charcoal to put the Fluor in, and then to put another piece of charcoal as a covering upon this, leaving only a small opening for the flame to come in at, and to look at the proof. As this stone will nevertheless mostly split and fly about, a larger piece thereof than is before-mentioned, (Sect. xvi.) must be taken, in order to have at least something of it left.

But if the experiment is to be made upon a stone whose effects one does not want to see in the fire *per se*, but rather with fluxes, then a piece of it ought to be forced down into melted borax, (Sect. xxiii.) when always some part of it will remain in the borax, notwithstanding the greatest part may sometimes fly away by cracking.

S E C T. XVIII.

As the stones undergo great alterations when exposed to the fire by themselves, whereby some of their characteristics, and often the most principal, are discovered, they ought first to be tried that way; observing what has been said before concerning the quantity of the matter, direction of the fire, &c. The following effects are generally the results of this experiment, viz.

1. Calcareous earth or stone, when it is pure, does never melt by itself, but becomes white and friable, so as to break freely between the fingers; and, if suffered to cool, and then mixed with water, it becomes hot, just as common quick lime. As in these experiments only very small pieces are used, (Sect. xvi.) this last effect is best discovered by putting the proof on the outside of the hand, with a drop of water to it, when instantly a very quick

quick heat is felt on the skin. When the calcareous substance is mixed with the vitriolic acid, as in the gypsum; or with a clay, as in the marle; it commonly melts by itself; yet more or less difficult in proportion to the differences of the mixtures: The gypsum produces generally a white, and the marle a grey glass or slag. When there is any iron in it, as in white iron ore, it becomes dark, and sometimes quite black, &c.

2. The Siliceæ never melt alone, but become generally more brittle after being burnt: Such of them as are coloured become colourless, and the sooner when it does not arise from any contained metal; for instance, the Topazes, Amethysts, &c. some of the precious stones, however, excepted. And such as are mixed with a quantity of iron, grow dark in the fire, as some of the Jaspers, &c.

3. The Garnet-kind melt always into a black slag, and that sometimes so easy, that it may be brought into a round globule upon the charcoal.

4. The Argillaceæ, when pure, never melt, but become white and hard: The same effects follow when they are mixed with phlogiston; for instance, the *Soap-rock* is easily cut with the knife; but, being burnt, it cuts glass, and would strike fire with the steel, if as large a piece, as is necessary for that purpose, could be tried in this way. The *Soap-rocks* are sometimes found of a dark brown and nearly black colour, but become for all that quite white in the fire, as a piece of China ware: However, care must be taken not to push the flame from the top of the wick, there being for the most part a sooty smoke, which commonly will darken all that it touches; and if this is not observed, a mistake in the experiment might easily happen: But if it is mixed with iron, as it is sometimes found, it does not so easily part with

its dark colour. The Argillaceæ, when mixed with lime, melt by themselves, as above-mentioned (1). When mixed with iron, as in the Boles, they grow dark or black; and if the iron is not in too great a quantity, they melt alone into a dark slag; the same happens, when they are mixed with iron and a little of the vitriolic acid, as in the common clay, &c.

5. The Micaceæ and Asbestinæ become somewhat hard and brittle in the fire, and are more or less refractory, though they give some marks of fusibility.

6. The Fluores discover one of their chief characteristics by giving a light, like Phosphorus, in the dark, when they are slowly heated; but lose this property, as well as their colour, as soon as they are made red hot: They commonly melt in the fire into a white opaque slag, though some of them not very easily.

7. Some sorts of the Zeolites, a stone lately discovered, melt easily and foam in the fire, sometimes nearly as much as Borax, and become a frothy slag, &c.

8. A great many of those mineral bodies which are impregnated with iron, as the Boles, and some of the White Iron Ores, &c. as well as some of the other iron ores, viz. the Bloodstone, are not attracted by the loadstone before they have been thoroughly roasted, &c.

A further digression upon these effects is unnecessary here, their enumeration belonging more properly to the Mineralogy; it is sufficient only to have mentioned the most common, in order the better to explain the experiments that are made with the Blow-pipe.

S E C T. XIX.

After the mineral bodies have been tried in the fire by themselves, they ought to be melted with fluxes, to find out if they can be dissolved or not, and some other phœnomena attending this operation. To this purpose three different kinds of salts are used as fluxes, viz. *Sal Sodæ*, *Borax*, and *Sal fusible microcosmicum* (Sect. xi).

S E C T. XX.

The *Sal Sodæ* is a mineral alkali well known, prepared from the herb *Kali* or *Saltwort*; this salt is however not much used in these small experiments, its effects upon the charcoal rendering it, for the most part, unfit for it; because, as soon as the flame begins to act upon it, it melts instantly, and is almost wholly attracted by the charcoal. When this salt is employed to make any experiment, but a very little quantity thereof is wanted at once, viz. about the cubical contents of an eighth part of an inch, more or less: This is laid upon the charcoal, and the flame blown on it with the *Blow-pipe*; but as this salt commonly is in form of a powder, it is necessary to go on very softly, that the force of the flame may not disperse the minute particles of the salt. As soon as it begins to melt it runs along on the charcoal almost as melted tallow, and when cold, it is a glassy matter of an opaque dull colour spread on the coal. The moment it is melted the matter which is to be tried ought to be put into it, because otherwise the greatest part of the salt will be soaked into the charcoal, and too little of it left for the intended purpose; the flame ought

then to be directed on the matter itself, and if the salt spreads too much about, leaving the proof almost alone, it may be brought to it again by blowing the flame on its extremities, and directing it towards the subject of the experiment. In the assays made with this salt, it is true, we may find if the mineral bodies which are melted with it have been dissolved by it or not; but we cannot tell with any certitude whether this is done hastily and with force, or gently and slowly; whether only a less or a greater part of the matter has been dissolved; nor can it be well distinguished if the matter has imparted any weak tincture to the slag; because this salt always bubbles upon the charcoal during the experiment, nor is it clear when cool; so that scarce any colour, except it be a very deep one, can be discovered, although it may sometimes be coloured by the matter that has been tried.

S E C T. XXI.

The other two salts, viz. the Borax, and the Sal fusibile microcosmicum, are very well adapted to these experiments, because they may by the flame be brought to a clear uncoloured and transparent glass; and as they have no attraction to the charcoal, they keep themselves always upon it in a round globular form. The Sal fusibile microcosmicum is very scarce, and perhaps not to be met with in the shops; it is made of urine: Mr. Margraff has given a full account of its preparation in the Memoirs of the Academy of Sciences at Berlin.

S E C T. XXII.

The quantity of these two salts required for an experiment is almost the same as the Sal Sodæ (Sect. xx.); but as these salts are cristallised, and consequently include a great deal of water, particularly the borax, their bulk is considerably reduced when melted, and therefore a little more of these may be taken than the before-mentioned quantity.

S E C T. XXIII.

Both these salts, (Sect. xxi.) when exposed to the flame of the Blow pipe, bubble very much and foam before they melt to a clear glass, but more so the borax, which for the most part depends on the water they contain: And as this would hinder the assayer to make due observations on the phœnomena of the experiment, the salt which is to be used, must first be brought to a clear glass, (Sect. xxi.) before it can serve as a flux; it must therefore be kept in the fire until it is become so transparent that the cracks in the charcoal may be seen through it. This done, whatsoever is to be tried, is put to it, and the fire continued.

S E C T. XXIV.

Here it is to be observed, that for the assays made with any of these two fluxes (Sect. xxii) on mineral bodies, no larger pieces of these must be taken, than that altogether they may keep a globular form upon the charcoal; because then it may be better distinguished in what manner the flux acts upon the matter during the ex-

periment: If this is not observed, the flux, communicating itself with every point of the surface of the mineral body, spreads all over it, and keeps the form of this last, which commonly is flat, (Sect. xvi.) and by that means hinders the operator to observe all the phœnomena which may happen. Besides, the flux being in too small a quantity, in proportion to the body to be tried, is too weak to act with all its force upon it. The best proportion, therefore, is about a third part of the mineral body to the flux; and, as the quantity of the flux, mentioned in Sect. xx. xxii. makes a globe of a due size, in regard to the greatest heat that is possible to procure in these experiments; the size of the mineral body, proposed in Sect. xvi. required when it is to be tried in the fire by itself, is too large on this occasion, the third part of it being here almost sufficient.

S E C T. XXV.

The Sal Sodæ, as has been said before, is not of much use in these experiments; nor has it any particular qualities in preference to the two last mentioned salts, except that it dissolves the Zeolites easier than the Borax and the Sal fusibile microcosmicum.

This last mentioned salt shews almost the same effects in the fire as the borax, and differs from this in very few circumstances, of which one of the most principal is, that, when melted with manganese, it becomes of a crimson hue, instead of a jacinth colour, which borax takes.

This salt is, however, for its scarcity, still very little in use, borax alone being that which is commonly used. Whenever a mineral body is melted with any of these two last mentioned salts, in the
above

above described manner (Sect. xxii. *et seq.*) it is easily seen whether it is quickly dissolved, because in that case an effervescence arises, which lasts till the whole is dissolved; or whether this is slowly done, in which case few and small bubbles only rise from the matter: Likewise, if it cannot be dissolved at all, because then it is observed only to turn round in the flux without the least bubble, and the edges look as sharp as they were before.

S E C T. XXVI.

In order further to illustrate what has been said about these experiments, I will mention some instances out of the Mineralogy, concerning the effects of borax upon the mineral bodies, viz.

1. The calcareous substances, and all those stones which contain any thing of lime in their composition, dissolve readily and with effervescence in the borax: This effervescence is the more violent, the greater the portion of lime contained in the stone. This reason, however, is not the only one in the gypsum, because both the constituents of this do readily mix with the borax, and therefore a greater effervescence arises in melting gypsum with the borax, than lime alone.

2. The Siliceæ do not dissolve, unless some few, which contain a quantity of iron.

3. The Argillaceæ, when pure, are not acted upon by the borax; but when they are mixed with some heterogeneous bodies, they are dissolved, though very slowly; such is for instance the Stone Marrow, the Common Clay, &c.

4. The Granateæ, Zeolites, and Trapp, dissolve but slowly.

5. The Fluores, Asbestinæ, and Micaceæ, dissolve for the most part very easily, and so forth.

S E C T. XXVII.

Some of these bodies melt to a colourless transparent glass with the borax; for instance, the Calcareous Substances, when pure, the Fluores, some of the Zeolites, &c. Others tinge the borax with a green transparent colour; viz. the *Granateæ*, *Trapp*, some of the *Argillaceæ*, some of the *Mica-cææ* and *Asbestinæ*: This green has its origin, partly from a small portion of iron, which the *Granateæ* particularly contain, and partly from phlogiston.

S E C T. XXVIII.

The borax cannot dissolve but a certain quantity of a mineral body proportional to its own. Of the calcareous kind it dissolves a vast quantity, but turns at last, when too much has been added, from a clear, transparent, to a white, opaque slag. When the quantity of the calcareous matter exceeds but little in proportion, the glass looks very clear as long as it remains hot; but as soon as it begins to cool, a white half opaque cloud is seen to arise from the bottom, which spreads over the third, half, or more of the glass globe, in proportion to the quantity of calcareous matter; but the glass or slag is nevertheless shining, and of a glassy texture when broke; if more of this matter be added, the cloud rises quicker and more opaque, and so by degrees till the slag becomes quite milk white: It is then no more of a shining, but rather dry appearance, on the surface; is very brittle, and of a grained texture, when broke.

S E C T. XXIX.

All that has been said hitherto of experiments upon mineral bodies, is only concerning the stones and earths. I am now proceeding to the metals and ores, in order to describe the manner of examining these bodies, and particularly the management of the Blow-pipe in these experiments. An exact knowledge, and nice proceeding are so much the more necessary here, as the metals are often so disguised in their ores, as to be very difficultly known by their external appearance, and liable sometimes to be mistaken one for the other: Some of the cobalt ores for instance, resemble much a Pyrites Arsenicalis; there are also some iron and lead ores, which are nearly like one another, &c.

S E C T. XXX.

As the ores generally consist of metals mineralised with sulphur or arsenic, or sometimes both together; they ought first to be exposed to the fire by themselves, in order, not only to determine with which of these they are mineralised, but also to set them free from these volatile mineralising bodies: Thus this serves instead of calcination, by which they are prepared for further essays.

S E C T. XXXI.

Here it must be observed, that, whenever any metal, or fusible ore is to be tried, a little concavity must be made in that place of the charcoal where the matter is to be put; because, as soon as it is melted, it forms itself into a globular figure,
and

and might then roll from the charcoal, if its surface was plain; but when borax is put to it, this inconveniency is not so much to be feared.

S E C T. XXXII.

Whenever an ore is to be tried, a small bit is broke off for that purpose, of such a size as is directed in Sect. xvi. this bit is laid upon the charcoal, and the flame blown on it slowly: Then the sulphur or arsenic begins to part from it in form of smoke; these are easily distinguished from one another by their smell, that of sulphur being sufficiently known, and the arsenic smelling like garlick. The flame ought to be blown very softly, as long as any smoke is seen to part from the ore; but, after that, the heat must be augmented by degrees, in order to make the calcination as perfect as possible. If the heat is applied very strong from the beginning upon an ore, that contains much of the sulphur, or arsenic, this ore will presently melt, and yet lose very little of its mineralising bodies, and by that means render the calcination very imperfect. It is however, impossible to calcine the ores in this manner to the utmost perfection, which is easily seen in the following instance, viz. in melting down a calcined Potter's ore with borax, it will be found to bubble upon the coal, which depends on the sulphur, which is still left, the vitriolic acid of this uniting with the borax, and causing this motion. However, lead in its metallic form, melted in this manner, bubbles alone upon the charcoal, if any sulphur remains in it. But, as the lead, as well as some of the other metals, may raise bubbles upon the charcoal, although they are quite free from the sulphur, only by the flames being forced too violently

lently on it, these phœnomena ought not to be confounded with each other.

S E C T. XXXIII.

The ores being thus calcined, the metals contained in them may be discovered, either by being melted alone, or with fluxes: when they shew themselves, either in their pure metallic state, or by tinging the slag with colours peculiar to each of them. In these experiments it is not to be expected, that the quantity of metal contained in the ore should be exactly determined; this must be done in larger laboratories. This cannot, however, be looked upon as any defect, since it is sufficient for a mineralist, only to find out what sort of metal is contained in the ore. There is another circumstance, which I am sorry to say, is a more real defect in our little laboratory, which is, that some ores are not at all able to be tried in it, by so small an apparatus: for instance, the gold ore called *Pyrites aureus*, which consists of gold, iron, and sulphur. The greatest quantity of gold, which this ore contains, is about one ounce, or one ounce and an half out of one hundred pounds of the ore, the rest being iron and sulphur; and as only a very small bit is allowed for these experiments, (Sect. xvi. xxxi.) the gold contained therein, can hardly be discerned by the eye, even if it could be extracted, but it goes along with the iron in the slag, this last metal being in so large a quantity in proportion to the other, and both of them having a commicible power with each other.

All the kinds of Blende, Black jack, which are mineralised zink ores, containing zink, sulphur, and iron, cannot be tried this way, because they cannot be perfectly calcined, and besides, the zink
flies

flies off, when the iron scorifies: neither can all those Blendes, which contain silver or gold mineralised with them, be tried in this manner, which is particularly owing to the imperfect calcination; nor are the quicksilver ores fit for these experiments, the volatility of this semi-metal making it impossible to bring it out of the poorer sort of ores*; and the rich ores, which sweat out the quicksilver, when kept close in the hand, not wanting any of these assays, &c. Those ores ought to be assayed in larger quantities, and even with such other methods, as cannot be applied upon a piece of charcoal.

S E C T. XXXIV.

Some of the rich silver ores are easily tried: for instance, *Minera argenti vitrea*, commonly called Silver-glass, which consists only of silver and sulphur. When this ore is exposed to the flame, it melts instantly, and the sulphur goes away in fume, leaving the silver pure upon the charcoal, in a globular form. If this silver should happen to be of a dirty appearance, which often is the case, then it must be melted anew with a very little borax, and after it has been kept in fusion for a minute or two, so as to be perfectly melted and red-hot, the proof is suffered to cool: it may then be taken off the coal, and being laid upon the steel-plate, (Sect. xi. n.) the silver is separated from the slag by one or two strokes of the hammer (Sect. xi. g.). Here the use of the iron ring (Sect. xi.) is manifest, for this ought first to be placed upon the plate, to hinder the proof from flying off by the violence of the stroke, which otherwise would

* A piece of gold being laid over the proof, to receive the fumes, readily discovers if it contains any quick-silver. And it is probable, that by like processes, we may also be enabled to discover with the Blow-pipe other of the volatile substances.

happen. The silver is then found inclosed in the slag of a globular form, and quite shining, as if it were polished. When a large quantity of silver is contained in a lead ore, viz. in a potter's ore, it can likewise be discovered through the use of the blowpipe, of which more will be mentioned hereafter. (Sect. xxxix.)

S E C T. XXXV.

Of the pure Tin ores, the tin may be melted out in its metallic state. Some of these ores melt very easily, and yield their metal in quantity, if only exposed to the fire by themselves: but others are more refractory, and as these melt very slowly, the tin, which sweats out in form of very small globules, is instantly burnt to ashes, before these globules have time to unite, in order to compose a larger globe, which might be seen by the eye, and is not so soon destroyed by the fire; it is therefore necessary to add a little borax to these from the beginning, and then to blow the flame violently at the proof. The borax does here preserve the metal from being too soon calcined, and even contributes to the readier collecting of the small metallic particles, which soon are seen to form themselves into a globule of metallic tin at the bottom of the whole mass, nearest to the charcoal. As soon as so much of metallic tin is produced, as is sufficient to convince the operator of its presence, the fire ought to be ceased; although not the whole of the ore is yet melted; because seldom, or rather never, the whole of this kind of ore can be reduced into metal by means of these experiments, a great deal thereof always being calcined: and if the fire is continued too long, perhaps even the metal, already reduced, may likewise be burnt to ashes: for the tin is very soon destroyed from its metallic state by the fire.

S E C T. XXXVI.

Most part of the lead ores may be brought to a metallic lead upon the charcoal. The *Mineræ plumbi calciformes*, which are pure, are easily melted into lead : but such of them, as are mixed with an *ochra ferri*, or any kind of earth, as Clay, Lime, &c. yield very little of lead, and even nothing at all, if the heterogenea are combined therewith in any large quantity : this happens even with the *Minera plumbi calciformis arsenico mixta*. These, therefore, are not to be tried but in larger laboratories. However, every mineral body suspected to contain any metallic substance, may be tried by the blow-pipe, so as to give sufficient proofs, whether it contains or not, by its effects being different from those of the stone or earths, &c.

S E C T. XXXVII.

The *Mineræ plumbi mineralisatæ*, leave the lead in a metallic form, if not too large a quantity of iron is mixed with it. For example, when a tessellated or steel-grained lead ore is exposed to the flame, its sulphur, and even the arsenic, if there be any, begins to fume, and the ore itself immediately to melt into a globular form ; the rest of the sulphur continues then to fly off, if the flame is blown slowly upon the mass, instead of that, very little of the sulphur will go off, if the flame is forced violently on it : in this case, it rather happens that the lead itself crackles and dissipates, throwing about very minute metallic particles. The sulphur being driven out, as much as possible, which is known by finding no sulphureous vapour in smelling at the proof, the whole is suf-
fered

ferred to cool, and then a globule of metallic lead will be left upon the coal. If any iron is contained in the lead ore, the lead, which is melted out of it, is not of a metallic shining, but rather of a black and uneven surface: a little borax must in this case be melted with it, and as soon as no bubble is seen to rise any longer from the metal into the borax, the fire must be discontinued: when the mass is grown cold, the iron will be found scorified with the borax, and the lead left pure, and of a shining colour.

S E C T. XXXVII.

The borax does not scorify the lead in these small experiments, when it is pure: if the flame is forced with violence on it, a bubbling will ensue, resembling that which is observed when borax dissolves a body melted with it, but when the fire ceases, the slag will be perfectly clear and transparent, and a quantity of very minute lead particles will be seen spread about in the borax, which have been torn off from the mass during the bubbling.

S E C T. XXXIX.

If such a lead ore (Sect. xxxvii.) is rich in silver, this last metal may likewise be discovered by this experiment; because, as the lead is volatile, it may be forced off, and the silver remain. To effect this, the lead, which is melted out of the ore, must be kept in constant fusion with a slow heat, that it may be consumed. This end will be sooner obtained, and the lead part quicker, if, during the fusion, the wind through the Blow-pipe is directed immediately, though not forcibly, upon the melted mass itself, until it begins to cool, then the fire must be directed on it again. The lead, which

is already in a volatilising state, will by this artifice be driven out in form of a subtil smoke; and by thus continuing by turns, to melt the mass, and then to blow off the lead, as has been said, until no smoke is any longer perceived; the silver will at last be obtained pure. The same observation holds good here also, which was made about the gold, that, as none but very little bits of the ores can be employed in these experiments, it will be difficult to extract the silver out of a poor ore; for some part of it will fly off with the lead, and, what might be left, is too little to be discerned by the eye. The silver, which, by this means is obtained, is easily distinguished from lead by the following external marks, viz. that it must be red-hot, before it can be melted: it cooles sooner than lead: it has a silver colour; that is to say, brighter and whiter than lead: and is harder to beat with the hammer. (Sect. xxxiv.)

S E C T. XL.

The *Mineræ cupri calciformes*, (at least some of them) when not mixed with too much stone or earth, are easily reduced to copper with any flux: if the copper is found not to have its natural bright colour, it must be melted with a little borax, which purifies it. Some of these ores do not at all discover their metal, if not immediately melted with borax; the heterogenea, contained in them, hindering the fusion, before these are scorified by the flux.

S E C T. XLI.

The grey Copper ores, which only consist of copper and sulphur, are tried almost in the same manner, as above-mentioned. (Sect. xl.) Being exposed

exposed to the flame by themselves, they will be found instantly to melt, and part of their sulphur to go off; the copper may afterwards be obtained in two ways: the one, by keeping the proof in fusion for about a minute, and after suffering it to cool; when it will be found to have a dark and uneven appearance externally, but which, after being broke, discovers the metallic copper of a globular form in its centre, surrounded with a regule, which still contains some sulphur and a portion of the metal: the other, by being melted with borax, which last way sometimes makes the metal appear sooner.

S E C T. XLII.

The *Mineræ cupri pyritacæ*, containing copper, sulphur, and iron, may be tried with the blow-pipe, if they are not too poor: in these experiments the ore ought to be calcined, and, after that, the iron scorified. For this purpose a bit of the ore must be exposed to a slow flame, that as much of the sulphur as possible may part from it, before it is melted, because the ore commonly melts very soon, and then the sulphur is more difficult to drive off. After being melted, it must be kept in fusion with a strong fire, for about a minute, that a great part of the iron may be calcined: and, after that, some borax must be added, which scorifies the iron, and turns with it to a black slag. If the ore is very rich, a metallic copper will be had in the slag, after the scorification: if the ore is of a moderate richness, the copper will still retain a little sulphur, and sometimes iron: the product will therefore be brittle, and must with great caution be separated from the slag, that it may not break into pieces; and if this product is

afterwards treated in the same manner as before said, in speaking of the grey copper-ores (Sect. xli.), the metal will soon be produced. But, if the ore is poor, the product after the first scorification must be brought into fusion, and afterwards melted with some fresh borax, in order to calcine and scorify the remaining portion of iron; after which it may be treated as mentioned in Sect. xli. The copper will, in this last case, be found in a very small globule.

S E C T. XLIII.

The copper is not very easily scorified with this apparatus, when it is melted together with borax; unless it has first been exposed to the fire by itself for a while, in order to be calcined. When only a little of this metal is dissolved, it instantly tinges the slag of a reddish brown colour, and mostly opaque; but as soon as this slag is kept in fusion for a little while, it becomes quite green and transparent: and thus the presence of the copper may be discovered by the colour, when it is concealed in heterogeneous bodies, so as not to be discovered by any other experiment.

S E C T. XLIV.

If metallic copper is melted with borax by a slow fire, and only for a very little time, the glass, or slag, becomes of a fine transparent blue or violet colour, inclining more or less to the green; but this colour is not properly owing to the copper, but it may rather be to its phlogiston; because the same colour is to be had in the same manner from iron: and these glasses, which are coloured with either of these two metals, soon lose their colour, if exposed

posed to a strong fire, in which they are made quite clear, and colourless. Besides, if this glass, tinged blue with the copper, is again melted with more of this metal, it becomes of a good green colour, which for a long time keeps unchanged in the fire.

S E C T. XLV.

The iron ores, when pure, can never be melted by themselves, through the means of the blow-pipe alone, nor do they yield their metal, when melted with fluxes, because they require too strong a heat to be brought into fusion; and, as both the ore and the metal itself very soon lose their phlogiston in the fire, and cannot be supplied with a sufficient quantity from the charcoal, so likewise they are very soon calcined in the fire. This easy calcination is also the reason why the fluxes, for instance borax, readily scorify this ore, and even the metal itself. The iron loses its phlogiston in the fire sooner than the copper, it is therefore easier scorified; and this is the principle on which the experiment mentioned in Sect. xlii. is founded.

S E C T. XLVI.

The iron is, however, discovered without much difficulty, although it were mixed but in a very small quantity with heterogeneous bodies. The ore, or those bodies which contain any large quantity of the metal, are all attracted by the loadstone, some without any previous calcination, and others not till after having being roasted. When a clay is mixed with a little iron, it commonly melts by itself in the fire; but, if this metal is contained in a limestone, it does not promote the
 X 2 fusion,

fusion, but gives the stone a dark, and sometimes a deep black colour, which always is the character of iron. A *Minera ferri calciformis pura crystallifata*, is commonly of a red colour: This being exposed to the flame, becomes quite black, and is then readily attracted by the loadstone, which it was not before. Besides these signs, the iron discovers itself, by tinging the slag of a green transparent colour, inclining to brown, when only a little of the metal is scorified; but as soon as any larger quantity thereof is dissolved in the slag, this becomes first a blackish brown, and afterwards quite black and opaque.

S E C T. XLVII.

Bismuth is known by its communicating a yellowish brown colour to borax: and Arsenic by its volatility, and garlick smell. Antimony, both in form of regulus and ore, is wholly volatile in the fire, when it is not mixed with any other metal (except arsenic), and is known by its particular smell; easier to be distinguished, when once known, than described. When the ore of antimony is melted upon the charcoal, it bubbles constantly, during its volatilising.

S E C T. XLVII.

Zinc ores are not easily tried upon the coal (Sect. xxxiii.). But the regulus of zinc, exposed to the fire upon the charcoal, burns with a beautiful blue flame, and forms itself almost instantly into white flowers, which are the common flowers of zinc.

S E C T. XLVIII.

Cobalt is particularly remarkable for giving to the glass a blue colour, which is the zaffre or smalt. To produce this, a piece of cobalt ore must be calcined in the fire (Sect. xxx. xxxi.) and afterwards melted with borax. As soon as the glass, during the fusion, from being clear, seems to grow opaque, it is a sign, that it is already tinged a little; the fire is then to be discontinued, and the operator must take hold with the nippers (Sect. xi. 6.) of a little of the glass, whilst yet hot, and draw it out slowly in the beginning, but afterwards very quick, before it cools, whereby a thread of the coloured glass is procured, more or less thick, on which the colour may easier be seen against the day or candle-light, than if it was left in a globular form. This thread melts easily if only put in the flame of the candle, without the help of the blow-pipe.

If this glass is melted again with more of the cobalt, and kept in fusion for a while, the colour becomes very deep; and thus the colour may be altered, according to pleasure.

S E C T. L.

When the cobalt ore is pure, or at least contains but little iron, a cobalt regulus is almost instantly produced in the borax, during the fusion: but when it is mixed with a quantity of iron, this last metal ought first to be separated, which is easily performed, since it scorifies sooner than the cobalt; therefore, as long as the slag retains any brown or black colour Sect. xlvi. it must be separated,

and melted again with fresh borax, until it shews the blue colour.

S E C T. LI.

Nickel is very seldom to be had, and as its ores are seldom free from mixtures of other metals, it is very difficultly tried with the blowpipe. However, when this semi-metal is mixed with iron and cobalt, it is easily freed from these heterogeneous metals, and reduced to a pure nickel regulus by means of scorification with borax, in the same manner as is mentioned Sect. I. because both the iron and cobalt sooner scorify than the nickel. The regulus of nickel itself is of a green colour, when calcined: it requires a pretty strong fire before it melts, and tinges the borax with a jacinth colour. Manganese gives the same colour to borax, but its other qualities are quite different, so as not to be confounded with the nickel.

S E C T. LII.

Thus I have briefly described the use of the Blow-pipe, and the method of employing it in the study of Mineralogy. Any gentleman who is a lover of this science, will, by attending to the rules here laid down, be able in an easy manner to amuse himself in discovering the properties of those works of nature which the mineral kingdom furnishes us with. The husbandman may by its help find out what sorts of stones, earths, ores, &c. there are on his estate, and to what oeconomic uses they may be employed. The Scientific Mineralist may, by examining into the properties and effects of the mineral bodies, discover the natural
relation

relation these bodies stand in to each other, and thereby furnish himself with materials for establishing a Mineral System, founded on such principles as Nature herself has laid down in them; and this in his own study, without being forced to have recourse to great laboratories, crucibles, furnaces, &c. which is attended with a great deal of trouble, and is the reason why so few can have an opportunity of gratifying their desire of knowledge in this part of natural history. I do not pretend to say, that the Pocket-Laboratory here described, is in every respect as perfect as it is capable of being made: and I have in the foregoing pages indicated some instances where it is not sufficient; yet those instances are very few. Besides, the short time since it has been invented, and the few persons that have known how to make use of it, are a sufficient apology for its not being brought to the utmost degree of perfection. It is to be hoped, that the more general its use be made, the more and sooner will such imperfections be removed, and such wants filled up, as will be found necessary and convenient. I shall now add some hints towards these improvements, leaving to the judicious practitioner the manner of completing them.

S E C T. LIII.

A greater number of fluxes might, perhaps, be found out, whose effects on mineral bodies might be different from these already in use, whereby more distinct characters of those mineral bodies might be discovered, which now either shew ambiguous ones, or which are almost impossible to try exactly with the Blow-pipe. Instead of the *sal jodæ*, some other salts might be found out, more fit for these experiments. But it is very necessary

not to make use of any other fluxes than such as have no attraction to the charcoal: if they, at the same time, are clear and transparent, when melted, as the borax and the *sal fusibile microcosmicum*, it is still better: however, the transparency or opacity are of no great consequence, if a substance is essayed only in order to discover its fusibility, without any attention to its colour; in which case, some metallic slag, perhaps, might be useful.

S E C T. LIV.

When such ores are to be reduced whose metals are very apt to calcine, such as tin, zinc, &c. it might perhaps be of service to add some phlogiston, since the charcoal cannot afford enough of it in the open fire of these essays: such a phlogiston might be the hard resin, or some such body. The manner of melting the volatile metals out of their ores *per descensum* might also, perhaps, be imitated: for instance, a hole might be made in the charcoal, wide above, and very narrow at the bottom; a little piece of the ore being then laid at the upper end of the hole, and covered with some very small pieces of the charcoal, the flame must be directed on the top: the metal might, perhaps, by this method gather in the hole below, concealed from the violence of the fire, particularly if the ore is very fusible, &c.

Several of my experiments have indeed induced me to believe the possibility of these improvements; but as I have not yet had an opportunity of bringing them to perfection, I will not deliver them as infallible: these hints are only communicated as an inducement to farther experience.

S E C T. LV.

The use of the Pocket-Laboratory, as here described, is chiefly calculated for a travelling mineralist. But a person who is always residing at one and the same place, may by some small alteration make it more commodious to himself, and avoid the trouble of blowing with the mouth. For this purpose he may have the Blow-pipe go through a hole in a table, and fixed underneath to a small pair of bellows with double bottoms, such as some of the glass-blowers use, and then nothing more is required, than to move the bellows with the feet during the experiment; but in this case a lamp may be used instead of a candle. This method would be attended with a still greater advantage, if there were many such parts as fig. 3. tab. 1. the openings of which were of different dimensions: these parts might by means of a screw be fastened to the main body of the Blow-pipe, and taken away at leisure. The benefit of having these nozzles, if I may be permitted to call them so, of different capacities at their ends, would be that of exciting a stronger or weaker heat as occasion might require. It would only be necessary to observe, that in proportion as the opening of the pipe (nozzle) is enlarged, the quantity of the flame must be augmented by a thicker wick in the lamp, and the force of blowing increased by means of weights laid on the bellows. A much intenser heat would thus be procured by a pipe of a considerable opening at the end, by which the experiments might undoubtedly be carried farther than with the common Blow-pipe.

S E C T. LVI.

A traveller, who has seldom an opportunity of carrying many things along with him, may very well be contented with this Pocket-Laboratory, and its apparatus, which is sufficient for most part of such experiments as can be made on a journey. There are, however, other things very useful to have at hand on a journey, which ought to make a second part of the Pocket-Laboratory, if the manner of travelling does not oppose it: this consists of a little box including the different acids, and one or two matraffes, in order to try the mineral bodies in liquid menstrua, if required.

S E C T. LVII.

These acids are, the Acid of Nitre, of Vitriol, and of Common Salt. Most of the stones and earths are attacked, at least in some degree, by the acids; but the calcareous are the easiest of all to be dissolved by them, which is accounted for by their calcareous properties. The acid of nitre is that which is most used in these experiments; it dissolves the limestone, when pure, perfectly, with a violent effervescence, and the solution becomes clear: when the limestone enters into some other body, it is nevertheless discovered by this acid, through a greater or less effervescence in proportion to the quantity of the calcareous particles, unless these are so few, as to be almost concealed from the acid by the heterogeneous ones. In this manner, a calcareous body, which sometimes nearly resembles a siliceous or argillaceous one, may be known from these latter, without the help of the Blow-pipe, only by pouring one or two drops of this acid
upon

upon the subject; which is very convenient when there is no opportunity, nor time, of using this instrument.

S E C T. LVIII.

The Gypsa, which consist of lime and the vitriolic acid, (Sect. xviii. 12.) are not in the least attacked by the acid of nitre, if they contain a sufficient quantity of their own acid, because the vitriolic acid has a stronger attraction to the lime, than the acid of nitre: but if the calcareous substance is not perfectly saturated with the acid of vitriol, then an effervescence arises with the acid of nitre, more or less in proportion to the want of the vitriolic acid. These circumstances are often very essential in distinguishing the *calcarei* and *gypsa* from one another.

S E C T. LIX.

The acid of nitre is likewise necessary in trying the zeolites, of which some species have the singular effect to dissolve with effervescence in the abovementioned acid; and within a quarter of an hour, or even sometimes not until several hours after, to change the whole solution into a clear jelly, of so firm a consistence, that the glass, wherein it is contained, may be reversed, without its falling out.

S E C T. LX.

If any mineral body is tried in this menstruum, and only a small quantity is suspected to be dissolved, though it was impossible to distinguish it with the eye during the solution, it can be easily discovered
by

by adding to it *ad saturitatem* a clear solution of an alkali, when the dissolved part will be precipitated, and fall to the bottom. For this purpose the *sal sodæ* (Sect. xx.) may be very useful.

S E C T. LXI.

The acid of nitre will suffice for making experiments upon stones and earths; but if the experiments are to be extended to the metals, the other two acids (Sect. lvii.) are also necessary. As the acids are very corrosive, they must not be kept in the ordinary Pocket-Laboratory, already described, for fear of spoiling the other apparatus, if the stoppers should happen not to fit exactly to the necks of the bottles, and some of the acid should be split.

S E C T. LXII.

I have a separate box, which is eight inches and three quarters long, four inches broad, and five inches high. In this box are three long and narrow bottles, containing the acids, placed upright at one end of it, two glass matrasses laid horizontally in the upper part, and a little drawer underneath, made on purpose to fill the empty room below the matrasses, and to give the box a regular form; and as charcoal is not every where to be met with in travelling, I always have a piece in this drawer for the use of the Blow-pipe.

S E C T. LXIII.

In order to keep the acids more close in the bottles, since the glass-stopper is not always sufficient, I have a glass-cover besides, made so, as to screw round
round

round the neck of the bottle; and if this is nicely made, nothing can come through, though the box be inclined, or even reversed, which sometimes may happen. The natural form and bigness of the glass matrasses is seen tab. 1, fig. 4. They ought to be very thin at the bottom, that they may not crack, by being suddenly put over the fire, or taken off it. In these matrasses solutions may very easily be made over the flame of a candle: every mineral body capable of being affected by the acids in this degree of heat, may here be dissolved, and particularly the metals. As the management in these processes is the same as in ordinary laboratories, of which we have ample descriptions in several books, it is not necessary to copy them here, my intention being only to describe an easy way of making experiments upon mineral bodies, which has not before been published; in explaining of which I nevertheless have been forced now and then to mention something that more properly belongs to Mineralogy.

S E C T. LXIV.

Another instrument is likewise necessary to a complete Pocket-Laboratory, viz. a Washing-trough, in which the mineral bodies, and particularly the ores, may be separated from each other, and from the adherent rock, by means of water.

This trough is very common in the laboratories, and is used of different sizes; but here only one is required of a moderate size, such as twelve inches and a half long, three inches broad at the one end, and one inch and a half at the other end, sloping down from the sides and the broad end to the bottom, where it is three quarters of an inch deep: I have given a figure of it in tab. 1. fig. 5. It is com-

commonly made of wood, which ought to be chosen smooth, hard and compact, wherein are no pores in which the minute grains of the pounded matter may conceal themselves.

It is to be observed, that if any such matter is to be washed, which is suspected to contain some native metal, as silver or gold; a trough should be procured for this purpose, of a very shallow slope, because the minute particles of the native metal have then more power to assemble together at the broad end, separate from the other matter.

S E C T. LXV.

The management of this trough, or the manner of washing, which I suppose to be known before, consists chiefly in this: That when the matter is mixed with about three or four times its quantity of water in the trough, this is kept very loose between two fingers of the left hand, and some light strokes given on its broad end with the right, that it may move backwards and forwards, by which means the heaviest particles assemble at the broad and upper end, from which the lighter ones are to be separated by inclining the trough and pouring a little water on them. By repeating this process, all such particles as are of the same gravity may be collected together, separate from those of a different gravity, provided they all were before equally pounded; though such as are of a clayish nature, are often very difficult to separate from the rest, which, however, is of no great consequence to a skilful and experienced washer. The washing process is very necessary, as there are often rich ores, and even native metals, found concealed in earths and sand in so minute particles, as not to be discovered by any other means.

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A N

ALPHABETICAL TABLE

OF DIFFERENT

M I N E R A L S,

WITH THE

SWEDISH and GERMAN Names added thereto,

For rendering more easy the Knowledge of *Mineralogy* ;
 a Subject treated of by some Writers, who make Use
 of several original Terms taken from those Two Lan-
 guages.

A CIDS, (mineral) *Sw.* Mineraliska Syror ; *Germ.* Saure-
 Saltz ; or Mineralische-Sauron. Section 120.

Acid of common salt, *Sw.* Kok-salt-fyra ; *Germ.* Koch-
 saltz-faure. Sect. 127. Vid. Vitriolic.

Agates. The irregular nodules in which they are found,
 are called *Amorphi*, Page 69, in the note.

Argillacea (terra) *Sw.* Ler-arter ; *Germ.* Thon-arten. Sect. 77.

Alabastrites, *Sw.* Strat-gips. Sect. 17.

Alkali, (*Sal*) *Sw.* Alcaliska.

Alkali of the Sea, *Sw.* Haf's Salt's Alkali. Sect. 136.

Alkaline mineral salts, *Germ.* Mineralische-laugen Salter.
 Sect. 135.

Alum, *Sw.* Alun ; *Germ.* Alaun.

Common Alum ore, *Sw.* Vanlig alum malm ; *Germ.* Ge-
 mines alaun erts. Sect. 124. C.

Alum like Vitriol, *Germ.* Galitzenstein. Sect. 231, p. 219.

Alumen plumosum, *Sw.* Gedigen-alun ; *Germ.* Fieder-alaun,
 or Gediegner-alaun. Sect. 124, B. 2. a.

Minera aluminis alba, *Sw.* Hvit-alun malm ; *Germ.* Weifes
 alaun erts.

Y

Amber

Amber, *Szw.* Ambra.

Amber Succinum, *Szw.* Bernsten. Sect. 133.

Ammoniacum fixum Naturale (Sal) *Szw.* Salt-aska. Sect. 21.

Amygdaloides, *Szw.* Mandelsten. Sect. 268.

Antimony, *Szw.* Spits glas; *Germ.* Spies glas. Sect. 232.

Crude antimony, *Szw.* Skiersten. Sect. 237.

Aphronitrum, *Szw.* Mur-salt; *Germ.* Mauer-saltz. Sect. 137.

Arsenic, *Szw.* and *Germ.* Arsenik.

Arsenic iron ore, *Szw.* Mispickel. Sect. 114.

Native Arsenic, *Germ.* Scherben cobolt, and Fliegenstein.
Sect. 239.

Native Arsenic with shining fissures, *Germ.* Spiegel Cobolt.
Sect. 239. C.

Yellow Arsenic, *Szw.* Orpement; *Germ.* Auripigment. Sect.
241.

Realgar mineralis, *Germ.* Gediegen Rauschgelb. Sect. 241.

Arsenicum ferro sulphurato mineralisatum, *Szw.* Gift-kies; *Germ.*
Rauschgelb kies.

A ste of an imperfect kind, *Szw.* Galtfnas, Sad Slag, Brinda.
See the Note at p. 82.

Asbestos membranaceus, *Szw.* Berg Lader, and Berg Kiot;
Germ. Berg Fleisch. Sect. 103. A.

Suber montanum, *Szw.* Berg Kork. Sect. 104. B.

Earth Flax, *Szw.* Berglin; *Germ.* Berg Flachs, Sect. 105. A.

Broken earth flax, *Szw.* Sad Slaglin. Sect. 106.

Basaltes, *Szw.* Skiorl; *Germ.* Schirl; Saulenstein. Sect. 72.

Sparry Basaltes, *Szw.* Skiorl-spat. Sect. 73.

The Pin-ore Basaltes, *Szw.* Gran-ris-malm. Sect. 74. a.

Shirl with concentrated fibres, *Szw.* Stiern slag. Sect. 74. b.

Bismuth, *Szw.* Akbly, Vismut; *Germ.* Wismuth. Sect. 221.

Flowers of Bismuth, *Szw.* Vismut blute, Sect. 223.

Bismuth mineralised with sulphur, *Szw.* Vismut glans. Sect.
224. n. 1.

Blac-lead, *Szw.* Blyerts; *Germ.* Bleyerts, Wafferbly. Sect. 154.

Blood-stone. See Iron.

Bog-ores, *Szw.* Siòmalm; *Germ.* Suerts and Sumpferts. Sect. 202.

Bole, *Szw.* Iern Lera; *Germ.* Eifenthon. Sect. 85.

Indurated Bole, *Szw.* Flets-malm. Sect. 87.

Terra rubrica, *Szw.* Rod-krita; *Germ.* Rothel Kreida. Sect. 86:

Slaty Bole, *Szw.* Skifver Lera. Sect. 87.

Of Scaly Particles, *Szw.* Hornblende. Sect. 88.

Bononian stone, *Szw.* Bononisk-spat; *Germ.* Bologneser-spat.
Sect. 18. A.

Cæruleum montanum, *Szw.* Bergblott; *Germ.* Bergblau. Sect. 194.

Calcareous earths, *Szw.* and *Germ.* Kalk-arten. Sect. 4.

Phlogistum

- Pblogistum minerale terrâ calcareâ imbutum*, Sw. Orsten. Sect. 157. See Limestone.
- Calcedony, Sw. Calcedon. Sect. 57.
- Call, *Germ.* Wolfram, p. 84. in the Note. and p. 125. Note.
- Catt's Eye, Sw. Kattoga; *Germ.* Kazen auge. Sect. 55. C.
- Chalk, Sw. Krita; *Germ.* Kreide. Sect. 7.
- Chert, *Germ.* Hornstein. Sect. 64.
- Cinnabaris Nativa*, Sw. Berg Cinnober, Sect. 218.
Solid Cinnabar, Sw. Fast-cinnober. Sect. 218. b.
- Cineres Vulcanorum*, Sw. Slagg-sand; *Germ.* Slagg-aska. Sect. 299.
- Clay, Sw. Lera. Sect. 78.
Porcelain Clay, Sw. Porcelin's-lera, Eld-fast-lera; *Germ.* Porcelain-thon, Feuer-bestandiger-thon. Sect. 78.
- Common Clay, Sw. Gement-lera; *Germ.* Gemeiner-thon. Sect. 90.
- Red Clay, Sw. Rod-lera, and Alfwarmo. Sect. 90. A. a.
- Blue Clay, Sw. Bla-lera. Sect. 9. A. d.
- White Clay, Sw. Biorklera. Sect. 90. A. e.
- Fermenting Clay, Sw. Gas-lera, and Wefa; *Germ.* Brau-fethon. Sect. 90. A.
- Fermenting Clay mixed with gravel, Sw. Stenwefa. Sect. 90. A. f.
- Grey Slaty Clay, Sw. Gra ler Skifver. Sect. 91. n. 1. a.
- Red Slaty Clay, Sw. Rod ler Skifver. Sect. 91. n. 1. b.
- Lime Clay, Sw. Mergel Skifver. Sect. 91. n. 3.
- Pipe Clay, Sw. Pip-lera, and Colnisk-lera. Sect. 78. A. 2. a.
- Clefts, or Veins of unctuous Clays, Sw. Flott-loffnor, as p. 71. line 17.
And when they are too close one to another, Sw. *Skiolige*, as in the Note to Sect. 80.
- Coal, Sw. Stenkol; *Germ.* Steinkohle. Sect. 158.
Stone-Coal, Sw. Brand Skifver. Sect. 160.
Metallic Coal, Sw. Kolmalm; *Germ.* Brand erts. Sect. 161.
When the Coal has some vitriolic acid, it is called in Sw. Kolm. Sect. 159.
- Coarse, Sw. Grof.
- Coat, or Crust, Sw. Kaper.
- Cobalt, Sw. and *Germ.* Kobolt. Sect. 246.
Minera Cobalti vitrea, Sw. Schlacken Kobolt. Sect. 247. b.
Flowers of Cobalt, Sw. Kobolt blute, or Beslag. Sect. 248.
Shining Cobalt, Sw. Glans Kobolt. Sect. 249. d. 2.
- Common, Sw. Kok.
- Copper, Sw. Kopper; *Germ.* Kupfer. Sect. 192.
Grey copper ore, *Germ.* Graues Kupfererts. Sect. 197.
Glass copper ore, *Germ.* Kupfer lebererts. Sect. 195.

Pyrites cupri, Sw. Gul Kopper malm ; Germ. Fahl Kupfererts. Sect. 198.

Liver brown copper ore, Sw. Kopper lazur. Sect. 198.

Cross-stone, or *Lapis cruciferus*, Germ. Basler Taufstein. Sect. 75.

Crystallus montana, Sw. Berg-kryftall. Sect. 52.

Rhomboidal crystals, Sw. Mossgrufvan. Sect. 66.

Pebble crystal, Sw. Wattn-kryftall. Sect. 53, in the note.

Crust, or Coat, Sw. Kaper.

The crust which covers the agates, Sw. Agate-gall.

Decomposing away, or weathering, Sw. Witring.

Diamond, Sw. Diamant. Sect. 42.

Dusk, or Dark, Sw. Fluff. ver. gr. Amethyst fluss.

Earths in general, Sw. Jord-arter ; Germ. Erd-arten. Sect. 3.

English earth, or *Cologne Clay* of Sect. 78, Sw. Engelsk-jord.

Emerald, Sw. Smaragd. Sect. 48.

Emery, Sw. Smergel ; Germ. Smirgel. Sect. 113. n. 2.

Flint, Sw. Kifel flinta ; Germ. Hornstein. Sect. 54.

Siliceous earth, Sw. Kifel-arter ; Germ. Kiesel-arten. Sect. 40.

Common flint, Sw. Bosse-flinta ; Germ. Teverstein. Sect. 61.

Small Flints and pebbles for ballast, Sw. Singel. Sect. 62.

Chert, Sw. Helleflinta ; Germ. Hornstein. Sect. 63.

Flos ferri, Sw. Eischblute, and Eisenblute. See Iron.

Fluor of a polygonal form, Sw. Slag. Sect. 99. No. 13.

Fluors in general, Sw. and Germ. Flufs. Sect. 97.

Fullers earth, Sw. Walksfera. Sect. 84. A.

Fusible, Sw. Quicka.

Fusible rock, Sw. Quicksten.

Garnet (coarse) Sw. Granat-berg. Sect. 69. A. 1.

Glacies Mariæ, Sw. Marien-glass. Sect. 18.

Gold, Sw. Guld.

Native gold, Sw. Gediget-guld ; Germ. Gewachsen gold. Sect. 165.

Leaved gold, Sw. Angefloget-guld. Sect. 165. n. 1.

Solid gold, Sw. Massiot-guld. Sect. 165. n. 2.

Gold in a crystalline figure, Sw. Drufigt-guld. Sect. 165. n. 3.

Gold dust, Sw. Wask-guld. Sect. 165. n. 4.

Gold mineralised with mercury and silver, Sw. Guldsk-cinnober. Sect. 166. c.

Gold mineralised with silver, zink, and iron, Sw. Schemnizer-blende, Germ. Kiegelerts.

Grains, Sw. Graupe.

Granite,

Granite, *Sw.* Graberg, and Graften. Sect. 270.

Loose granite, *Sw.* Gintsten. Sect. 270.

Gypseous earth, *Sw.* Gur, or Kimmels-miol. Sect. 14.

Gypsum, *Sw.* Gips. Sect. 13.

CrySTALLISED gypsum. *Sw.* Gips-drufer. Sect. 19.

Wedge-formed ditto, *Sw.* Gips-viggar; *Germ.* Gips-keile, p. 26. *A.*

Stalactitical gypsum, *Sw.* Gips-finter; *Germ.* Gipsa-nigertropfstein. Sect. 20. See Plaster.

Hæmatites. See Iron-ore.

Holes of Drusen-spars, *Sw.* Drake. Sect. 11, note.

Humus. See Mould.

Iceland Agate, *Sw.* Islands agat; *Germ.* Glas agat. Sect. 295.

Iron, *Sw.* Iern; *Germ.* Eisen. Sect. 201.

Iron ore in grains, *Sw.* Smamalm. Sect. 202.

Ditto in lumps, *Sw.* Orkes. Sect. 202.

Scaly ditto, *Sw.* Iern glimmer; *Germ.* Eisenman. Sect. 203.

Cellular ditto, *Sw.* Kist formig. Sect. 203. *e.* 3.

White ditto, *Germ.* Sthalstein, and Weisses Eiseners. Sect. 30.

Cellular calcareous iron ore, *Sw.* Kist formig. Sect. 33. 4, *b.* 2.

• Iron sand ore, *Sw.* Iern sand malm.

White sparlike iron, *Sw.* Hvit Iern malm. Sect. 30.

Black iron ore, *Sw.* Svart Iern malm. Sect. 111. *b.*

Cold short iron, *Sw.* Kall breckt. Sect. 215.

Red Short, *Sw.* Rod breckt. Sect. 215.

Tough iron, *Sw.* Enfuidt. Sect. 215.

Iron which wants no admixture, *Sw.* Sielf gangande. Sect. 215.

Flos ferri, *Germ.* Eisenblute. Sect. 33. *b.* *n.* 2.

Martial jasper, *Sw.* Iernig jaspis, Sect. 64.

Hæmatites, *Germ.* Blutstein. Sect. 203.

Fibrous hæmatites, *Sw.* Torrsten.

Hæmatites nigrescens, *Sw.* Svart glas kopf Sect. 204.

Scaly red hæmatites, *Germ.* Eisenram. Sect. 205. *b.*

Blood-stone, *Sw.* Blod sten Sect. 203.

Red blood stone, *Sw.* Rod glas kopf. Sect. 205.

Iron ore in form of solid balls, *Sw.* Purle malm. Sect. 202.

Ditto in form of porous balls, *Sw.* Skragg malm. Sect. 202.

Ditto in flat cakes, *Sw.* Penninge malm. Sect. 202.

Oebra ferri, *Sw.* Iern okra. Sect. 202. 1.

Bog ore, *Sw.* Siomalm; *Germ.* Suertes, and Sumpferts. Sect. 202. 2.

Islandicum spatum. Vid. Spatum.

- Lac Lunæ*, Sw. Bleke. Sect. 5.
Lapis cruciferus. See Cross-stone.
Lapis ollaris, Sw. Telgsten. Sect. 80, and 265.
Lapis fuillus, Sw. Orsten; Germ. Saustein, and Stink-stein. Sect. 23.
Larvæ, or petrifications, Sw. Vandlingar; ver. gr. *Terræ larvata*, Jord Vandlingar.
 In chalk, Sw. Kalk Vandlingar.
 Ditto in flint, Sw. Flint vandlingar, &c. Sect. 272, and 281.
 Lead, Sw. Bly; Germ. Bley. Sect. 184.
Cerusa nativa, Sw. Bly okra; Germ. Bley ocher. Sect. 185.
 Lead Spar, Sw. Bly spat.
 Blue Potter's ore, Sw. Bly glans, and Bly scheweif; Germ. Bley glantz, and Bley scheweiff.
 Steel grained lead, Sw. Bly stal malm. Sect. 188.
 Sparkling ditto, Sw. Skigg malm. Sect. 188.
 Lead ore with sulphurated iron and silver, Sw. Iernhaltig bly glans. Sect. 189.
 Ditto with antimony and sulphur, Sw. Strip malm; Germ. Striputs.
 Limestone, Sw. Kalksten; Germ. Kalkstein. Sect. 9.
 Coarse grained ditto, Sw. Salt Slag. Sect. 8.
 White Limestone, Sw. Kritsten.
 Common Limestone, Sw. Telgsten, or Alfvarsten, or Oelandsten.
 Scaly Limestone, Sw. Limsten, and Limberg. Sect. 9.
 White and green, Sw. Storghufvan.
 White and black, Sw. Herr stens bottn.
 Liver-stone, Sw. Lefversten; Germ. Leberstein. Sect. 18. n. 3.
 Load-stone, (coarse and scaly) Sw. Magnetiskt-eissen-glimmer. Sect. 111. d.
Lusus naturæ, or casual figures in minerals, Sw. Stengyckel.
 Manganese ore, or earth, Sw. Brunstens arter; Germ. Braunschweins-arten. Sect. 113.
 Stony manganese, Sw. Brunsten. Sect. 113.
 Marcasite. See Pyrites.
 Marle, Sw. Mergel. Sect. 25.
 Semi-indurated Marle, Sw. Mergel skifver. Sect. 28.
 Stone marle, Sw. Malreka and Necrebrod; Germ. Dukstein or Tophstein.
 Marbles indurated, Sw. Malrekor.
Marmor metallicum, Sw. Tung-spat. Sect. 18.
 Marrow (stone) Sw. Sten merg; Germ. Stein mergel. Sect. 84.
 Stone marrow like soap, Sw. Keffekil. Sect. 84.
 Martial earth (bricks made of) Sw. Water klinkert. Sect. 83.
 Martial soap rock, Sw. Iern holtig specr'sten. Sect. 83.

Metals.

Metals, *Sw.* Metaller; *Germ.* Metalle.

Mica, and Micaceous, *Sw.* and *Germ.* Glimmer.

Large plates of Mica, *Sw.* Chludna and Rufs glas; *Germ.*
Ruffisch glas.

Small plates of mica, *Sw.* Kattfilfver; *Germ.* Kazen filber.

Crumpled mica, *Sw.* Talc. Sect. 94.

Mica Drufica, *Sw.* Talc Drus. Sect. 95.

Mica squamosa martialis, *Sw.* Kattgull.

Crumpled mica martialis, *Sw.* Wrefig-glimmer. Sect. 95.

Mineral, *Sw.* Mineraliska.

Mock-lead, *Sw.* Wolfram.

Mountain blue, *Sw.* Berg blot; *Germ.* Berg-blau. Sect. 34.

Mountains, *Sw.* Fiell.

Mould, *Sw.* Mylla.

Black mould, *Sw.* Mat jord; *Germ.* Sumpfende, and Stan-
berde. Sect. 293.

Humus animalis, *Sw.* Diur jord; *Germ.* Thiererde.

Humus conchaceus, *Sw.* Sneck mylla.

Humus lacustris, *Sw.* Dy. Sect. 293. b. 2.

Humus vegetabilis, *Sw.* Vext-mylla, and Vext-jord. See
Turf.

Naphta, *Sw.* Berg-balsam. Sect. 148.

Native, *Sw.* Naturligt, and Gediget.

Nickel mineralised, *Sw.* Kupfernichel. Sect. 252.

Ochre. See Iron.

Ollaris. Vid. Lapis Ollaris.

Ore, *Sw.* Malm.

Opal, *Sw.* Elementsten. Sect. 55.

Pea-stone, *Germ.* Sprudelstein. Sect. 12. 1. a. 1.

Pebbles (loose) *Sw.* Kislar

Pearl slag, *Sw.* Perle slag. Sect. 298.

Petrificata, *Sw.* Petrificater; *Germ.* Verfeinerungen.

Petroleum, *Sw.* Berg-olia; *Germ.* Berg-ol. Sect. 147.

Phlogista mineralia, *Sw.* Jord fettmor; *Germ.* Erd-harze.
Sect. 144.

Pipe-clay, *Sw.* Pip-lera. Sect. 86. and 95.

Pitch rock oil, *Sw.* Berg tiera; *Germ.* Berg thear. Sect. 149.

Pix montana, *Sw.* Berg beck; *Germ.* Berg pech. Sect. 150.

Plaster stone (common) *Sw.* Gips-sten. Sect. 16.

Loose plaster, or in powder, *Sw.* Gur, or Himmels-miol.
See Gypsum.

Plum-pudding stone, *Sw.* Kisel breccia. Sect. 273.

Porcelana (terra) *Germ.* Porcelain thon, and Feuer-bestandi-
ger-thon. Sect. 78.

Porphyry,

- Porphyry, *Szw.* Porphyr. Sect. 266.
 Powder, [impalpable slime] *Szw.* Slamm. Sect. 5. and p. 14.
 N. *.
Pumex, *Szw.* Pims-sten; *Germ.* Bims-stein. Sect. 297.
 Pyrites, *Szw.* and *Germ.* Kies
 Pale yellow ditto, *Szw.* Blekel-gul-svafvel kies. Sect. 152.
 Liver-coloured ditto, *Szw.* Wattn kies; or, Tenbett
 lefver slag. Sect. 153.
 Copper and iron marcasite, *Germ.* Kupfer kies. Sect. 155.
 Quartz, *Szw.* Katt flinta, and Hvit flinta. Sect. 50.
 Rhombic quartz, *Szw.* Felt-spat. Sect. 66.
 Iron ore with quartz, *Szw.* Torrsten. Sect. 77. Note.
 Grained quartz, *Szw.* Torrquartz.
 Quick-silver, *Szw.* Queck-silber.
 Red, *Szw.* Rod.
 Refractory, *Szw.* Torra.
Regulus, *Szw.* Skiersten.
 Rich copper *Regulus*, *Szw.* Trotsten.
 Rhenish mill-stone, *Szw.* Renlandsk Quarnten. Sect. 296.
 Rock-stone, *Szw.* Stellstén.
 A kind of Rocks spoken of in Sect. 39. *Szw.* Graberg.
 Rocks, (high) *Szw.* Fiell.
 Ruble-stone, *Szw.* Gorsten. Sect. 39.
Rubrica, (*terra*) *Szw.* Rod krita; *Germ.* Rothel kreide. Sect. 86.
 a. 3.
 Ruby, *Szw.* Rubin. Sect. 43.
 Salt, *Germ.* Salz.
Sal fontanum, *Szw.* Kel-falt; *Germ.* Brunnen-falz. Sect. 131.
Sal urinosum, *Szw.* Rot-falt. Sect. 140.
Sal marinum, *Szw.* Haf's-falt; *Germ.* Meer falz. Sect. 130.
Sal montanum, *Szw.* Berg-falt. Sect. 129. B.
Sal commune, *Szw.* Kok-falt.
Sal ammoniacum fixum, *Szw.* Salt-aska; *Germ.* Salz-asche.
 Sect. 128.
Sal ammoniacum naturale, *Szw.* Salmiac. Sect. 132.
 Acid Salts, *Szw.* Sura falter; Sect. 120.
Salia neutra, *Szw.* Medel-falter; *Germ.* Mittel-falze.
 Weak falt-water, *Szw.* Salen. Sect. 131.
 Sand-stones, *Szw.* Sandsten. Sect. 276.
Saxa composita, *Szw.* Sammen-fatte, and Stelle-arter. Sect.
 260.
Saxum compositum ex mica et hornblende, *Szw.* Gronsten.
Saxum compositum ex variorum fragmentis, *Szw.* Stelearts
 breccia.

- Saxa conglutinata*, Sw. Samman gytttrade Stelle arter. Sect. 260. n. 3.
- Saxum compositum micâ et quartz*, Sw. Stelstén. Sect. 262.
- Ditto, *ex micâ, quartz & granato*, Sw. Norrka, and Murksten. Sect. 263.
- Ditto, *ex jaspide martiali molli, seu argilli*, &c. Sw. Trappskiol, or Tegel-skiol, or Swart-skiol, or Blabest; Germ. Schwach, or Schwarts stein.
- Scoriae Vulcanorum*, Sw. Naturliga slager; Germ. Naturliche Schlaken. Sect. 294.
- Serpentine stone, Germ. Serpentin stein. Sect. 81.
- Selenites, Sw. Gips-spar. Sect. 18.
- Semi-metals, Sw. Halfwa-metaller; Germ. Halb metalle.
- Shirl, Sw. Skiorl, and sometimes Wolfram, Note p. 125; Germ. Saulenstein. Sect. 72.
- Coarse shirl, Sw. Skiorl berg.
- Striated shirl, Sw. Strat skiorl. Sect. 74.
- Starred shirl, Sw. Stiern-flag.
- Siliceous. Vid. Flint.
- Silver, Sw. Silfver; Germ. Silber.
- Pure native silver, Sw. Berg flint silfver.
- Capillary silver, Sw. Har silfver.
- Glass silver ore, Sw. Silfver glas; Germ. Glaserts. Sect. 169.
- The goose dung ore, Sw. Ganskotig erts. Sect. 168.
- Red silver ore, Sw. and Germ. Rot gulden. Sect. 170.
- Grey silver ore with antimony, Germ. Leberertz. Sect. 73.
- Horn silver ore, Sw. Hornertz. Sect. 177.
- Silver ore with sulphur, lead, and antimony, Sw. Strip malm; Germ. Stripertz. Sect. 176.
- With sulphur and lead, or Galena, Sw. Bly glans; Germ. Blygantz. See Lead.
- Silver ore in balls, Sw. Kugel erts. Sect. 175.
- With copper, sulphur, and zinc, Sw. Beck blend; Germ. Pech blende. Sect. 175.
- With copper, antimony, and sulphur, Sw. Dalfalertz. Sect. 174.
- Plumose silver, Germ. Feder-ertz. Sect. 163.
- White silver ore, Germ. Weissertz. Sect. 172.
- Black or sooty silver ore, Germ. Ruffigtes ertz, and Silber schwartz. Sect. 171.
- Grey silver ore, Sw. Falerts, and Gra malm. Sect. 171.
- Slate, Sw. Skifver.

- Table slate, *Sw.* Taffel skifver; *Germ.* Tak skifver. Sect. 264.
- Smectis Briançon, *Sw.* Brianzoner krita. Sect. 79.
- Soap rock, *Sw.* Speck stén. Sect. 79.
- Spar, *Sw.* Spat.
- Double refracting spar, or *Spatum islandicum*, *Sw.* Dubbel stén; *Germ.* Doppel stein. Sect. 10.
- Stalactitical ditto, *Sw.* Droppsten, and Skorpsten; *Germ.* Tropfstein, and Rindenstein. Sect. 12.
- Calcareous spar, *Sw.* Kalk spat.
- Fluor spatofus*, *Sw.* Lys-spat. Sect. 99.
- Common spar, *Sw.* Ratfigtig spat. Sect. 10. a. 2.
- Dog's teeth spar, *Sw.* Swin-tender. Sect. 11. b.
- Cockle spar, *Sw.* Skiorl spat.
- Lead spar, *Sw.* Bly-spat.
- Balls of crystallised spar, *Sw.* Spat-klot. Sect. 11.
- Holes filled with drusen spar, *Sw.* Drake-hol. Sect. 11.
- Crystallised spar, *Sw.* Kalk spat druser.
- Selenites, *Sw.* Gips spat.
- Flux spar, *Sw.* Flus spat.
- Spuma Lupi*, *Sw.* Wolfran. See Sect. 117.
- Steel (like steel) *Sw.* Stal slag.
- Stone, *Sw.* Sten; *Germ.* Stein.
- Touch-stone, *Sw.* Prober sten. Sect. 250.
- Whet-stone, *Sw.* Hwethesten, and Brynsten. Sect. 264.
- Veins of stony matter, *Sw.* Gangar, and Klyfter. Sect. 12.
- Note.
- Heap of stones, Mundik, &c. *Sw.* Warp.
- Succinum*, *Sw.* Bernsten; *Germ.* Bernstein. Sect. 146.
- Sulphur, *Sw.* Svafvel; *Germ.* Shwefel. Sect. 125, and 151.
- Superficial, *Sw.* Angeflogen.
- Swine spars, *Sw.* Orsten. Sect. 157.
- Talc, *Sw.* Lrat gips. Sect. 17.
- Talc cubes. *Sw.* Talc-terringer. Sect. 96. See Mica
- Terra, *Sw.* Arten; *Germ.* Arter.
- Terra Tripolitana*, *Sw.* Trippel. Sect. 89.
- Tin, *Sw.* Tenn; *Germ.* Zinn. Sect. 180.
- Tin stone, *Sw.* Tenn berg; *Germ.* Zinn stein. Sect. 181.
- Tin grains, *Sw.* and *Germ.* Zinn-graupe. Sect. 181—84
- Topaz, *Sw.* Topas. Sect. 45.
- Smoaked topaz, *Sw.* Rok topas; *Germ.* Rauch-topas. Sect. 52.

Turf, *Sw.* Torf; *Germ.* Dammerde torf. Sect. 293

Solid turf, *Sw.* Beck torf.

Lamellated ditto, *Sw.* Papers turf. See Mould.

Veins (small) separating the load from the rock, *Sw.* Sleppskiok, or Skioler.

Viride montanum, *Sw.* Berg gron; *Germ.* Berg-grün. Sect. 194.

Vitriol, *Sw.* Viktril.

Blue vitriol, *Sw.* Bla viktril; *Germ.* Blauer vitriol. Sect. 122.

Copper vitriol, *Germ.* Kupfer vitriol.

Vitriol of zink, *Sw.* Hvit viktril; *Germ.* Weissen vitriol, and Galizen stein. Sect. 122 n. 3.

Ditto of iron and copper, *Sw.* Salzber viktril. Sect. 123.

Ditto of iron, zinc, and copper, *Sw.* Faln viktril.

Ditto of nickel and iron, *Sw.* Nikel viktril.

Vitriolic, Viktriler.

Vitriolic acid, *Sw.* Viktrils-syra; *Germ.* Vitrioliske-saure. Sect. 121.

Volatile, *Sw.* Flygtigl; *Germ.* Fluchliges.

White, *Sw.* Weiss.

Zinc, *Sw.* Spiauter.

Fine sparkling zinc, *Sw.* Braun bley erts goslaria. Sect. 229. 3.

Zinc mineralised with sulphurated iron, *Sw.* Blende. Sect. 229.

Lapis calaminaris, *Sw.* Gal meya. Sect. 228. a. 1.

N. B. The **POCKET LABORATORIES** for Mineralogical Experiments. mentioned in the Note at Page 283, are still to be had at the same general Office, lately removed from *Wood-street, Cheap-side*, to the Shop of Mr. *W. Brown*, Bookseller, at the Corner of *Essex-Street*, in the Strand, near *Temple-Bar, London*.

