AN ESSAY
TOWARDS A
SYSTEM OF MINERALOGY.

BY AXEL FREDERIC CRONSTEDT,
MINE-MASTER OR SUPERINTENDANT OF MINES IN SWEDEN.

TRANSLATED FROM THE ORIGINAL SWEDISH,

WITH ANNOTATIONS, AND AN ADDITIONAL TREATISE ON THE BLOW-PIPE.

BY GUSTAV VON ENGESTROM,
COUNSELLOR OF THE COLLEGE OF MINES IN SWEDEN.

THE SECOND EDITION,

GREATLY ENLARGED AND IMPROVED, BY THE ADDITION OF THE MODERN DISCOVERIES; AND BY A NEW ARRANGEMENT OF THE ARTICLES,

BY JOHN HYACINTH DE MAGELLAN,

TALABRICO-LUSITANUS, ET REG. SOC. LONDIN. ACADEMIARUM IMP. SCIENTIAR. PETROPOLIT. ET BRUXELL. REG. ULISIPON. MADRIT. ET BEROLIN. SOCIET. PHILOS. PHILADEL. HARL. ET MANCHEST. SOCIUS; ET ACAD. REG. PARIS. SCIENTIAR. CORRESPONDENS.

IN TWO VOLUMES.

VOL. I.

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TO

COUNT LOUIS

DE BARBIANO DE BELGIOIOSO,

KNIGHT OF THE ORDER OF MALTA,

ACTUAL CHAMBERLAIN

AND PRIVY COUNSELLOR OF STATE

TO HIS IMPERIAL AND ROYAL MAJESTY,

LIEUTENANT GENERAL OF HIS ARMIES,

AND PROPRIETOR OF A REGIMENT

OF INFANTRY

IN THE IMPERIAL TROOPS, &c. &c. &c.

THIS IMPROVED ESSAY,

TOWARDS A SYSTEM OF MINERALOGY,

IS,

WITH THE GREATEST RESPECT AND

GRATITUDE,

INSCRIBED,

BY HIS MUCH OBLIGED,

AND VERY HUMBLE SERVANT,

J. H. DE MAGELLAN.

THE EDITOR's PREFACE.

THE great ſuperiority of Cronſtedt's Mineralogical Syſtem, when compared with every attempt of the kind before publiſhed, is univerſally admitted. I have always eſteemed it a fortunate circumſtance, that I met with it in the commencement of my acquaintance with this branch of knowledge, and am greatly indebted to the friendſhip of Mr. Engeſtrom, who firſt recommended it to my attention. This Gentleman, who was formerly a pupil of the illuſtrious Author, brought with him a copy of the firſt edition of this work, publiſhed in Swediſh in 1758, when he viſited this capital. In a variety of converſations with him on the ſubject, I was ſtrongly impreſſed with the ſolidity of judgement in which the ſyſtem is founded: and I earneſtly entreated him to tranſlate it into Engliſh, for the advantage of the public. He complied with this requeſt, and the tranſlation was printed in 1770.

This treaſure of Mineralogical knowledge was gladly received; and in a ſhort time the edition was exhauſted. The Proprietor, who knew my attachment to the ſubject, applied to me to ſuperintend a ſecond edition, to which propoſition I immediately acceded, without any view to pecuniary emolument. My intention was to add, by way of Notes, the chief diſcoveries and improvements that have been made ſince the Author's time. Mr. J. Fabroni, whoſe great ſkill in Mineralogy and Chemiſtry is well known, and who is at preſent employed in arranging the celebrated collection of his Royal Highneſs the Grand Duke of Tuſcany, was then in London, and very kindly obliged me with various accounts of the new improvements in theſe ſiſter-ſciences, written in the French language. A very obſtinate complaint of violent pains in the head and eyes, with which I was at that time afflicted, prevented me from proceeding; but it gave me the utmoſt pleaſure, in this diſtreſſing ſituation, that Mr. Kirwan, to whom I mentioned it, undertook to have Mr. Fabroni's Notes tranſlated into Engliſh, and to add ſuch facts as might occur to him for the information of the public. The undertaking was in this ſtate when I viſited the continent, chiefly with a view to conſult about the cure of the complaint I was afflicted with. I was happy enough to ſucceed, and returning after an abſence of near two years,

years, I found that Mr. Kirwan had been prevented, by various accidents, from accompliſhing his promiſe. He returned the original papers with very few new pages of the Notes in Engliſh; and ſome time afterwards acquainted me with his intention of publiſhing a ſummary view of Mineralogy. This was actually publiſhed in 1784, under the title of *Elements of Mineralogy*, and has with juſtice been highly eſteemed by the public. The event, however, inſtead of being a check to my ſecond edition of Cronſtedt's Mineralogical Eſſay, has rather encouraged my zeal to avail myſelf of the contents of Mr. Kirwan's performance (with his conſent), which may be conſidered as a very valuable improvement of the preſent work.

Upon mature reflection, I was convinced that my original intention of retaining the order which the Author had adopted in his Syſtem, could not be adhered to without a manifeſt confuſion of the whole. *If*, as the great Bergman obſerves, *the Author had lived longer for the benefit of the Sciences, he would no doubt have rectified the diſpoſition of his Mineralogical Syſtem.* For without mentioning other numerous diſcoveries, it has been well aſcertained ſome years ago, that there are but five primitive Earths, inſtead of the nine deſcribed by the Author, moſt of which are mere compounds of the former; the Ponderous Earth was unknown in his time, though its exiſtence as a peculiar ſubſtance was ſuſpected by him;

and

and the Magneſian Earth was almoſt equally unattended to. I was therefore obliged of courſe to give the whole under a new arrangement, placing the ſeveral Sections of the Author under ſuch Orders and Genera, as the improved knowlege of later times dictated, as will be ſeen on conſulting the work; but I have, at the ſame time, been careful in changing only the places of the Sections, to leave the matter unaltered nearly as it ſtood in the firſt edition, and at the head of every Section I have added either its number according to the firſt arrangement, or have mentioned that it is additional or altered as the caſe may be. Beſides which, I have prefixed a Table of Contents of the original order, that the Reader may ſee the whole at one view, and more readily compare it with the order I have adopted.

The number of Sections in the preſent edition amount to 443, occupying 923 pages, with many Notes, great part of which are of importance, and every one either founded on facts within my own knowledge, or extracted from Authors of the firſt reputation. The Sections of the former edition were only 300, and were printed in 272 pages, not nearly ſo full as the pages of the work now preſented to the public. The Treatiſe of M. Engeſtrom on the Blow-pipe and Pocket Laboratory, firſt publiſhed with this work, but ſince tranſlated into almoſt every European language, is alſo reprinted at the end of this Mineralogy, with Notes from Bergman, and two ſhort Appendices,

dices are ſubjoined, one containing a deſcription of the travelling apparatus for the *dry* and *humid aſſays*, and of the *Lamp Furnace* uſed by the celebrated Profeſſor Bergman, for chemical experiments, on a ſmall but advantageous ſcale, which was firſt publiſhed by M. de Morveau, and is now greatly improved; the other conſiſting of the method of aſſaying earths and ſtones, extracted from Kirwan's Elements of Mineralogy; the deſcription of a new inſtrument contrived by Mr. W. Nicholſon, for aſcertaining ſpecific gravities; and laſtly, a new method of my own, for making general weights with the greateſt eaſe and accuracy.

I am perſuaded, that ſuch as are acquainted with the improved ſtate of Mineralogy, will approve of the method I have adopted, in preference to the numerous and often contradictory notes which would otherwiſe have been required to ſettle the ſeveral matters in their proper order. To arrange the moſt important facts in an advantageous manner, has been the only aim of my labour, imperfect as it may be. I have not been actuated by the vanity of pretending to be the Author of a Syſtem, nor to inſtruct the moſt accompliſhed Mineralogiſts of our age. I have uſed none of the artifices of book-makers: I have, without heſitation, availed myſelf of every help I could procure; but I have been equally ready and careful to name all my authorities, as well for the obvious advantage of authenticity, as that I might not inſidiouſly derive fame from the labours of others. Thoſe who are as ignorant of the ſubject

ject as I have formerly been, may, I flatter myſelf, receive great advantage from this performance, by ſaving the labour and time I was obliged to beſtow, in acquiring an acquaintance with the modern diſcoveries. I have done whatever lay in my power to render it complete, notwithſtanding the variety and multiplicity of my other avocations, which did not allow ſufficient time to reconſider and reviſe my manuſcript before it went to the preſs. I have not, however, neglected to employ a proper perſon to correct the language, which otherwiſe would have been ſcarcely proper for the public eye, as I am myſelf a foreigner, who came to England at an advanced age. In whatever manner the numerous kinds of readers, which compoſe the heterogeneous maſs called the Public, may decide concerning my labours, I ſhall reſt contented with that approbation, which the uprightneſs of my intentions may juſtly claim. Not at all agitated with hopes, either of a pecuniary or even honorary nature, I am already in poſſeſſion of that ſatisfaction which a ſincere, though perhaps weak exertion to promote the public good, cannot fail to produce in a well-diſpoſed mind. Convinced that, at leaſt ſo far, I ſhall have the worthy and eſtimable part of mankind on my ſide, I can with eaſe overlook the efforts of the malignant, which, though they may excite compaſſion and contempt, are hardly of importance enough to produce any other emotion.

London, 1788.

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 Conſtedt. 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 Public 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 approved in Germany; nor, indeed, has

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 elegancy of ſtile, particularly in ſcientifical 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 PREFACE.

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

are repreſented 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 with 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 mineralogiſts 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 found.

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* 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 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*. But at length Mr. Pott, a chemiſt by profeſſion, and conſequently inclined rather to truſt to the effects of his experiments, than to 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 *Lithogeogneſia*. From this book the ſaid author received conſiderable honour, becauſe the true advantage of his reſearches began to appear: Miners and others manufacturers were by it able to determine the reaſon of certain effects, which they either did not obſerve before, 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. Wolterſdorff, a diſciple of Mr. Pott, then began *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, from a ſenſe of 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 long 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 the one ſide I reflected upon the paſſion which our learned men 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 ſight, 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 advan-

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, reſpecting ſome of the effects of his experiments. Thus, we ſhould be employed in obſerving the phænomena 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 ſeldom, 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 decompounding 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 miſletoes, 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 œconomical 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 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 *Lithogeogneſia*, 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 the reſt are compounded, although this

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 an 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 unnneceſſary 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

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 decompounded 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 well know, and which have not yet obtained

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 among the Saxa.*

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APPENDIX. *On Compound Stones and Petrefactions.*

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COR.

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316 18 *of the Note*, precipitated, *read* ſeparated.

320 16 *of the Note*, ſalts, *read* teſts.

324 10 *of the Note*, the ſecond, *read* the third.

384 15 195, *read* 196, (Additional).

445 *Add to the end of Note* c, But the late experiments communicated by Dr. Prieſtley to the Royal Society of London, which will be inſerted in the Philoſophical Tranſactions for 1788, demonſtrate, that the above opinion of Dr. De la Metherie is the true one; viz. 1. that the water or moiſture remaining after the repeated exploſions of *inflammable* and *dephlogiſtated air*, was previouſly contained in them both. 2. That if they are previouſly taken upon mercury, covered with *fixed ammoniac*, and well ſhaked with it, they then hardly produce the half, or leſs, of that watery moiſture. 3. That all aeriform ſubſtances, as the *phlogiſticated*, *dephogiſticated* and the *inflammable air*, cannot be produced without water. 4. That the inflammable air, produced by the vapour of boiling water paſſing through a red-hot iron tube, proceeds from the metal, to which the water unites and calcines it; whilſt the *inflammable part* (or the *phlogiſton*) of it, is expelled with part of the ſame water, in the form of what is called *inflammable air*.

Finally, the experiments and ingenious deductions of Dr. Crawford, in the ſecond edition of his Treatiſe on *Heat* and *Combuſtion*, (juſt now publiſhed, the 13th of April, 1788,) irreſiſtibly evinces the fallacy of the pretended arguments againſt the exiſtence of *phlogiſton*. The Editor.

495 8 of the Note, 12, *read* 12 ounces.

Page.	*Line.*	
545	7	of the Note, 1754 to 1736, *read* 1754 to 1756.
557	10	*Add (a),*
565	14	*erez,* read *ertz.*
576	35	William, *read* Thomas Cooper.
578	15	of the Note, No. 5, *read* No. 6, of the Note to page 614.
662	6	*from the bottom,* add, and Note *b,* to page 544.
747		*Add to Note* 11, The ſtrong blaſt of air, whilſt the caſt iron is red hot, or rather in a half melted ſtate, is the moſt neceſſary, if not the only neceſſary circumſtance, to render it malleable. In this operation a quantity of liquid matter runs from it, called *finery cinder,* which is very brittle when cold; and on its being ſeparated from the metal, the latter remains malleable. But the iron being in looſe ſpungy maſſes, requires the hammer to conſolidate it, and a conſiderable quantity of the *finery cinder,* which remains among the inſtertices of the ſpungy fibres, is driven out by the application of the hammer. The *finery cinder* is thrown away, as uſeleſs, by many iron-maſters; but it has been found, that it may be partly employed, with the other uſual fluxes, to ſmelt the iron-ores. *The Editor from Prieſtley.* Obſerv. on Nat. Ph. Vol. III. p. 357. and 372.
756	14	*Add,* See however, Note 14, page 840, concerning the magnetic power of Nickel.
757	to 801,	At the top of every page, inſtead of *Baſe Metals,* read *Semi-metals.*
787	30	by whom, *read,* by which.
793	2	Sect. 307, *read* 767.

Page.	*Line.*	
795	19	(243), *read* (234).
893	6	*Add*, A ſingular variety of ſand-ſtone, which is flexible and *elaſtic*, was ſhown to the Royal Academy of Sciences at Paris, four years ago, by the Baron de Dietrich. It conſiſts of ſmall grains of hard quartz, that ſtrike fire with tempered ſteel, together with ſome micaceous mixture. The elaſticity ſeems to depend on the micaceous part, and ſoftneſs of the natural gluten between both. It is ſaid, that this *elaſtic ſtone* was found in Brazil, and brought to Germany by his Excellency the Marquis do Lavradio. There are alſo two tables of white marble, kept in the Palace Borgheſe, at Rome, which have the ſame property. But the ſparry particles of their ſubſtance, though tranſparent, are rather ſoft; may be eaſily ſeparated with the nail, and effervesce with *aqua fortis:* and there is alſo in it a little mixture of ſmall particles of talc, or mica. *See* Journal de Phyſ. for October, 1784, p. 275.
910		*Add to the middle of this Page*, The great volcanic eruption in Iceland above-mentioned happened in June 1783, after having been preceded for 10 days by violent earthquakes, thick clouds of ſmoke, and denſe ſtreams ariſing out of the earth. It did burſt at laſt, and continued during the three following months. Three ſpouts of fire broke out from different mouths, which, after riſing to a conſiderable height, collected into a ſingle ſtream, ſo high as to be ſeen at the diſtance of 34 miles and upwards, throwing out with great force, noiſe, and ſhaking of the earth, prodigious quantities of brimſtones, ſand, pumice-ſtones, and aſhes, which fell

Page. *Line.*

felt all over the country at great diſtances, along with great quantity of a dirty ſubſtance, reſembling pitch. The melted lava ran out in ſuch abundance, as to cover the land above 15 miles in length, and ſeven in breadth, and formed lakes of ignited matter, which filled and dried the beds of 12 rivers; entirely deſtroyed 20 and more villages, beſides 30 more which were materially damaged. Two new iſlands were thrown up afterwards from the bottom of the ſea, one above 100 fathoms from the bottom, and the other farther off between Iceland and Greenland; both were burning without intermiſſion for a long time, and produced the moſt dreadful effects, &c. *See the* account *of this horrible convulſion of that almoſt neighbouring part of our globe, in the* Magazine of Edinburgh for June, 1787. If ever the land or ground of England was ſeparated, as it ſeems, from that of France, at an epocha preceding all written records, there is no doubt but that there muſt have happened a convulſion on this part of the globe, ſimilar at leaſt, if not greater, than that at Iceland. *The Editor.*

914 3 *before the end,* the calcareous ſpar, *read,* the polygonous configuration.

ESSAY

ESSAY

TOWARDS A

SYSTEM

OF THE

MINERAL KINGDOM.

SECTION I.

On the formation of Minerals.

THE Mineral Kingdom contains all thoſe bodies which have been formed under the ſurface of our earth, whether at the firſt creation, or at 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 [a].

The

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[a] 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 ſuch general definition would be of any uſe, when we become ſo far advanced in knowledge, as to be able to diſtinguiſh, on ſure foundations, the

Page. *Line.*

96 22 *Add*, 16. According to Lavoiſier and Macquer, when Magneſia is calcined, it becomes phoſphoreſcent.

124 29 of quartz, *read* of zeolytes.

125 12 *Add*, I have ſeen alſo a ſmall cubic diamond belonging to Dr. Combe, of London, whoſe ſquare ſides were naturally joined by two very narrow long facets, forming angles of about 120 *degrees*; and its corners were quite perfect. *The Editor.*

131 11 *Add*, If the model be exactly done.

133 *Add at the end*, Adamantine ſpars, ſo called on account of their extreme hardneſs, have been brought within theſe few years from the Eaſt-Indies. They are known by the name of *grinding ſpars* at Madras, as their powder is probably employed there to poliſh hard gems. Their figure is that of a right hexagonal priſm, of a grey greeniſh colour, partly covered with a dark bluiſh cruſt, to which was adhering part of a calcareous matrix. The ſubſtance of theſe ſpars is lamellated and ſemi-tranſparent, diſcovering blackiſh ſpots within, ſome of which are alſo at the ſurface, and are magnetic; theſe produce ſparks when electrified. Some of the ſpars appear partly micaceous. I have ſeen one of them about *two inches* long. Another, about half this ſize in its diagonal length, being weighed hydroſtatically by Mr. Kirwan's operator, gave 3,847 for its *ſpecific gravity*, weighing 376 grains in the air, and loſing 9,775 in diſtilled water. According to Mr. Hauy, theſe ſpars conſtitute a new kind of cryſtalline bodies; but I do not know whether they have been as yet properly analyſed.

The words, *circulation of fluids*, are to be conſidered jointly with 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, in other reſpects, they have ſome reſemblance, ſome foſſils being ſtill produced nearly in the ſame manner as we conceive vegetables to be. The clefts, fiſſures, and veins [b], 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 vehicle of nutriment common to them both. Fire, of whoſe nature we ſtill know ſo little that we can hardly determine whether it exiſts in the earth in any peculiar manner or quantity, farther than it muſt neceſſarily exiſt in the general or ſolar ſyſtem, may, perhaps, be an auxiliary equally neceſſary to all the three kingdoms of nature.

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the ſeveral individuals belonging to each kingdom: and likewiſe thoſe which form the connexion between the three.

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

[b] Or *countries*, which is an Engliſh mine-term for the ſides or incloſures of a vein or load of ore: e. g. the *country* of the lead is limeſtone, killas, &c. &c. *D. C.*

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 production of ſeeds, the properties of the animal and vegetable kingdoms.

Minerals are here to be deſcribed in the ſtate and condition in which they are now actually found: nor are we to enter into the principia, or primary atoms, which have concurred to their formation, and into which we cannot now reſolve them; ſince it may be preſumed 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 the external appoſition 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. If it ſhould 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 through the pores of the tree; I could likewiſe ſhow inſtances in the mineral kingdom, that ſeem plainly to indicate ſome proceſs 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 with regard to the mineral kingdom: and we cannot for this reaſon admit any *circulation of juices*; not to mention that we have another refuge left, namely *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 likewiſe outlive the greateſt part of them, ſo that we can treat them with more eaſe and convenience; whereas the changes which the mineral kingdom undergoes are hidden to us, and require many centuries to compleat them.

I cannot ſuppoſe mineral bodies to be produced by ſeeds, 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-

Ziment copper [c], 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 thing more, than the accretion of iron or copper in a metallic ſtate into a moſs-like form in the poor or rich roaſted ores or reguli, does 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 being under the neceſſity of recurring to the ſuppoſition of a melting heat; if we only carefully obſerve thoſe marks, which, beſides, plainly ſhew their having once been ſoft, or diſſolved.

Many obſervations and experiments muſt yet be made before we can determine whether mineral bodies are at preſent formed, in that large elaboratory the earth, by the very ſame proceſs as the ſituation and circumſtances of full-grown minerals ſeem to have required.

The whole flinty claſs may be offered to evince the truth of this aſſertion. We have not one obſervation that determines the manner of their generation. For if any one ſhould pretend to have diſcovered the quartz cry-

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[c] Called *Ziment-copper* from its being firſt obſerved in a vitriolic water, called *ziment*, at Herrengrund, in Hungary, *D. C.*

ſtals [d] in the very inſtant of their ſhooting, it might be asked, Whether he only depended upon the figure, or if he had made experiments ſufficient to 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 animate perſons of more experience and leiſure to the purſuit of theſe enquiries.

Precipitation from or by means of 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 ſlimy gelatinous, or mucilaginous matter; and conſequently, a more radical ſolution, if I may be allowed that expreſſion; and this is again to be conſidered as a different method.

Another manner of accounting for this formation of mineral bodies, more generally received at preſent, is that by decompoſition [e], partly

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

[c] By *deſtruction that acts privativè* (as it is in the original) is to be underſtood, that ſome few ores, owing their origin to decompoſition, are formed out of others, which, by ſome

partly by very violent means, ſuch as ſubterranean fires, and partly by more mild ones, ſuch as the weathering, waſting, or decompounding 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 continually in 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 inertiæ*, 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 that 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

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ſome natural operation, have loſt one or more of their conſtituent parts. So *brown-iron ochre* is produced by *decayed pyrites*: *black-copper*, and that ore called by the Germans *Fahlerz*, from decayed copper-pyrites, &c. *Note of the Editor from the German tranſlation of* Prof. Werner.

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 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 analogous 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 bones do when diſperſed in a church-yard.

SECT. 2.

General diviſion of Minerals, or Foſſils.

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

1. EARTHS, are thoſe ſubſtances which are not ductile, that are moſtly indiſſoluble in water or oil, and that preſerve their conſtitution in a ſtrong heat [*f*].

2. SALTS,

[*f*] Earths are inſipid, not ſoluble in 1000 times their weight of boiling water, though perhaps water, in Papin's digeſtor,

2. Salts, are ſoluble 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 [g].

3. Inflammables, are ſoluble in oils, but not in water, and are combuſtible [h].

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digeſtor, will diſſolve ſome, if not all, of them; eſpecially if their ſurface be greatly increaſed by a previous ſolution in, and precipitation from, ſome other menſtruum. In the chain of nature, they are by inſenſible gradation, joined to the ſalts, ſo as not to be diſtinguiſhed without artificial limits. Their form is not changed by a moderate heat, nor are they diſſipated by a violent one. Their ſpecific gravity is, to water, leſs than 5 to 1. Bergman's Sciagraphia, § 21.

Wallerius and others, out of a too ſcrupulous attention to the *externa facies*, make ſtones one of the genera of foſſils, the conſequence of which is, as Bergman juſtly obſerves (Sciag. § 7.) "that a ſtone of a certain ſize muſt conſtitute one genus, "whilſt the ſame, reduced to powder, muſt be placed under "another genus, which ſhall not be found even in the ſame "claſs."

[g] Salts, or ſaline ſubſtances, are more or leſs ſapid, and when finely powdered diſſolve in at leaſt 1000 times their weight of boiling water. They melt in the fire, which for the moſt part changes or deſtroys them. Berg. Sc. § 20.

The definition of ſalts by Dr. Culen ſeems leſs exceptionable; viz. *Saline bodies are ſapid, miſcible with water, and not inflammable.* However the *volatile alkaly*, in an aerial ſtate, is in a certain degree inflammable. *Dr. Withering.*

N. B. The ſtudy of Mineralogy, according to the great Bergman (ſc. § 24.) ſhould begin by acquiring a good knowledge of the nature and properties of ſaline bodies; for, unacquinted with theſe, ſays he, our knowledge of other bodies muſt be exceedingly imperfect. *The Ed.*

[h] Inflammable foſſils abound with phlogiſton, do not unite with water, but when pure diſſolve in oils: expoſed to the fire, they ſmoke, generally inflame, are for the moſt part conſumed, and ſometimes totally vaniſh. Berg. Sc. § 22.

4. Metals, are the heavieſt of all bodies hitherto known [i], ſome are malleable, and ſome can be decompounded; 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 [k].

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[i] Metals when perfect do not diſſolve at all in water; only a few of them in oils, and then only when in part deprived of their phlogiſton. They are the heavieſt of all known ſubſtances, the lighteſt of them weighing more than ſix times its bulk of water. They melt in the fire, with a ſhining ſurface: and, in clay veſſels, the ſurface is convex. Berg. ſc. § 23.

[k] Here occurs the ſame difficulty in regard to the definitions, as was before (Sect. 1.) 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 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

SECT. 3.

The firſt claſs Earths. *Lat.* Terræ. *Sw.* Jordarter. *French*, Les Terres. *Germ.* Erdarten.

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

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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. *The Author.*

[*l*] *in a ſtrong heat*] without melting, like *metals*; though earths may ſometimes vitrify, and become glaſs, by ſtrong heat; nor flying or vaniſhing away, like *bituminous* ſubſtances: that, notwithſtanding they be reduced to the fineſt powder, yet are not ſoluble, like *ſalts*, in open veſſels, though in a quantity of boiling water 1000 times their weight; nor have, like them, any taſte when applied to the tongue; and, finally, they are ſpecifically lighter than five times their weight of water, as aboveſaid in note *f* to § 2.

Earths however are, in many inſtances, ſo far of a ſaline nature, as to be ſoluble by means of Papin's digeſter. This holds good even in regard to Quartz. Indeed in the ſtate in which earths are found in the ground, they are almoſt always combined with an acid, and are therefore in fact, according to their different natures, ſo many *earthy ſalts*. Theſe are alſo called *middle ſalts* (ſales medii terreſtres), being combined with ſoluble ſalts; but of theſe hereafter, in the ſecond claſs of this Eſſay. *Ed. from Berg.*

Theſe Earths (§ 3.) are here arranged according to their conſtituent parts [m], as far as hitherto

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[m] The Author means to treat of earths under ſo many heads, as there are primitive or ſimple earths; viz. ſuch as cannot be decompoſed, nor changed into one another; or undergo any real tranſmutation, by any means whatſoever as yet known. Modern diſcoveries have however reduced their number to near the half there reckoned by the noble author. It appears, by the numerous and moſt accurate analyſes of mineral bodies, made by that great philoſopher Sir Torbern Bergman, Profeſſor at Upſal, that there are only *five*, or at moſt *ſix*, primitive or ſimple kinds of earth. The following are his words, in a letter to Dr. Troil, written in 1776, and printed in 1780, among thoſe of this laſt, on the ſubject of Iceland: "I have," ſays that eminent chymiſt, "for ſeveral years paſt, endeavoured to diſcover the number, as well as the nature, of the original kinds of earth. In the year 1758 Mr. Cronſtedt counted nine: if he had lived longer, for the benefit of the ſciences, he would no doubt have rectified this account." The following are the ſame Profeſſor's words, in his Sciagraphia, lately publiſhed (in 1782) § 83, and following. "Before we can underſtand the nature of earths, we muſt know their component parts. Thoſe earths, which cannot be further decompoſed, we call *primitive*; and thoſe which conſiſt of two, or more, of theſe intimately united, *derivative*. By this union we do not mean a mere mechanical diffuſion, at leaſt not ſuch as can be diſtinguiſhed by the eye, as is the caſe in ſtones *(ſaxa.)*

"It is evident that the primitive earths will conſtitute ſo many natural Genera, and different mixtures of theſe the Species.

"They who would make ſeveral Genera out of one primitive earth, muſt ſeparate the glaſſy, red, white, horny ſilver ores, and other different compoſitions, into as many Genera, or elſe act inconſiſtently with their own principles.

"At preſent we only know five primitive earths. They who reckon fewer, reſt their opinions upon fanciful metamorphoſes unſupported by faithful experiments. As experiments teach us that there are five primitive earths, it is "evident hitherto diſcovered; and are divided into nine orders [m].

SECT.

"evident that the ſpecies ariſing from the mixture of theſe "cannot exceed twenty-four, viz. 10 double (conſiſting of "two earths) 6 triple, 3 quadruple, and the 5 primitive.

"Although theſe different mixtures are poſſible, and probably do exiſt, they have not yet been all found. The "natural compoſitions of acids with the earths, forming ſubſtances not ſoluble in 1000 times their weight of boiling "water, and which may be called ſaline earths, muſt be added "to the ſpecies, as they are certainly chemical combinations.

"The primitive earths hitherto detected are,

"TERRA PONDEROSA,	or heavy earth.
"CALX, - - -	calcareous earth.
"MAGNESIA, - -	magneſia.
"ARGILLA, - -	argillaceous earth.
"TERRA SILICEA,	ſiliceous earth.

"And we muſt believe theſe to be primitive, until it ſhall "appear, by proper experiments, that they may be ſeparated "into others ſtill more ſimple, or changed into one another "by art.

"Theſe are firſt to be conſidered in their greateſt ſimplicity "and purity, although nature never preſents us with ſuch, "nor can they even by art be rendered abſolutely free from "all heterogeneous mixture. Water and aerial acid readily "unite with the four firſt, and when expelled by fire, a little "of the matter of heat is added, and remains until driven "out by a more powerful attraction. But in this ſtate they "poſſeſs a degree of purity not to be attained by any other "known method. Therefore it is neceſſary to examine them "when ſufficiently burnt, in order to diſtinguiſh better what "properties depend upon adhering heterogeneous matters."

To the above five kinds of Earth, Profeſſor Bergman added, at firſt the *Earth of Gems*, as being of a different kind: but he found afterwards, that all gems, the diamonds excepted, are compounded from ſome of the above earths, and

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SECT. 4.

General Properties of Calcareous Earth.

CLASS I.

FIRST ORDER.

Calcareous Earth, Chalk. *Lat.* Terra Calcarea.
Sw. Kalk-Jord, Brann-Jord, Krita.
French, Terre Calcaire. Craie.
Germ. Kalckartrige erden, Keide.

Specimens of this earth, when pure and free from heterogeneous matters [n], have the following qualities common to them all [o]:

1. That

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may be ſaid to belong to the *Argillaceous* kind, becauſe this is the moſt predominant of their component parts. Nevertheleſs the generality of mankind have from immemorial time been apt to conſider precious ſtones, as of a diſtinct and ſuperior rank, among mineral productions, on account of their brilliancy, fine colours, and great hardneſs: and on this account they deſerve to be ſeparately treated of in a ſyſtem of Mineralogy. As to the earth of diamonds, although its characteriſtical properties are as yet unknown; it is however well aſcertained, that it does not belong to any of the five kinds of earths already mentioned. *See Bergm. Opuſc.* De terra gemmarum. *tom. 2. pag. 72, & foll.* The Ed.

[n] As calcareous earth united to the *aerial acid* is found native, it requires but little trouble to have it pure. Let ſelected pieces of chalk, reduced to fine powder, be repeatedly

1. That they become friable, when burnt in the fire; and afterwards fall into a white powder [*p*].

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.

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peatedly boiled in pure water: this diſſolves any *calx*, or *magneſia ſalita*,, which it may contain. This done, it holds no heterogeneous matter, but what mechanically adheres to it, the quantity of which is generally extremely ſmall. If we deſire to be free from this likewiſe, diſſolve the waſhed chalk in diſtilled vinegar; precipitate with volatile alkaly; and after waſhing the precipitate well, dry it. *Berg. Sc.*

[*o*] The ſpecific gravity of calcareous earth thus purified, is 2,720. 100 parts of it contain about 34 of aerial acid, 11 of water, and 55 of pure earth.

Acids unite with it effervefcing, and a centenary (*centenarius*) excites about 22 degrees of heat. The vitriolic acid forms *gypſum*, difficult to diſſolve, (59). The *nitrous* and *muriatic acids* form deliqueſcent ſalts (§§ 60, 61), and the *acetous acid* permanent chryſtals. *Berg. Sc.* § 93.

[*p*] Pure calcareous earth does not melt in the fire, but loſes $\frac{41}{100}$ of its weight. It diſſolves in 700 times its weight of water, generating heat. Acids diſſolve it, producing, from a *centenary*, 252 degrees of heat, but without any effervefcence. This laſt circumſtance may be beſt obſerved by immerging the burnt earth in water, to diſſipate a part of the heat, which would otherwiſe make the acid boil. The water likewiſe expels the atmoſpheric air from the pores of the lime. In this ſituation, if nitrous or muriatic acid be poured upon it, and if it was previouſly well burnt, no effervefcence will take place. The ſolution proceeds ſlowly, but the ſaturation becomes as perfect as if the calcareous earth had been in a mild ſtate. This burnt earth, or *lime*, expels the *volatile alkaly* from *ſal ammoniac* in a cauſtic ſtate, and it diſſolves *ſulphur*; but this compound is ſeparated upon the addition of any *acid*, even the *aerial*. *Berg. Sc.* § 93.

3. They

6. They melt eaſily with borax into a glaſs, which ſuffers inpreſſions in a degree of heat below ignition.

7. They likewiſe fuſe into a glaſs, with *ſal fuſibile microcoſmicum* with an efferverence [*t*].

8. Fluſs-ſpat melts the moſt readily of all kinds of ſtones, with the calcareous, into a corroſive glaſs or ſlag [*u*].

9. They have alſo ſome power of reducing certain metallic earths or calces; for inſtance thoſe of lead [*w*] and of biſmuth: and likewiſe,

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With *phoſphoric acid*, it forms the earth of *animal bones*, *nails*, *hairs*, *horns*, &c. This was diſcovered in Sweden by J. G. Ghan, but a few years ago. *Fabr.*

With the acid of vinegar it cryſtaliſes into a neutral ſalt, which does not deliqueſce like thoſe produced by the *muriatic* and *nitrous* acids. *Berg.*

[*t*] It is to be underſtood that this efferveſcence is alſo made with *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. *The Author.*

N. B. Theſe glaſs-beads are tranſparent only whilſt they are hot; but as ſoon as they cool, they become opake. There is however a remarkable phenomenon to be noticed; viz. that if the hot bead is thrown into melted tallow, or even into warm water or any other warm liquor, it preſerves its tranſparency. *The Editor* from Bergman, *de tubo ferruminatorio.*

[*u*] *Corroſive*, becauſe certain vitrifications of calcareous earth, particularly thoſe made with calx of lead and ſparry fluor, eat through the crucibles. *Werner.* N. B. This muſt be totally attributed to the ſolvents: Glaſs of lead being the moſt active of all fluxes, and the ſparry-acid, which is one of the conſtituent parts of the ſparry fluor, is already known to corrode even glaſs veſſels. *The Edit.*

[*w*] This is to be underſtood, when calcareous earth is combined with *aerial-acid*: thus calces of lead are in ſome meaſure

wiſe, though in a leſs degree, thoſe of copper and of iron: thus

10. They do in this laſt mentioned caſe (article 9), as well as in other circumſtances, reſemble *fixed alcaline ſalts*, from whence alſo this whole kind is very often, and properly, called *alcaline earths*.

11. This earth is common to all the three kingdoms of nature. For it is found in the bones and ſhells of animals [x], as well as in the aſhes of burnt vegetables; it muſt, conſequently, have exiſted before any living or vegetable ſubſtance; and is, no doubt, diſtributed throughout the globe, in a quantity adequate to its univerſal uſe.

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meaſure reduced by chalk, but not at all by lime; and this evidently proves, that they receive phlogiſton from *fixed air* or *aerial acid*, which is a compound of *phlogiſton* and *dephlogiſticated* air. *Kirwan.*

[x] Mr. de Morveau has evidently proved this *earth* to be *calcareous*, and that the *abſorbent* earth ſuppoſed by Meſſrs. Sage, Romé de l'Iſle, &c. is nothing more than a mere calcareous earth. *See his Memoir inſerted in* Journ. de Phyſique for March 1781. *The Edit.*

SECT. 5.

The calcareous earth is found.

I. Pure [u].

1. Looſe, in form of powder, *agaricus mineralis*, or *lac lunæ* [w].

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, Oſtergotland, and iſland of Gottland in Sweden [x].

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[u] It appears from what has been ſaid in the preceding ſection, that as far as we know, pure calcareous earth is not found native. The ſpecimens of this diviſion conſiſt chiefly of the *calx aerata* or calcareous earth combined with the aerial acid or fixed air. But the following ſpecies, mentioned by Wallerius, may as well be noted here.

1. *Calx nativa Wallerii*, vel *terra aceldama*.
This calcareous earth hardens immediately with water, as quick lime does.
Calx Balnei Bathenſis. It is found at Bath in England: effervesces with cold water: and when mixed with brimſtone, forms a *liver of ſulphur*.
Calx nativa Panormitana. It is found near Palermo in Sicily, and is called *waſher's earth*; when mixed with water it does not effervesce, but conſolidates into a hard maſs." *Wall.* N°. 4. page 31 & ſeq. vol. I. 1778.

[w] This is a miſtaken name, taken from the Swiſs word *Month*, which ſignifies *mountain*, confounded with the German word *mond*, which ſignifies *moon*. The German name of this earth is *bergmilch*, mountain milk. *Wern.*

[x] The white *mineral agaric*, ſo called from its fineneſs and lightneſs, reſembling the vegetable agaric, is found in ſwamp or peat moors, in England and Scotland; as likewiſe in the fiſſures of the free-ſtone quarries of Oxfordſhire, Northamptonſhire, &c. but the red and yellow ſorts I never heard of in England. *D. C.*

b. Red is alſo found in Gottland.

c. Yellow, is found at Timmerdala, in Weſtergottland [*y*].

SECT. 6.

II. Friable and coherent, *Solida Friabilis,* Chalk, *Creta.*

a. White *Creta alba*, is found in England, and 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,

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[*y*] 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 is conveniently burnt into lime, if it is previouſly preſſed into moulds, that it may better cohere: it is 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. *Auth.*

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, and 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 the 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.

SECT. 7.

III. Indurated, or hard, *Terra calcarea indurata*, lime-ſtone, *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, *chalk-ſtone*, from Hull in England.
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,

e. Grey, at the ſame places.

f. Variegated with many colours, found in Italy, at Blankenburgh, and many other places, and is particularly called Marble [z].

g. Black, in the province of Jemtland in Sweden, and in Flanders.

SECT. 8.

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

1. Coarſe grained and of a looſe texture. This is called *Saltſlag* in Swediſh, from its re-

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[z] 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 all ſolid limeſtones 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 conſiſts of the fineſt particles of pounded rocks) gathers together at the ſtamping mills; and as they are thus formed in the water, there always are heterogenous parts along with them. Theſe heterogenous 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. *Auth.*

ſemblance 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 mines of Salberg. The grained flux ſpar is alſo ſometimes called *Salt-ſlag*.

2. Fine grained.

a. White, found at Salberg.

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

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

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

b. White and black from the mine at Salberg [a], called *Herr ſtans Bottn.*

SECT. 9.

C. Scaly limeſtone, *lapis calcareus particulis ſquamoſis ſive ſpatoſis*, vel *ſpathaſeis*. *Limſten.*

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

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[a] 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. *The Author.*

calcining heat forty per cent. of its weight; and expoſed to the air, acquires a browniſh efloreſcence, a ſign that it contains ſome iron, and is a medium between a limeſtone and the white iron ore called *ſtahl*-ſteine; it does not 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 Oſtergothland, the pariſh of Lillkyrke in the province of Nerike, and at Remito 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 [*b*].

SECT. 10.

D. Lime or calcareous ſpar. *Lat.* Spatum calcareum. *Sw. Fr.* and *Germ.* Spath.

1. Of a rhomboidal figure.

a. Tranſparent, or diaphanous.

[*b*] 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 ſlaty limeſtones (ſect. 8 and 9) are either found in veins, or elſe form whole mountains, without ſhewing any ſtrata, or ſigns of petrefactions. *Auth.*

1. Refracting ſpar. *Lat. Spatum Iſlandicum. Sw.* Dubbelſtein. *Germ.* Doppel ſtein.

This repreſents the objects, ſeen through it, double [c]. It is found at Brattforſs, an iron-mine in the province of Weroneland, in Switzerland, and Iceland [d].

2. Common ſpar, which ſhews the object ſingle.
   1. White, or colourleſs.
   2. Yellowiſh and phoſphoreſcent [e]. This is found at Jonuſwando 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.

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[c] I have found various pieces of the Derbyſhire-ſpar, through which the light of a candle formed many images, ſome ſhewing 8, ſome 12, or 16, and even more images at once. Roch-criſtal is well known to have alſo a double refraction, of which property Mr. Rochon, of the Royal Academy of Sciences at Paris, availed himſelf to make a new kind of micrometer for aſtronomical obſervations. And laſtly Mr. Fromond, profeſſor of natural philoſophy at Milan, has lately obſerved the ſame effect of a double refraction in common plate-glaſs, whenever many parallel lines have been cut in its ſurface, by a diamond, at the diſtance of one five hundredth, or one thouſandth part of an inch from each other: I have myſelf ſeen a piece of plated glaſs cut in this manner by the ſame gentleman, which produced the phenomenon abovementioned. *Edit.*

[d] Its ſpecific gravity is 2,720. *Newt. and Waller.*

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.*

[e] This ſpecies probably contains the ſparry acid; if ſo, it belongs to thoſe in ſect. 22. *Fabr.*

3. Browniſh yellow, at Salberg.

1. Foliated or thin 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 Konigſberg, and Scaragrufvan at Egeren in Norway.

SECT. II.

E. Criſtalliſed calcareous ſpars [*f*] ſpar druſen.

[*f*] The name ſpar is very well known, and only uſed to determine a certain figure, viz. when a ſtone breaks into a 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, Shorl or Cockle Spar, &c. This term, however, is not applied but 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

* The name of ſpar is never uſed with ſuch a latitude in our language. Thoſe of this flakey texture were, by our former writers, as Grew and Woodward, called talcy ſpars; but that term now is juſtly exploded. *D. C.*

to

ſen [*g*]. *Lat.* Lapis calcareus cryſtalliſatus. *Swed.* Spat-cryſtaller, ſpat druſer. *Fr.* Spath cryſtalliſé en groupes. *Germ.* Spath cryſtallen, ſpath druſen.

It is contained under ſeveral planes or ſides, from the relative poſitions of which many different figures ariſe, that have not all 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

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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. *Auth.*

[*g*] 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 cluſter only, whether regular or of indeterminate figures. *D. C.*

in Germany, and at Jonuſwando in Lapland.

b. Pyramidals, *pyramidales*.

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

2. Balls of cryſtalliſed ſpar, *pyramidales concreti* [b].

Theſe are balls which conſiſt of concentric octaedral pyramidal ſpar cryſtals, they are found at Rettwick in the province of Dalarne and other places.

SECT. 12.

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

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.

1. Scaled ſtalactites of very fine particles, *ſtalactites teſtaceus particulis impalpabilibus*.

a. Of a globular form, *S. teſtaceus globuloſus*.

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[b] The concave figured ſpar balls in the quarries of Somerſetſhire and other counties in England. Such balls of freeſtone are not unfrequently found. *D. C.*

1. White, the pea-ſtone from Carlsbad, in Bohemia.
2. Grey, *Piſolithus*, *Oolithus*, from Gottland in Sweden [i].

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.* 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 another, diminiſhing by degrees both in height and other dimenſions [k].

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

[k] This ſpecies is likewiſe found in the neighbourhood of Peterwalde, in Lower Saxony. *Brun.*

* Eſpecially in all hot baths. *Brun.*

2. Solid ſtalactites of a ſparry texture, *ſtalactites ſolidus particulis ſpatoſis* [l].
a. Hollow, and in form of a cone, *coniformis.*
1. White and ſemitranſparent from Chaceline near Rouen in France [m].

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[l] In making lime-water (*aqua calcis vivæ*) 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. *The Author.*

[m] 3. Solid ſtalactites, of a radiated texture.
a. In form of corals.
1. White, abounds in the caverns of the ſteel-mines in Upper Stiria, and more ſcarce in the ſhaft of *Backen*, near Chemnitz in Hungary. *Brun.*

SECT. 13.

B. Calcareous earth, combined with vitriolic acid. Plaſter-ſtone. Parget. *Lat.* Terra calcarea acido vitrioli ſaturata. Gypſum. *Sw.* Gyps arter. *Fr.* Gypſe. Platre. *Germ.* Gypſarten [*n*]. 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 made red-hot, its powder readily concretes with water into a maſs which ſoon hardens; and then
5. No heat is perceived in the operation.

[*n*] Plaſter contains about half of its weight of vitriolic acid, viz. $\frac{46}{100}$ of this acid, $\frac{32}{100}$ of pure calcareous earth, and $\frac{22}{100}$ of water. It is ſoluble in 500 times its own weight of warm water, or 450 of boiling ditto, *(Berg. de Analyſi Aquarum:)* from whence it appears that it ſhould be placed among ſalts. It is well known by the property it has of forming, after a ſlight burning, a hard maſs with water. In the act of this mixture ſome heat is produced, though much leſs than when lime is mixed with water. *Berg.* Scia. § 59.

Plaſter is often employed in building: it may alſo be taken off afterwards, and by burning, again and again, be made fit for uſe. *Theoph. on Stones*, § 115.

6. It

6. It is nearly as difficult to be melted by itſelf as the limeſtone [*o*], 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 [*p*].
8. Burnt with any inflammable matter it emits a ſulphureous ſmell, and may as well by that means, as by either of the fixed alcaline ſalts be decompounded: but for this purpoſe there ought to be five or ſix times as much weight of ſalt as of gypſum.
9. Being thus decompounded the calx or earth which is left, ſhews commonly ſome marks of iron.

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

[*p*] When a ſmall quantity of any gypſum is melted together with borax, the glaſs becomes colourleſs and tranſparent, (ſee note *b* § 4,) but I have found ſome ſorts of alabaſter and ſparry gypſa that, when melted in ſome quantity with borax, yield a fine yellow tranſparent colour, reſembling that of the beſt topaſes.

This phænomenon 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, the glaſs becomes opaque, juſt as it happens with the pure limeſtone. See the following *Treatiſe on the pocket Laboratory.* E.

SECT. 16.

B. Gypſum of a ſcaly ſtructure. *Gypſum particulis micaceis.* This is the common plaſter of Paris.

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

SECT. 17.

C. Fibrous gypſum, or plaſter-ſtone, *gypſum fibroſum, alabaſtrites.*

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

Great variety of fine alabaſters are found in Italy: at Volterra alone no leſs than twenty-four quarries of them, each of a different colour, are now worked out. The Romans however brought from Greece the greateſt part of thoſe alabaſters they made uſe of. *Fabr.*

SECT. 18.

D. Spar like gypſum, *ſelenites.* This by ſome is alſo called *glacies mariæ*, and is confounded with the clear and tranſparent mica.

1. Pure ſelenites.

Tranſparent, *ſpatum gypſum diaphanum.*

a. Colourleſs, from Swiſſerland.

b. Yellowiſh, from Mont-martre near Paris.

N. B. *The* marmor metallicum, *which the author has inſerted in this ſection, belongs to ſect.* 40. *This and ſome other minerals of this kind deſcribed by the noble author of this mineralogy, contain the* ponderous earth, *which properly conſtitutes the* ſecond Order of earths, *as has been hinted in the note* m *to ſect.* 3. *and for this reaſon will be put ſeparately in ſect.* 40. See Berg. Scia. § 89.

SECT. 19.

E. Cryſtalliſed gypſum, *gypſum cryſtalliſatum.*

Gypſeous druſen, *druſeæ gypſeæ.*

1. Druſen of cryſtals of pure ſparry gypſum. *See* § 18. n. 1.

A. Wedge-formed, *cuneiformes*, are compoſed of a pure ſpar-like gypſum, from St. Andreaſberg.

1. Clear

1. Clear and colourleſs, from Switzerland.
2. Whitiſh yellow, from Montmartre.

B. Capillary, *capillares.*

a. Opaque, whitiſh yellow, from Stollberget in Kopparbergſlan in Sweden [r].

N. B. *The three ſpars here deſcribed by the author, under the ſpecies of* marmor metallicum druſicum: *viz. the* jagged, *the* white, *and the* reddiſh, *are inſerted in the additional* Order of earths ſect. 46. *to which they properly belong.*

SECT. 20.

F. Stalactitical gypſum. *Stalactites gypſeus. Gips ſinter.* This, perhaps, may be found of as many different figures as the calcareous ſtalactites or ſinters. *See* § 12. *c.*

I have only ſeen the following, viz.

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.

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[r] *b.* Hexagonal, Priſmatic, in Normandy.
c. Globular, conſiſting of cuneated rays, proceeding from the centre. *Brun.*

them have a ſparry form and appearance: they are, however, often met in an indeterminate figure [x].

They are only known in an indurated ſtate, and diſtinguiſh themſelves from the other earths, by the following characters [y].

1. They are ſcarce harder than common calcareous ſpars and conſequently do not ſtrike fire with ſteel.
2. They do not ferment with acids neither before nor after calcination.
3. They do not melt by themſelves; but crack and ſplit to pieces when expoſed to a ſtrong fire [z]. But
4. In mixtures with all other earths they are very fuſible, and eſpecially with calcareous

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have diſſolved them often with boiling vitriolic acid, to get the ſparry acid under an aerial form, within a veſſel of quickſilver, where the admiſſion of common water reduces this kind of air into earth, as Dr. Prieſtley diſcovered ſome few years ago. *The Edit.*

[x] I have adopted the name of *fluors* in Engliſh, to this order. *D. C.*

They are called *fluors* from their comparatively ready fuſibility, which makes them be uſed, particularly in England, as flux for lead-ores, whoſe veins they generally accompany. *Fabr.*

[y] Their ſpecific gravity is, 3,144, and even 3,175. *Wall.*

[z] 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. *Eng.*

earth

earth with which they melt into a corroding glaſs that diſſolves the ſtrongeſt crucibles, unleſs ſome quartz or apyrous clay be added thereto [a].

5. When heated ſlowly, and by degrees they give a phoſphoreſcent light: but as ſoon as they are made red-hot, they looſe this quality. The coloured ones, 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.

SECT. 23. (98 of the Author).

A. Indurated fluor, *fluor mineralis induratus.*

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

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

a. White, found in Batgruſvan, at Yxſio in Nya Kopparberget in Weſtmanland.

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[a] See note *u* to § 4.

SECT. 24. (99 of the Author).

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, 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.

SECT. 25. (100 of the Author).

3. Cryſtalliſed fluor, *fluor cryſtalliſatus.*

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 Giſlos 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 an octoëdral figure.

a. Clear, colourleſs. This I have ſeen in the collection of the mine-maſter Mr. Von Swab [*a*].

SECT. 26. (101 of the Author).

Obſervations on Fluors.

That which cauſes the phoſphoreſcent light (§ 22. N° 5.) vaniſhes in the fire, it being impoſſible to collect it, by any method we are yet acquainted

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[*a*] "In Hungary and Tranſilvania are no fluors; there are ſome in Saxony, yet not in ſufficient quantity to be uſed in melting of ores. Upon the Hartz, and eſpecially near Stollberg, there are ſome veins of it, of the width of ſeveral fathoms. From this place they ſell it to the copper works of Mansfield and parts adjacent, where they uſe it as a flux to their refractory ſlate." *Brun.*

acquainted with. 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 eſſayers: it has alſo from this quality got the name of fluor, or flux [b].

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[b] That theſe ſparry fluors are but a combination of calcareous earth with the *fluor acid*, is evidently demonſtrated, both by the chemical analyſis of theſe ſubſtances, and by their ſynthetical production. In the firſt caſe, the ſparry acid is expelled from theſe ſpars by any of the three mineral acids; but more eaſily by the vitriolic acid. This acid (the ſparry) for the moſt part is developed in the form of an elaſtic vapour, which, according to Meſſrs. Scheele and Bergman, forms a *ſiliceous earth* as ſoon as it comes in contact with water, or even with vapour of water. And if the ſame ſparry acid is joined to calcareous earth, true ſparry fluors are produced; which ſynthetically demonſtrates their real component principles. *Fabr.*

But Mr. Meyer, of Stetin, has ſhewn that the opinion of Meſſrs. Scheele and Bergman (viz. that the *fluor acid* produced *ſiliceous earth* when in contact with water) is erroneous: and Mr. Bergman has acknowledged the miſtake with a degree of readineſs and candour that reflects the greateſt honour on his character, in a letter I received from this great philoſopher, dated December 24, 1782. The cauſe of this miſtake proceeds from the property which the *fluor acid* poſſeſſes of volatizing the *ſilicious earth*, contained either in the glaſs retort, or in the *ſparry fluor* when it is expelled by the vitriolic and in that operation above-mentioned by Mr. Fabroni. *Edit.*

The reſemblance between the coloured fluors, and the compoſitions made of glaſs, has perhaps 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 to their alſo obtaining a rank among the precious ſtones in the apothecaries and druggiſts ſhops [c]. 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. 27. (210 of the Author).

Calcareous earth ſaturated with a particular acid, perhaps of the metallic kind, *(viz.* the Tungſtenic acid). *Calx acido peculiari, forte metallico ſatiata* [d]. The *Tungſtein* of the

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[c] This combination of *calcareous earth* with the *ſparry acid* is almoſt always tranſparent: it often cryſtaliſes in regular cubes, ſometimes ſingle from one line to two inches in diameter, and ſometimes of an indeterminate figure. They are ſometimes of a blue colour, others are purple like amethiſtes; ſome are of a brown colour, and ſome are opaque. *Fabr.*

[d] The author ſays that this ſubſtance is a calx of iron, united with another unknown earth, *Ferrum calciforme terrâ quâdam incognitâ intimè mixtum.* But both Scheele and Bergman, after the exact analyſis made by each of them ſeparately of this ore, deciſively affirm, that its baſis is merely a *calcareous earth*; and that it is combined in this ore with the *Tungſtenic acid*, which was unknown in the time of the author; but it will be deſcribed hereafter in Sect. 163. It is evident, therefore, that this ore ought never to be called *Lapis ponderoſus*, which conveys the wrong idea of belonging to the *ponderous earths* of the ſecond order, Sect. 48. *See* Bergm. *Sciagr.* § 97. and *De Tubo Ferrum.* § 17. but more particularly in their own accounts, inſerted in *Journ. de Phyſiq.* for *February* 1783, p. 124 and 128.

Swedes

Swedes [e]. This is alſo, though improperly, called white Tingrains [f].

This reſembles the garnet-ſtone (of Sect. 115), 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 thirty per cent. [g]. It is very difficultly diſſolved by borax and alcaline ſalts, but melts very eaſily with the microcoſmic ſalt, giving a black ſlag: and for this reaſon, the laſt-mentioned ſalt muſt be employed in the eſſays of this ſtone. It is found,

1. Solid and fine-grained.

a. Reddiſh or fleſh-coloured.

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[e] The ſpecific gravity of this ſubſtance is 3,600. Berg. in *Journ.* de Phyſ. Feb. 1783, where may be ſeen the analyſis of this ſubſtance, both by the ſame profeſſor, and by Mr. Scheele.

This ſubſtance is not very ſoluble in acids, and is eaſily known by reducing it into powder, and digeſting it over the fire with muriatic acid; becauſe it will ſoon take a fine yellow colour. Beſides calcareous earth, it contains alſo ſome portion of ſilicious earth. *The Edit.*

[f] This mineral, called *zin graupen* by the Germans, commonly named white tin ore, or *white cryſtals of tin*, is very often nothing elſe but a true *tungſtein*, from whence it appears the abſolute neceſſity of a chemical analyſis to diſtinguiſh one ore from another. *The Edit.*

[g] In all probability theſe were true cryſtals of *garnets*, though ſimilar to the *tungſtein:* as Mr. Scheele above quoted could hardly find two grains of Pruſſian blue in a conſiderable ſolution of this laſt ſubſtance. *The Edit.*

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 [*h.*]

SECT. 28. (22.)

D. Calcareous earth united with the inflammable ſubſtance [*i*]. *Terra calcarea phlogiſto mixta, ſeu impregnata.*

These

[*h*] 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. *The Author.*

Authough the Tungſtein be generally found in or near the mines of *Molybdu*, and *black lead*; the metallic acid which unites with its calcareous baſis is far different from the Molybdenic acid, notwithſtanding that ſome of their properties are ſimilar in them both: as will be ſeen in Sect. 162 and 163. *The Editor.*

[*i*] Calx *aerata* (*mild* calcareous earth), with more or leſs *petroleum.* It efferveſces, and diſſolves with acids; with the vitriolic acid it frequently turns brown. Is fœtid when heated or rubbed. The oil is not in ſufficient quantity to be collected,

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.

SECT. 29. (23.)

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

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 Wretſtrop at Skoers in the province of Nerike.

C. Scaly, *Particulis micaceis.*

1. With coarſe ſcales.

a. Black, at Nas in Jemtland.

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lected, by diſtillation, in drops; it only fouls the inſide of the veſſels, unleſs a very great quantity be operated upon. In an open fire the colour preſently vaniſhes, from the petroleum drying up. It generally contains a portion of martial clay. *Berg. Sc.* § 95.

2. With fine glittering on 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 Kraſnaſelo in Ingermanland [k].

N. B. *The mineral deſcribed in the 24th ſection of the Author as belonging to the* calcareous earths, *being now acknowledged, as belonging to the* ponderous earth [l], *will be inſerted in that order of earths.*

SECT. 30. (25.)

E. Calcareous earth blended with an argillaceous earth. Marle. *Lat.* Terra calcarea argilla intimè mixta. Marga. *Swed.* Mergelarter. *Fr.* Marne. *Germ.* Mergel.

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

[l] Berg. Sciagr. § 90.

1. When crude, it makes an effervefcence with acids [m], 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.
5. It is of great uſe in promoting the growth of vegetables, ſince the clay tempers the drying quality of the calcareous earth.
6. 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 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.

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[m] If marle be put into fuſed nitre, it does not make any detonation, but it is decompoſed by the ſame.

Every *argillaceous* earth, mixed with one quarter of its weight of *calcareous* earth, is called marle. *Fabr.*

SECT. 31. (26.)

1. Looſe and compact. *Marga friabilis.*
This diffuſes in water like common clay.
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 Rorſtrand near Stockholm.

SECT. 32. (27.)

2. Semi-indurated. *Marga indurata aëre fatiſcens.*

It is nearly as hard as a ſtone when firſt dug up, but moulders in the open air. It is moſtly ſlaty, and it is not uncommon in the ſlate rocks of Sweden, where it lies between the thick beds of ſlaty limeſtone. It 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.

SECT. 33. (28.)

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

A. In looſe pieces, *Marga indurata amorpha*; 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 is formed from a ſediment which the water carries along with it.

B. In continued ſtrata, *Marga indurata ſtratis continuis.* Hard ſlaty marle.

SECT. 34. (Additional.)

Obſervations on Marle and arable Soil.

It is probable that the good effects of marle in agriculture proceed from its containing an earth ſoluble in water, and that it ſerves to haſten or facilitate the decompoſition of vegetable or animal ſubſtances that may be mixed therewith, rendering their oily parts mucilaginous, and ſoluble in water, and thereby capable of penetrating into the pores of the roots of plants: it may alſo hinder the propagation of inſects.

inſects. Beſides I believe it contributes much to vegetation by furniſhing aerial acid or fixed air which it may afterwards reaſſume from the atmoſphere. *Fabr.*

The efficacy of marle, as a manure in agriculture, has been explained at large in a book publiſhed a few years ago at Paris, with the title *Reflections ſur l'Agriculture* in 12mo. to which the author (Mr. J. Fabroni) out of modeſty did not prefix his name. *The Edit.*

Engliſh farmers diſtinguiſh ſix ſorts of marle.

1. The *Coro-ſhut marle*, which is brown mixed with fragments of chalk and blue veins.

2. *Stone ſlate*, or flag-marle, it reſembles blue ſlate and crumbles eaſily when expoſed to the air.

3. *Pont marle*, or delving marle, it is brown and rough to the touch.

4. *Clay-marle*, which contains much clay.

5. *Steel-marle*, it is of an aſh grey colour, and breaks in cubes.

6. *Paper-marle*, its colour is black, its conſiſtence like that of bits of paper. *Fabr.*

It is however highly probable, that the good effects of marle in agriculture, depend from the circumſtances of the ſoil, by ſupplying it with that part of *clay* and *chalk*, which is wanting to make up the beſt proportion of its component parts. That this is the caſe in many inſtances, is evident by the judicious experiments of profeſſor Bergman, which ſhow, that, in Sweden, the beſt arable land of a flat ground, where about 15 inches of rain fall yearly, contains 4 parts

parts of *clay*, 3 of *ſiliceous* earth or *ſand*, 2 of *chalk*, and 1 of *magneſian* or *ſoapy earth*, viz. that which conſtitutes the baſis of Epſom ſalt. Theſe proportions muſt vary according to the local circumſtances of the ground and climate of each country. But after the diſcovery of ſuch a leading principle, no rational farmer can be excuſable hereafter, if he does not take the neceſſary ſteps to aſcertain the moſt advantageous proportion of theſe component parts, that are ſuitable to his ſoil, and does not improve it accordingly, by employing ſuch manures as tend to ſupply their deficiency. The above learned Profeſſor practiced this method in his own country to the utmoſt advantage: and there is not the leaſt doubt but the general ignorance of farmers in this reſpect has been the cauſe of continued blunders, and numberleſs wrong practices in huſbandry ſuch as throwing *chalk* or *lime* on grounds which wanted *clay*, or *ſand*, and the like. By ſuch blind proceedings many valuable means of rural improvement have been brought to common diſcredit, which if properly applied would be extremely profitable in their reſpective circumſtances [*n*]. *Edit.*

SECT.

[*n*] The Society for the encouragement of arts, manufactures, &c. in London, has offered, at my requeſt, a premium in this year (1783) for this purpoſe, which I hope will be attended with great advantage to the Britiſh agriculture: it runs thus. "To the perſon who ſhall produce to the Society the moſt "ſatisfactory ſet of experiments to aſcertain the due propor- "tion of the ſeveral component parts of the beſt arable land "in

SECT. 35. (29.)

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

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" in one or more counties in Great Britain, by an accurate " analyſis of it; and who having made a like analyſis of ſome " poor land, ſhall by comparing the component parts of each, " and thereby aſcertaining the deficiency in the poor ſoil, " improve a quantity of it not leſs than two acres, by the addition of ſuch parts as the former experiments have diſcovered to be wanting therein, and therefore probably the " cauſe of its ſterility, the gold medal.

" It is required that the manurings, plowings, and crops " of the improved land be the ſame after the improvement as " before: and that a minute account of the produce in each " ſtate; of the weather, and of the various influencing circumſtances together with the method made uſe of in analyſing the ſoils, be produced with proper certificates; and " the chymical reſults of the analyſis, which are to remain " the property of the Society, on or before the laſt Tueſday " in November 1788.

" It is expected that a quantity not leſs than ſix pounds " of the rich, of the poor, and of the improved ſoils, be produced with the certificates.

" N. B. Among the methods or proceſſes made uſe of by " chymiſts and called *dry*, or *moiſt*, the latter appears only " adapted to the aſcertaining the reſpective proportion of the " component parts of arable earth. Dr. Shaw in his *Chymical Lectures*; Dr. Home in his *Principles of Agriculture*; " Dr. George Fordyce in his *Elements of Agriculture*, and Sir " Torbern Bergman in his *Diſſertation Sur les Terres Geoponiques*, have treated of theſe ſubjects." See the Tranſactions of the Society for the Encouragement of Arts, &c. for 1783, in 8vo. p. 94. *The Editor.*

cannot

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 calcareous earth, viz.

SECT. 36. (30.)

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.

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 is found,

SECT. 37. (31.)

A. Looſe, *Minera ferri alba pulverulenta*, which is the mouldered part of the indurated ſort.

a. Black.

Is like ſoot. It is found at Weſterſilverberg in Kopparbergſlan in Sweden among the earth that covers the white iron ore.

b. Dark brown.

This ſomewhat reſembles umbre, and is found at Solſkienſberg in Norberg in the province of Weſtmanland.

SECT. 38. (32.)

B. Indurated, *Indurata.*

1. 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 effervеſcence. It is found at Hellefors in the province of Weſtmanland, and at Graſberg in Grangierde in the province of Dalarne.

SECT. 39. (33.)

2. Scaly, *Particulis micaceis.*

a. White, from Naſſau Siegen, and Weſterſilverberget in the province of Weſtmanland.

b. Blackiſh grey, in Smalkalden, and the old mines at Helleforſſen in Weſtmanland [*o*].

3. Spar like, *Spatoſa.*

a. Light brown, from Naſſauſiegen and Smalkald.

4. Druſen, *Druſica.*

a. Blackiſh brown from Smalkalden.

b. White.

1. Porous. This is often called eiſenblute, or flos ferri. It is found at Weſterſilfverberg.

2. Cellular, from Weſterſilfverberg [*p*].

[*o*] In England in the foreſt of Dean, where it is called *grey ore*, and at Bigrig Moor in Cumberland.

[*p*] Theſe kinds, in regard to their texture, are ſo like thoſe calcareous ſtones we call *limeſtones* (§ 9), and ſpars (§ 10 and 11), that they may be eaſily confounded with one another, were not the other characters obſerved at the ſame time. *The Author.*

SECT. 40. (34.)

2. Calcareous earth united with copper, *Terra calcarea croco, ſeu calce veneris intrinſecè mixta.*

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

This diſſolves in aqua fortis with effervefcence.

SECT. 41. (35.)

B. Indurated *indurata.*

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

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[q] M. Marggraf and other chymiſts have proved that *lapis lazuli* contains no copper at all. It is ſometimes melted on account of the ſilver it contains. The particles of marcaſite in it indicate ſome martial or irony parts, and the blue colour, together with its ſtanding the fire, depends upon the metallic parts. The Hungarian gang-works in the new mine of *St. Antonio di Padua* near Hoderitch, are ſometimes full of fine blue ſpecks, which indicate that there is a good deal of ſilver in it. The ſtone itſelf is certainly a compounded one; it is generally calcareous, and ſometimes particles of quartz are mixed in it. *Brun.*

Such

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. 42. (36.)

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 [r].

SECT. 43. (37.)

3. Calcareous earth united with the calx of lead, *Terra calcarea ceruſſa nativa intime mixta.*

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[r] By chemiſtry we know, that alcaline 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. *The Author.*

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 effervesſces with acids.

A. Looſe and friable, *Friabilis.*

a. White from Kriſtierſberget in Nya Kopparberget pariſh in Weſtmanland.

SECT. 44. (38.)

B. Indurated.

1. Scaly.

a. Yellowiſh from Kriſterſberget [*s*].

SECT. 45. (39.)

Obſervations on the calcareous Earths in general.

The calcareous earth is diſtributed over the whole world in proportion to its great utility, though it is ſometimes abſorbed and concealed in

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[*s*] 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 (§ 36). Thus may theſe be diſtinguiſhed from other lead ochres and ſpar-like lead ores, which are much richer in lead, and never effervеſce 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. *Author.*

in heterogeneous ſubſtances. If it could be proved that nature, to perform its works, does not require more than thoſe two active agents, the acid and the alcali, and that the calcareous earth might under certain circumſtances be changed into a mineral alcali as ſome have conjectured; the neceſſity of the exiſtence of the calcareous earth would be ſufficiently obvious. But I paſs over all theſe hypotheſes; ſince they will perhaps, remain for ever undecided. It is certainly of more conſequence to attend to 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, it is uſed for white-waſhing. It is mixed to advantage with clay in agriculture: for, according to Dr. Kullbell's rules of vegetation, its alcaline 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 vegetation like marle. The *humus conchacea*, or ſhelly 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 it poſſibly can perform. This looſe or friable calcareous earth may eaſily be made into lime, if it be previouſly ſlacked with water, and made up in moulds.

The indurated calcareous earth, or lime 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 other kinds of ſtones. The arable lands in the province of Jemtland, at Rettwick in Dalarne, at Kinnekulle in Weſtergottland, and in other places, which conſiſt merely of a calcareous earth, or a mouldered ſlate, would ſuffer a great deal from the ſun in dry ſeaſons, 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 commonly found in Sweden, is moſtly ſlaty, 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 other œconomical uſes. But great care muſt be taken in the choice of theſe ſtones, ſince it may happen that the finer works, made of this kind of ſtone, will in length of time, crack and break into two or more plates, eſpecially

cially 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. It is, 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 lie 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 limeſtones, 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:

Marmo nero di Fiandra—The black marble of Flanders.

Marmo giallo di Siena—Plain yellow.

Marmo giallo antico—Yellow, with ſome white veins.

Marmo di fiume d'Arno—Yellow, with black dendrites.

Marmo di Firenza, Paeſino—Yellow, with brown figures, reſembling ruins.

Marmo nero e giallo di Porto Venere—Black and yellow.

Marmo nero et bianco di Carrara—Black and white.

Marmo tartufato d'Urbino—Pale yellow, with ſpots of a blackiſh grey colour.

Marmo brocatello di Spagna—Yellow, white and red.

Marmo palombino antico—Pale yellow.

Marmo alberino di monte Gallicano—Olive colour with deeper coloured croſs lines, and dendrites.

Marmo roſſo di San-Giuſto—Browniſh red.

Marmo carnagione de Piſtoia—Fleſh coloured and yellow.

Marmo roſſo di Monſummano—Common red marble.

Marmo fior di Perſico di Saravezza—Crimſon, white and grey.

Marmo pavonazzo—Reddiſh-brown lumps on a whitiſh ground.

Marmo bardiglio—Bluiſh-grey.

Marmo ſtatuario di carrara—Of a ſnowy white.

With infinitely more varieties, whoſe number is improperly augmented by thoſe who for intereſt ſake collect ſpecimens, and likewiſe by ſome virtuoſos, 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* or *broccatellato*. The figures are chiefly regarded in the *Paeſino di Firenza*,

Firenza, *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 *marmo 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 in Sect. 9.

There are, however, ſeveral among the abovementioned marbles which are partly mixed with the ſcaly limeſtones (Sect. 9.) 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 the maſons term it, and do not ſhow their true colours, by reaſon of the ſemi-tranſparency of their particles, and their different poſitions in regard to one another, as may be ſeen in the marble from the pariſh of Perno in Finland.

Of the fine glittering limeſtone (§ 9. n. 3.) are the following:

Marmo 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 abbruciato*; every one of which is ſomewhat tranſparent at the edges.

In the pariſh of Pargos, 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 Lillkirke 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 look rather like alabaſter.

While we are on the ſubject of marbles, it is neceſſary to obſerve, that as the Italians have a well-

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 *ſtudi*, that moſt ſtones which take a poliſh 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 theſe 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, though 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 di 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 (§ 10), and its cryſtalliſations (§ 11), are more difficult to be burnt into lime, than other limeſtones. They are alſo of no great uſe in architecture, any further than that they may be employed in making *grottos*. Nature ſeems to have made the quantity of this kind proportionable to its uſe. But

Gypſum or plaſter ſtone is of very great conſequence in building; and its ſtrata, which are very ſparingly diſtributed in the earth, are worth ſearching for. If it be 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, whether the gypſum ought to be ſearched for in any other place beſides thoſe ſtrata where there is a poſitive proof of their having been 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, whether theſe ſtrata ought before to have been ſet on fire, whereby the vitriolic acid already contained in them has been ſeparated from the inflammable

flammable ſubſtance, by the action of fire, and afterwards fixed itſelf in the pure calcareous earth?

The miners uſe crude limeſtone to make the hearths 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 (§ 9.) is the beſt, and next to that the grained limeſtone (§ 8.)

Thoſe who intend to ſearch for limeſtone to make lime, and are afraid to miſtake the white iron ore (§ 36.) for it, ought only to obſerve, that the latter always decays in the open air into 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 in the *alſwarſten*, in which there is always ſome mixture of clay.

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 it is neither 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, for which reaſon the cement containing it muſt in length of time be diſſolved and rendered uſeleſs, and likewiſe on the contrary, that a perfectly calcined iron is not 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, whether it poſſeſſes the requiſite durability. The *terra puzzolana* or *terras* is a ſandy marle mixed with iron and baked in a ſtrong fire. Its effects, however, in the cement, may, perhaps, depend only on the iron which has been reduced into a particular ſubſtance by means of ſubterraneous fires, evident ſigns of which are obſervable in the places where it is obtained.

If the ſlate in Henneberg, or Kinnekulle in the province of Weſtergottland ſhould happen to get fire, the uppermoſt ſtratum, which now conſiſts of a mixture of iron and different kinds of rocks, called *graberg* in the account given of them, they might perhaps be changed partly into ſlag and partly into *terra puzzolana*.

SECT. 46. (Additional.)

THE foregoing Sections were already printed off, when the work of that excellent philoſopher and able chemiſt Mr. Kirwan, whom I enjoy the happineſs of calling my friend, made its appearance to the public, under the title of *Elements of Mineralogy*; I therefore take the advantage of extracting from it ſome new obſervations which could not enter into their reſpective places, to illuſtrate the ſubject of calcareous earths.

Among the ſimple earths the calcareous alone (though perhaps the ponderous may have the ſame property, when proper experiments come to be made on it) can be looked upon, as the menſtruum of other earths; for according to the important diſcovery of Mr. D'Arcet, they are all rendered fuſible by a proper proportion of this earth, though infuſible by themſelves. *Calcareous* earth requires for its fuſion half its weight of *magneſian*, and only one third of its own weight of *argillaceous* earths, according to Mr. Achard: and Mr. Gerhard having expoſed *ſiliceous* earth to a violent heat in a crucible of chalk, found it vitrified in the edges, where it touched the *chalk*. Even in the *liquid way*, this earth manifeſts the ſame effinities. Thus if pure earth of alum (the *argillaceous*) be added to lime water, the lime will be precipitated

pitated as Mr. Scheele aſſerts: and this precipitate is ſoluble in marine acid, which ſhews that it does not ariſe from any remainder of the vitriolic acid, as ſelenite is not ſoluble in the marine acid.

The affinity of calcareous earth to other earths, according to Mr. Kirwan, ſtands thus, 1ſt, the calx of iron: 2dly, the argillaceous: 3dly, the magneſian: and 4thly, the ſiliceous earth.

When calcareous earth has acted as a menſtruum upon another earth, a compound ariſes, which acts more powerfully on other earths. Thus, though one hundred parts of *lime* can diſſolve or liquify very little of the *ſiliceous* earth, yet when it has taken up fifty of *magneſia*, they may diſſolve one hundred of the *ſiliceous:* and this laſt compound becomes ſtill more powerful; for equal parts of *lime*, *magneſia*, and *ſilex* form a perfect glaſs: hence equal parts of each ſimple earth will vitrify in ſufficient heat, provided the *calcareous* be one of them: nay equal parts of *lime* and *argill*, will melt 2 or 2½ of *ſilex:* and other mixtures will be more or leſs fuſible, as they approach to this proportion.

" Calcareous earth when pure has a hot burning taſte, acts powerfully on animal ſubſtances: and when in lumps heats by the addition of a moderate quantity of water."

" In the temperature of 60° (of Fahrenheit's thermometer) it requires about 680 times its weight of water to diſſolve it. Its taſte is then pungent, and urinous, yet ſweetiſh."

" When in veſſels, on which it cannot act, it is infuſible *per ſe* (ſingly), in a heat that would melt iron: yet it aſſumed a ſlight beginning of fuſion when expoſed, on a piece of charcoal, to the focus of the ſolar rays of the admirable burning lens lately made by Mr. Parker. But when mixed with other earths it eaſily melts: from whence it appears, why it melts when put on porcelain, or other earthen veſſels."

" It is hardly affected by fixed alkalis; but it eaſily melts, without efferveſcence, if pure, by *borax*, *microcoſpic ſalt*, or *calces of lead*."

Addition to note *u* § 5. The *Calx Bathenſis* already mentioned is a ſtone of a grey colour, moderately hard, or rather ſoft, found near Bath; compoſed of *calcareous* earth, partly *pure*, and partly *combined* with *aerial acid:* the firſt is evident by it being ſoluble in water, to which it communicates the taſte of lime: and the ſecond, by its efferveſcence with any *other acid* ſtronger than the *aerial one*, as mentioned note *q* to § 4. Theſe ſtones become harder when expoſed to the air ſome conſiderable time; becauſe they attract the ſufficient quantity of aerial acid to be ſaturated: and many other ſtones, which have the ſame property, ſeem to be in a ſimilar caſe [*t*].

Mr.

[*t*] This ſeems to be the chief circumſtance, to which the cement and mortar of the antients, owns its amazing hardneſs, as obſerved in many of the Roman buildings ſtill remaining

Mr. Monet found alſo this earth in a looſe, dry and powdry ſtate, in the mountains of Auvergne; which he ſuſpected to proceed from ſome volcanic operation.

Addition to § 10. Calcareous ſpars are of a lamellar texture, and moſtly break or ſplit into rhomboidal plates or laminæ: their cryſtallized forms are various, as rhomboidal, hexangular, triangular, polyangular, but the firſt is the more common. Their ſpecific gravity is generally about 2700, when pure from metallic particles. They generally contain from 34 to 36 per cent. of *aerial acid*, 53 to 55 of mere earth, and the remainder of water. When pure they are colourleſs: but the mixture of metallic particles renders the green, or brown, reddiſh, yellowiſh, and even black colours that ſome have.

Addition to note *i* § 12. The *Stalagmites* do not differ from the *Stalactites*, but in being formed at the bottom of caverns and vaults, whilſt the laſt are ſuſpended from the top of ſimilar places, where water impregnated with calcareous particles is droping down: and of courſe the firſt get a mammillary form, whilſt the *ſtalactites* acquire a conic figure: the *oolithes* and *piſolites* belong to the ſame ſpecies. Moſt of theſe ſtones contain a ſlight mixture of argill

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maining to our days. From thence it appears, that lime ought to be employed ſoon after being burned, in making mortar: and that it is wrong to leave this laſt a long while expoſed to the air, as I have ſeen in many places, before it is employed in building. *The Editor.*

and calx of iron: from which they are of a grey, yellow, or blackiſh colour.

The *Tophi, Pori*, or *Duckſtein* of the Germans differ from the preceding not only in ſhape, but principally in this, that they have been formed by a gradual depoſition of earths, chiefly of the calcareous kind, barely diffuſed through water, made within the water itſelf and not in the air. Hence they are of the ſame colour as the foregoing. Theſe are generally found on branches and roots of trees and ſtones of different kinds. Thoſe found on the roots of pines called *oſteocolla*, examined by Mr. Margraaf, conſiſt of calcareous earth, mixed with ſome ſiliceous earth, and volatile alkaly, together with ſome vegetable parts.

Addition to § 6. *Chalk, Craie de Champaigne, blanc d'Eſpagne* of the French, the pureſt is *white*, and yet it contains about two per cent. of argill. There is a *blue chalk* in the neighbourhood of Upſal which contains iron. Dry chalk contains more aerial acid, than any other of the calcareous kind; generally about forty per cent. Its ſpecific gravity is from 2400 to 2650.

Addition to § 45. The *Albareſe* of the Italians, and the *St. Stephen's* ſtones, ſo called on account of ſome red ſpots they have, are but lime ſtones: all contain ſome ſmall portion of argill, quartz, and iron. Lime ſtones contain ſometimes a ſmall portion of magneſia and ſea-ſalt: and ſome found in *Scania*, contain orpigment, according to Mr. Scheffer. Lime ſtones have in

general

general a ſpecific gravity from 2650 to 2700. That of *Portland ſtone* is 2533: and that of *Purbeck ſtone* 2680, this laſt affords more lime, according to Mr. Watſon's obſervation. The *Bath ſtone* has a more granular and open texture than the *Portland ſtone:* its ſpecific gravity is 2494.

The *calcareous flag-ſtone*, or Schiſtus near Woodſtock, is of a yellowiſh white colour, moderately hard: its ſpecific gravity is 2585, it contains a little iron.

The ſpecific gravity of marble is from 2700 to 2800: that of Carrara is 2717.

Black marble owes its colour to a ſlight mixture of iron. Mr. Bayen found ſome which contained five per cent. of iron: yet the lime made of it was white, but in time it acquired an ochry or reddiſh yellow colour.

Calcareous ſtones which grow black or brown, are ſuſpected by *Bergman*, to contain manganeſe, and in this caſe the lime thus afforded muſt form an excellent cement. According to *Rinman*, white calcareous ſtones which grow black by calcination, contain about ten per cent. of iron.

Grey marble receives its colour from iron, which is about two per centum in it.

Blue and *green* marbles derive their colour from a mixture of ſhorl, according to *Rinman*.

Addition to § 13. The ſpecific gravity of gypſum is generally 2320: ſometimes only 1870.

Addition to § 26. Blue fluors derive their colour moſtly from iron, but ſometimes from cobalt.

cobalt. If iron is precipitated from the ſparry acid by lime water, the precipitate is white with blue ſpecks.

Green fluors owe alſo their colour to iron.

The phoſphoreſcent property of fluors ſeems to ariſe not from the acid ſingly, otherwiſe all fluors would poſſeſs it; but from the acid, in contact with metallic particles; viz. from the acid and phlogiſton.

Addition to § 27. The ſpecific gravity of the Tungſten is from 4990 to 5800. It is inſoluble in acids, except by peculiar management. When powdered and digeſted with *nitrous*, or *marine* acid, it aſſumes a yellow colour, as was obſerved by Mr. Woulfe. When heated it burſts, becomes reddiſh, and melts very difficultly per ſe. It contains about half its weight of calcareous earth, and the remainder is a peculiar acid of an earthy appearance, and iron.

The *red or fleſh-coloured Tungſten* ſpoken of by the author in this § 27, does not efferveſce with acids: ſcarcely gives any fire with the ſteel: is of a coarſe texture, and is eaſily pulveriſed. Its ſpecific gravity is from 4900 to 5800. It becomes magnetic after calcination: is eaſily melted with its own weight of fluor: and with great difficulty affords about thirty per cent. of iron. Hence it is never uſed as an iron ore.

Addition to note *b* § 27. However the acid of tungſten has ſo different properties from thoſe of the acid of Molybdene, that it muſt be conſidered as a particular acid *ſui generis*: as will be ſeen hereafter, on treating of Acids.

SECT. 47. (Additional.)

Many compounds of calcareous earth with different mineral ſubſtances deſerve to be noticed in this place, which Mr. Kirwan mentions in the valuable Treatiſe that has afforded the materials for the foregoing Section.

1. A compound of *calcareous* and *barotical* earths: of this ſpecies are ſome yellowiſh ſtones found in *Derbyſhire*, conſiſting of lumps of *limeſtone* interſperſed with nodules of *baroſelenite* of § 49. Many more may occur as compounds of *gypſum* and *baroſelenite*, *fluor* and *baroſelenite*, &c. &c.
2. Compounds of *calcareous* and *magneſian* earths, ſuch as

a. The white marble interſperſed with ſpots of *ſteatites* or *ſoap rock*, either *green* or *black*, called by the Author *kolmord marble* in his § 261. This marble is of a ſcaly texture.

b. The *pietra talchina* of the Italians, which conſiſts of *white ſpar*, with veins of *talc*.

c. The *verde antico* of the Italians, which is a *light green marble*, with *deep green*, *black*, *white*, and *purple* ſpots. According to Mr. Bayen it contains ſixty-two parts of *mild calcareous earth*, thirty of *green talk*, one of *magneſia*, and one of *ſemiphlogiſticated iron*.

3. Compounds

3. Compounds of *calcareous* and *argillaceous earths.* Such as

a. The *green Campan marble* from the Pyrenées. It is ſlaty and ſomewhat magnetic. According to Mr. Bayen it contains 65 of mild *calcareous earth*, 32 of the *argillaceous*, and 3 of *ſemiphlogiſticated iron.*

N. B. Mr. Kirwan obſerves, that this ſhiſtus muſt have at leaſt 10 parts of iron to be magnetic: and that this iron is not much dephlogiſticated, as indicated by the *green* or *blue colour*, which when it proceeds from iron, always denotes that it is not much dephlogiſticated: whereas on the contrary, the *red* or *yellow colour*, denotes its being *dephlogiſticated.*

b. The *red Campan marble:* this is not magnetic: it contains 82 parts of *mild calcareous* earth, 11 of *argillaceous* ſhiſtus, and 7 of *dephlogiſticated iron.*

c. *Yellow figured marble* from Florence: according to Mr. Bayen, it contains 75 parts of *mild calcareous earth*, 13 or 14 of *ſhiſtus*, and 4 or 5 of *dephlogiſticated iron.*

d. *Griotte marble* from Autun of Burgundy in France: it contains 67 parts of *mild calcareous earth*, 26 of *rediſh ſhiſtus*, 2 of *iron*, and 1 of *magneſian earth.*

e. The *Amandola*, which is a green marble, honey-comb like with *white ſpots.* It contains 76 parts of *mild calcareous earth*, 20 of *ſhiſtus*, and 2 of *ſemiphlogiſticated iron.* The cellular appearance proceeds from the *ſhiſtus.*

4. Compounds of *calcareous earth* and *mica*, ſuch as

a. The *Cipolin* from Autun in France: it is of a green colour, and conſiſts of 83 parts of *chalk*, 12 of green *mica*, and 1 of *iron*.

b. The *micaceous* limeſtone, is of a glittering appearance, of various degrees of hardneſs, and effervеſces with acids. Such as the *macigno* of the Italians: their yellow *pietra bigia*, and their blue *pietra columbina*, or *turkina*.

5. Compounds of *calcareous* and *ſiliceous earths*, ſuch as

a. The *calcareous quartz* and *pudding ſtone*: this conſiſts of lumps of *quartz* and ſometimes of *felt-ſpar*, in a *calcareous cement*.

b. The *limeſtone* with veins of *quartz*, ſuch as The *Saxum Sahlbergenſe*, and ſeveral marbles of *Sweden* and *Siberia*, which ſtrike fire with ſteel.

6. *Calcareous volcanic pudding ſtone*, ſuch as

a. The *cierchina*, which conſiſts of lumps of *ſpar* and *lava*, in a *calcareous* cement, mentioned by Mr. Ferber.

b. The *marble* mixed with veins of *black* or *green lava* mentioned by the ſame Author.

7. Compounds of *calcareous* earth, mixed with two or more kinds of earth: ſuch as

a. The *cipolin* from Rome, which is a green marble, with white zones: it ſtrikes though difficultly, fire with ſteel: it contains 67, 8 parts of mild chalk, 25 of quartz, 8 of ſhiſtus, and 0, 2 of iron, beſides the iron contained in the *argillaceous ſhiſtus*.

b. The

b. The *calcareous porphyry*, which conſiſts of *quartz*, *felt ſpar*, and *mica* in ſeparate grains, united by a *calcareous* cement.

c. The *limeſtone* interſperſed with *ſhoerl*, and *mica*.

d. To theſe compounds belongs the *pyritaceous limeſtone*, called by the French *Pierre de St. Ambroix*. It is of an iron-grey colour, interſperſed with ſhining particles. Its texture is compact, and ſcarcely gives fire with ſteel. Its ſpecific gravity is 2,7034.

It is ſoluble in acids, and moſtly with effervеſcence: calcines in a ſtrong fire: makes nitre ſlighty detonate: and if diſtilled, affords a ſmall portion of vitriolic acid, and ſome ſulphur ſublimes.

Its component parts are 75 of mild *calcareous earth*, and 25 of *pyrites*, in which are contained 14 of *argill*, 7 of *quartz* and *ſulphur*, and 4 of *iron*.

ORDER THE SECOND,

PONDEROUS EARTHS.

SECT. 48. (Additional.)

PONDEROUS earth. Cauk, or calk. *Lat.* Terra ponderoſa. *Sw.* Tung-ſpat, ſpathig-gyps. *Fr.* Terra peſante, barote. *Germ.* Spathartiger gyps.

This is a particular kind of earth, like chalk in appearance, but with ſome very different properties, lately diſcovered in Sweden (about 1774), which by its reſults with other bodies has ſome ſimilarity to the known alkalis. It has not yet been found pure, but mixed with other ſubſtances: however, its great ſpecific weight eaſily diſtinguiſhes it from the others, it being the heavieſt of all earths.

1. Its ſpecific gravity when conſiderably purified by art [*u*] is 3,773.

2. This earth combines with aerial acid: and in this caſe effervеſces with ſtronger acids.

3. With vitriolic acid it forms the ponderous ſpar of Sect. 50, which is inſoluble in water.

4. Its cryſtalliſation after being combined with the nitrous, or with the muriatic acids, is hardly ſoluble;

5. But with acetous acid, it becomes deliqueſcent [*v*].

6. When pure; viz. without any mixture of acid or alkali, it does not vitrify in the fire.

[*u*] To have this earth as pure as poſſible, let the *ponderous ſpar* (ſect. 51.) or the marmor metallicum (ſect. 50.) be reduced into powder: and be burnt for one hour in a crucible, with equal parts of fixed alkali and charcoal: then reduce it into powder again: add to it nitrous, or diluted muriatic acid, till the effervеſcence is over, ſo that the acid may prevail: throw into it mild fixed alkali: and the ponderous earth will be precipitated. In a hundred parts by weight of this earth ſo purified, are contained twenty-eight parts of *water*, ſeven of *aerial acid*, and ſixty-five, of *ponderous earth*. It ſeems to contain ſome *metallic acid*, as yet unknown, ſimilar to the acid of Molybdene, except that its combination with *lime-water* is very different from this laſt. *Berg. Sc.* §. 33 and 88.

[*v*] The cryſtaliſations of calcareous earth have the contrary properties, being *deliqueſcent* when formed from the combination with nitrous or with muriatic acids: and *not deliqueſcent*, when formed by the acid of vinegar. *Berg.*

7. If deprived of the *aerial acid (fixed air)* by calcination, is then ſoluble in 900 times its weight of boiling water. This ſolution expoſed to air, forms a *cremor*, like that of lime-water in the ſame circumſtances, and like it changes alſo the vegetable colours.

8. Whilſt combined with *aerial acid*, it is only ſoluble in about 1550 times its weight of water [w] chiefly if the water has been impregnated alſo with the ſame aerial acid.

9. It expels the cauſtic volatil alkali from ammoniacal ſalt.

10. Mixed with brimſtone it produces a *hepar ſulphuris*, whoſe ſolution in water is but incompleatly decompoſed either by the nitrous or the muriatic acid, on account of the great attraction between this earth and the acid of ſulphur, which is ſo ſtrong that it

11. Separates this acid (the vitriolic) from the vegetable alkali [x].

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[w] On the contrary, calcareous earth, when pure, is more ſoluble in water, than when combined with aerial acid. *Berg.*

[x] Ponderous earth takes up the vitriolic acid, when combined with calcareous earth: but this laſt earth takes the acid of ſugar from its combination with ponderous earth. See *Morveau's Mem. in* Journ. de Phyſique *for March* 1783. *The Ed.*

Doctor Withering found that cauſtic alkali precipitates this earth from the *nitrous* and *marine acids*, which happens, it ſeems, from their taking up the exceſs of acid required to keep it in ſolution. *The Editor from Kirwan.*

SECT.

SECT. 49. (Additional.)

Ponderous earth combined with aerial acid. *Terra ponderoſa aërata.*

It reſembles alum, but is hard and ſtriated, as if compoſed of radiating fibres coming from a center. It is found in Alſton-moor in England [*y*].

Its ſpecific gravity is 4,338.

Dr. Withering found that this ſubſtance does not burn to lime, as it melts rather than parts with its aerial acid [*z*].

[*y*] Dr. William Withering of Birmingham made the analyſis of this ſubſtance which he communicated to the Royal Society of London: he was the firſt who diſcovered this earth by examining native ſpecimens found in England. It is highly probable that many different combinations of this new kind of earth will be found mixed with other earths, when mineralogiſts pay a proper attention to examine mineral ſubjects by a chemical analyſis with greater accuracy, than they have hitherto done, as Bergman remarks in § 91 of his Sciagraphia. *The Edit.*

[*z*] It contains 20.8 parts of *aerial acid*, 78.6 of *ponderous earth* and the remaining 6 conſiſt of the *vitriolic baro-ſelenite*, without any water. The artificial barote has very different component parts, as mentioned in § 48. *Withering.*

SECT. 50. (18.)

Spar-like gypſum. *Lat.* Marmor metallicum. Lapis Bononienſis. Phoſphorus nativus. *Sw.* Tarninge-ſpath. *Fr.* Baro-ſelenite. Spat ſeleniteux, gypſe phoſphorique. *Germ.* Wurffel-ſpath.

This ſtone, on account of its ſpecific gravity 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 except ſome traces of iron, which is no more than all other gypſa contain.

A. Semitranſparent, *ſpatum Bononienſe.* The Bononian ſtone or phoſphorus [a].

Its

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[a] Mr. Margraff has publiſhed ſome curious experiments in the Memoirs of the Academy at Berlin, about the quality theſe ſpars have to yield 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

Its ſpecific gravity is 4,500.

B. Opaque: *a.* white: *b.* Reddiſh: are found in Wildeman at Hartz, and in other German mines [b].

SECT. 51. (19.)

C. Ponderous Druſen ſpar. *Lat.* Marmor metallicum Druſicum [c].

1. Jagged or like cock's combs. *Criſtatum.* Theſe

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quality of theſe ſtones is, however, different from that of the ſparry 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. *The Author.*

It does not burn to plaſter of paris, as gypſum does: is infuſible *per ſe*: it is often mixed with calcareous earth: and ſometimes accompanies the ores of metals: it forms likewiſe the baſis of ſome petrifications. It contains 84 parts of *ponderous earth*, 13 of the *moſt concentrated vitriolic acid*, and 3 of *water:* but the artificial baroſelenite contains 33 parts of *vitriolic* acid, and 67 of *ponderous earth.*

Mr. Morveau decompoſes this ſubſtance by a very eaſy method: viz. by calcining it with one ſixth part of its weight of *charcoal*, for one hour in a crucible, well luted, in a ſtrong red heat: and finally diſſolving it in the *acetous acid.* The ſulphur is thus ſeparated.

[b] The red ſpar, or baro-ſelenite, and ſometimes the other varieties contain 1 or 2 parts of iron in one hundred. *Kirwan.*

[c] Regularly Cryſtalliſed aluminiforme, ſolid, and ſemitranſparent. This ſpecies is found in the lead mines of Alſton-moor on the county of Cumberland in England. Mr. William Thomſon, of Chriſt-church-college at Oxford, a young

Theſe reſemble cock's combs, and are found in clefts and fiſſures accreted on the ſurfaces of balls of the ſame ſubſtance [d].

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young gentleman intimately acquainted with mineralogy, ſhewed me ſome fine ſpecimens of this mineral, and very properly remarked *that it ſeems to affect the peculiarity of having its cryſtals laminated, as radiating from a center: but this radiation ſeldom amounts to a whole circle.* The corners of theſe flat criſtals are truncated, like thoſe of alum, and are thicker in one ſide than in the other of each parallelogram, ſo as to fit one another in the arch of the kind of vault they form together: and have ſome ſmall ones adhering to their ſides, like *druſen ſpars* leaving internal angles, as the *macles* of the French, or the cruciform criſtalliſations.

The ſpecific gravity of the fine ponderous cryſtals, being examined by my worthy friend Mr. Nicholſon, with an inſtrument of his own invention well calculated for the eaſy and exact finding of ſpecific gravities, was found from a piece of this ſpar, regularly cryſtallized and moſtly tranſparent, to be with reſpect to diſtilled water, at the temperature 60° fahrenheit, = 44745 : 10000. Dr. W. Withering, the learned tranſlator of Bergman's *Sciagraphia* into Engliſh, wrote to me not long ago, that he had *diſcovered ſome curious properties in the ſpatum ponderoſum*, which he intended to communicate ſoon to the Royal Society of London. *The Edit.*

This ſpecies is found alſo in Auvergne in France, and has been deſcribed by Mr. Bayen, who believed its baſis to be calcareous. The ſurface of its criſtals was covered with ferruginеous ochre. It was extremely refractory. *Fabroni.*

[d] This ſpecies is found alſo in Derbyſhire, where it is called *cauk*, or *calk*. My worthy friend Mr. J. Whitehurſt, F. R. S. ſhewed me various ſpecimens of this mineral, not only with convex, but with flat ſurfaces: the upper ſurfaces of the aggregated parts appear rather like the edges of very thin flattiſh lenſes put together, than edges of cock's combs. *Edit.*

2. White,

2. White, from Hartz and Kongſberg in Norway.
3. Reddiſh from Wildeman mine in the Hartz [e].

SECT. 52. (24.)

Ponderous earth united with phlogiſton and the vitriolic acid, *Terra ponderoſa phlogiſto et acido vitriolico mixta. Leberſtein* of the Germans and Swedes. *Lapis hepaticus.*

This ſtone in ſome ſpecimens conſtantly, but in others 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 fœtid ſtones of Section 29, with which it has, however, generally been claſſed, although no lime can be made from it; whereas they are the fitteſt of all the different lime-ſtones to be burnt into lime.

It is found.

A. Scaly.

1. With coarſe ſcales.

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[e] 4. Fibrous, in the form of zeolite or aſbeſtos in filaments. Mr. Monet has obſerved that theſe ſpars frequently contain phlogiſton, for they become a liver of ſulphur in a ſtrong heat without addition. But Mr. Woulfe never found any, and thinks Mr. Monet was deceived by charcoal falling into his crucible. *Phil. Tranſ.* 1779, p. 15. *Fabroni.*

a. Whitiſh yellow, from Stollen at the mine called Getteſhulffe in der Noth at Kongſberg in Norway.

2. With fine glittering or ſparkling ſcales.

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

ORDER

[*f*] The method that nature takes in combining thoſe matters which compoſe the *liver-ſtone*, may, perhaps, be the ſame, as when a limeſtone is laid in a heap of mundic, while it is roaſting: becauſe there the ſulphur unites itſelf with the limeſtone, whereby the limeſtone acquires the ſmell of 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 with 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 fœtid or ſwine-ſtones, and the liver-ſtone, are, in regard to the ſtructure of their parts, ſubject to the ſame varieties as the other ſpecies of lime-ſtone: and it is to be obſerved that a volatile alcali is commonly ſuppoſed to have entered into the compoſition of the fœtid ſtones, though it has never yet been diſcovered by any experiment. *The Author.*

N. B. This laſt aſſertion is contradicted by Wallerius ſect. 43 p. 149. who poſitively ſays, that a volatil alcali is certainly found by a chemical analyſis of theſe ſtones; but

Non noſtrum . . . . tantas componere lites.

According to Bergman this is a ponderous earth, combined with vitriolic acid, mixed with rock oil, and with the calcareous, argillaceous and ſiliceous earths. *See his Sciagraphia,* § 90.

ORDER THE THIRD,

MAGNESIAN EARTHS.

SECT. 53. (Additional.)

MAGNESIA, or Magneſian earth. *Lat.* Magneſia Alba, *vel* Terra *Muriatica.*

This is a white, looſe, and light earth, only known ſince the beginning of this century [g]. It

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§ 90. The ſame chemiſt adds, that one of theſe kernels from Andrarum, gave by a chemical analyſis twenty-nine parts of cauſtic ponderous earth; thirty-three of the ſiliceous: almoſt five of the argillaceous, and 3,7 parts of lime, beſides the water and vitriolic acid, which entered in its compoſition. *The Edit.*

The *lapis hepaticus* is generally compact, but not hard enough to ſtrike fire: its texture is either equable, or laminar, ſcaly, or ſparry, and it takes a poliſh like alabaſter, does not efferveſce with acids, and when calcined is partially reduced to a ſort of plaſter of Paris. One hundred parts of it contained, by the analyſis of profeſſor Bergman, 33 of baro-ſelenite, 38 of ſiliceous earth, 22 of alum, 7 of gypſum, and 5 of mineral oil. *Kirwan.*

[g] It was at Rome that this earth began to be known by the name of *Count de Palma's powder*, which a Regular Canon there

It is generally found combined, or mixed with other heterogeneous ſubſtances, as other ſimple earths are.

1. When pure [h] its ſpecific gravity is 2,330, and then
2. It neither hardens, contracts nor melts by the application of heat, even by the ſolar rays [i].

3. But

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there offered as a general remedy for all diſorders. It was conſidered by many, as a kind of calcareous earth: but F. Hoffman was the firſt that ſhewed it to be eſſentially different: and afterwards Dr. Black of Edinburgh, as well as the famous A. S. Margraaf of Berlin, though unknown to each other, demonſtrated this truth, by numerous and maſterly proceſſes. *Berg.*

[h] To have pure magneſia, let Epſom-ſalt in well formed cryſtals, be diſſolved in diſtilled water: and from this the magneſia is to be precipitated by mild volatil alkali. Some of this earth, that remains ſuſpended in the ſolution by means of the aerial acid, may be eaſily precipitated by a ſimple ebullition. The hundred weight of this magneſia when dried, contains near 25 parts of *aerial acid* or *fixed air*: 30 of water: and 45 of pure earth. Its ſpecific gravity then is 2,155. The fixed air and water may be totally driven off by calcination. *Bergman.*

[i] The contrary (ſeemingly) appeared by the experiments made in London the laſt ſummer (1782) with the burning lens of Mr. Parker, whoſe effects are the ſtrongeſt ever heard of, though its diameter is but 32 Engliſh inches and a half in the clear. A cubic piece of magneſia, a quarter of an inch ſquare being put in its focus, was hardened and reduced to leſs than a third part on each ſide, (viz. from the 25 hundredth part of an inch, to 8 hundredths.) I was ſtruck with this fact: but on applying to the ſame focus a ſimilar cube of the magneſia I had received from Mr. Henry's manufacture at Mancheſter; this neither became harder nor ſenſibly diminiſhed in its ſize. According to Bergman, unleſs this earth be precipitated by the volatil alkaly or by the neat cryſtalliſed tartar,

3. But it melts eaſily with borax, or microcoſmic ſalt; though it is ſcarcely affected by fixed alcalis, or calces of lead.
4. Mixed with other earths, it produces by fire, different hard maſſes [k].
5. It gives no cauſticity, except to the volatil alkali: and
6. Does not efferveſce with any acid.
7. When mixed with water it ſhews a very ſmall degree of heat, but without any efferveſcence. And when the water exceeds the weight of magneſia about ſeven thouſand ſix hundred and ninety-two times, it is totally diſſolved. (*Kirwan.*)

8 and 9. Being put in water and afterwards dried, it contains $\frac{18}{100}$ parts of its weight; though when ſaturated with aerial acid, it will abſorb and retain after being dried, $\frac{66}{100}$ parts of water.

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tartar, any other alkaly brings ſome mixture of ſiliceous or calcareous earth: and nearly the ſame happens, when it is ſeparated by calcination from the remaining lixiviations of the nitrous and marine acids; in which caſe by ſuch a continued fire, it adheres together and even ſhows a tendency to vitrify. *Edit.*

[k] Mixed with calcareous, ſiliceous, and argillaceous earths, it melts in the fire: and if four times its weight of green glaſs, be added to it, a kind of porcelain is produced hard enough to ſtrike fire. But neither an equal part of the above earths, or of ponderous earth, glaſs of lead, alkali of tartar, and vitriolated tartar added ſeparately to magneſia will melt in the fire: however when mixed with common argillaceous earth, it melts into a hard maſs. *Berg.*

10. This earth combined with aerial acid is more ſoluble in cold than in hot water.

11. Combined with vitriolic acid it criſtalliſes into a bitter ſalt, known by the name of *Epſom* and *Seydlitz* or *Seidſchülitz* ſalt, which is ſoluble in little more than its own weight of water.

12. With nitrous acid it forms a deliqueſcent ſalt.

13. With the muriatic, or the acetous acids it does not cryſtalliſe: and the maſs being dried, attracts humidity from the air.

14. It has a ſtronger attraction to the fluor acid than to any other, (*Berg.*): and criſtalliſes with it into hexangular priſms whoſe ends are formed of two low pyramids, of three rhombs each *(Romé de l'Iſle.)*

15. It is not precipitated from other acids by the vitriolic, as calcareous earth is [*l*].

[*l*] Calcareous earth has ſeveral different properties from thoſe of magneſia, as for inſtance, it does not take up more water when combined with aerial acid: it renders the fixed alkali cauſtic by calcination: its combination with vitriolic acid produces a ſelenite hardly ſoluble in 4 or 500 times its weight of water: with the acetous acid gives permanent cryſtals, &c. *Berg.*

SECT.

SECT. 54. (Additional.)

Magneſia combined with vitriolic and other acids.

A. Magneſia when ſaturated with the vitriolic acid, forms a bitter ſalt, called *Engliſh* or *Epſom*, *Seydſhutz* or *Sedlitz* ſalt. The ſalts known under theſe different names only differ from one another on account of ſome heterogeneous ſubſtance, which is combined in them, the vitriolated magneſia being the characteriſtic and principal ingredient in them all.

B. Magneſia is found not only combined with the vitriolic acid in the waters of Epſom, Sedlitz, &c. but alſo with the marine acid to a conſiderable quantity in ſea-water and other ſalt ſprings.

C. It is contained frequently in freſh waters where it is diſſolved by means of a quantity of aerial acid. *Fabroni* from *Bergman.*

SECT. 55. (79.)

Combined with other Earths [m].

A. Magneſia when combined with ſiliceous earth, is commonly unctuous to the touch: and more or leſs difficult to be cut or turned, in proportion to its different degrees of hardneſs.

It is not diffuſible in water: grows hard, and is very refractory in the fire.

When pounded and mixed with water, it will not eaſily cohere into a paſte: however, if it is managed with care, it may be baked in the fire to a maſs, which being broken, ſhews a dull and porous texture.

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

Compact and ſoft, *particulis impalpabilibus mollis*; *Smectis*, Briançon or French chalk [n].

a. White, from the Lands-end, in Cornwall.

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[m] The ſubſtances treated of in this and in the ſeveral following ſections have been indicated by Bergman (in his Sciagraphia § 107), as belonging to the *magneſian earths*. The ſame author reckons the asbeſtus kind among the ſame.

[n] The *ſmectis* or *ſteatites* and the ſhoerl or ſhirl conſiſt of the ſame kinds of earth as the *aſbeſtus*, except the *calcareous* earth; and is likewiſe contaminated with a ſmall portion of iron. See *Bergman* Diſſert. de Asbeſto. *The Editor*.

b. Yellow.

b. Yellow.

c. Red and white, from the Lands-End: the ſoap earth, from Switzerland: it looks like Caſtile-ſoap.

SECT. 56. (Additional.)

Magneſia mixed with ſiliceous earth is found in various parts of the world, particularly in the Eaſt, in veins of moderate thickneſs, and is the ſubſtance of which the large Turkey tobacco-pipes are made. It is called by ſome *ſpuma maris*, and is the *meerſhaum* of the Germans: (alſo *keffekill.* § 84. Cronſt.). It is probably what the Canadians call *terre à chalumeau*, found in North-America.

It is of a white or yellow colour, ſoapy feel, and moderately hard: it becomes harder in a moderate heat. In the ſtate we receive it, that is baked, does not efferveſce with acids; and is difficultly ſoluble therein.

According to the analyſis of Mr. Wiegleb, it conſiſts of equal parts of magneſian and ſiliceous earths.

A mixture of this earth with the calcareous earth and iron, is found near *Thionville* in the French part of *Luxembourg*, which is of a blue colour: and contains moſt calcareous earth, alſo iron, and a little argill, with ſome petrefactions.

Another of an olive colour is found in the ſame place: it contains no argillaceous earth, though both ſeem like clay; this laſt is uſed in pottery.

Alſo a mixture of this earth with clay, talç, and iron is found in *Sileſia*. This is of a greeniſh yellow: it is in a looſe form, of a greaſy feel: and according to Margraaf, it contains one third part of its weight of magneſia. *Kirwan*.

SECT. 57. (80.)

B. Steatites or ſoap rock.

1. Solid and compact, *Particulis impalpabilibus ſolida*;

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 Delarne, Jonuſwando, in Lapland, Salviſto, at Tamela, in Finland, &c.

c. Yellow from Juthyllen, at Salberg, Torrakeberget, at Goſborn, in the province of Vermeland, and China [*o*].

SECT.

[*o*] 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, Sikſioberg, and China, are a great deal harder and more ſolid than the Engliſh kind, from the Land's End, which

SECT. 58. (81.)

C. Solid, and of viſible particles, *Solida particulis majoribus*; ſerpentine ſtone, *Lapis ſerpentinus.*

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

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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, in working, as the harder. 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, *ſkiolige*; 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*. *The Author.*

The ſpecific gravity of the ſteatites is from 2,433 to 2,780. It is not eaſily difuſible in water, nor rendered ductile by mixture with it: it does not efferveſce with acids, and is very ſlowly and only partially ſoluble in them.

In fire it hardens, and becomes whiter; but is infuſible *per ſe.*

It is imperfectly melted by mineral alkali and microſcomic ſalt: but more perfectly by borax. It is apt to corode the crucibles: and the ſmall quantity of iron it contains, is in a ſemiphlogiſticated ſtate. *Kirwan.*

Its analyſis will be found in the table at the end of § 73. *The Editor.*

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 [o*].

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

[o*] Probably from Bohemia and Boſeith. *Brun.*

SECT. 59. (82.)

D. Fine grained ſerpentine ſtone, *Serpentinus particulis granulatis*, the Zoeblitz ſerpentine.

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 Zoeblitz, but the green is the moſt predominant colour.

SECT. 60. (83.)

E. Porcelain earth mixed with iron, *Terra porcellanea marte mixta.* This is

A. Diffuſible in water.
a. Red, *la terre rouge*, from Montmartre, and China.

The water-clinkers 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 Jaſberg, 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 [*p*].

SECT. 61. (265.)

F. The *Telg ſten* of the Swedes. *Lapis ollaris. Saxum compoſitum ſteatite et micâ* [*q*].

a. Light grey, from Fahlun, and alſo Byxberget at Norberke.

b. Whitiſh yellow, from Sikſioberget in Norberke.

[*p*] Since the iron renders the ſo called refractory clay, as well as other clays, more eaſily 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 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. *The Author.*

[*q*] *Gneis,* in Saxony, is the name of a rock-ſtone, conſiſting of glimmer, *lapis ollaris*, and quartz; the proportion, and the manner in which theſe parts are joined together, form ſeveral varieties. *Brun,*

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 ſlâty, the extremities of the ſtrata muſt be turned towards the fire.

SECT. 62. (Additional.)

Obſervations on Serpentines.

In reſpect to colour as well as compoſition this ſtone is ſuſceptible of great variety; for it is found either white, green, brown, reddiſh brown, yellow, light blue, black, ſpotted, or ſtreaked with veins of various colours. Its texture is either indiſtinct, obſcurely laminar, or fibrous. It is harder than ſoap rock, though not ſo hard as to give fire with ſteel. It is leſs ſmooth to the touch, but ſuſceptible of a good poliſh, looks like marble, and is often in thin plates ſemi-tranſparent.

Its ſpecific gravity is from 2,400 to 2,650. It does not efferveſce with acids, but is ſlowly and partially ſoluble in them. It melts *per ſe* in a ſtrong heat, and preys on the crucibles. In a lower degree of heat it hardens.

According to the analyſis of M. Bayen, 100 parts of it contain about 41 of ſilex (which he takes rather to be mica); 33 of magneſia; 10 of argill; 12 of water, and about 3 of iron. The

ſerpentine

ſerpentine of Corſica contains a larger proportion of argill, and a ſmaller of ſilex.

It has many varieties; being found (1) veined or ſpotted with green ſteatites, (2) red with veins of aſbeſtos, (3) red, green, yellow, or black with veins or ſpots of white calcareous ſpar, is called *potzevera*. The black is called *nero di prato*; the green *verde di Suza*; but theſe names are not reſtrained to this ſpecies. (4) Veined or ſpotted with gypſum, (5) veined or ſpotted with baroſelenite, (6) veined or ſpotted with ſhiſtus. And (7) with veins of quartz, feltſpar, or ſhoerl. *Kirwan's Elem. of Mineralogy*.

What is commonly called *ſerpentine*, is a true *lapis ollaris*; but being variegated with green, yellowiſh, and brown ſpots, like the ſkin of ſome common ſerpents, it is called by that name. Great quantities of this ſtone are found in Italy, and Switzerland, where it is often worked into the ſhape of diſhes and other vaſes. *Fabroni*.

And the *Gabro* of the Italians is nothing elſe but a kind of ſerpentine. *Edit.* from *Kirwan*.

SECT. 63. (93.)

The micaceous kind, *Terræ micaceæ*. The Glimmer, Daze, or Gliſt.

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 ſtep towards fuſion; though it is very difficult to reduce them into pure glaſs by themſelves or without addition.

3. They melt pretty eaſily with borax, the microcoſmic ſalt, and the alcaline 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 one [q*].

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

[q*] Its mean ſpecific gravity is 3,000. *Fabr.*

[r] However, ſuch as it is, it may be advantageouſly employed to purify muriatic ſalt, or nitre, by a decompoſition of its heterogeneous parts. *Fab.*

SECT. 64. (94.)

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

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

   Is tranſparent as glaſs; found in Siberia and Elfdalen in the province of Wermeland.
2. Of ſmall plates, *Mica ſquamoſa*, from Silfverberget, at Runneby, in the province of Blekinge.
3. Of fine particles like chaff, or chaffy mica, *Particulis acceroſis.*
4. Of twiſted plates, crumpled mica, *Mica contorta, talcum officinale.*

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[s] The ſpecific gravity of mica is from 2,535 to 3,000 when loaded with iron. One hundred parts of the colourleſs kind contain 38 of ſilex, 28 of argill, 20 of magneſia, and 14 of the moſt dephlogiſticated calx of iron. Martial mica contains beſides 10 or 12 per cent. of a more phlogiſticated calx of iron, from whence its various colours are derived, and a proportionally ſmaller quantity of the other ingredients. *Kirwan.*

[t] Muſcovy talc differs externally from mica only in being more ſoft and ſoapy to the touch. It contains 50 parts of ſilex, 45 of mild magneſia and 5 of argill in one hundred parts. Venetian talc is white, grey, yellowiſh or greeniſh and ſemi-tranſparent. It is much more tender and brittle than mica, and is ſo ſoft that it may be ſcratched with the nail. Its ſpecific gravity is 2,729. *Kirwan.*

SECT. 65. (95.)

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

- *a.* Brown ſemi-tranſparent, from Kola, in Lapland.
- 2. Of fine and minute ſcales, *Mica ſquamoſa martialis.*
- *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 coppermines; for inſtance, thoſe at Norberg, Flodberg, &c.
- 5. Criſtalliſed 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 of Salberg in the province of Weſtmanland [u].

SECT. 66. (96.)

Obſervations 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, 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 the *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

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[u] Theſe two ſpecies of *druſe*, or groupes, are often found in collections.

Some tin-floors at *Zinnwald* in Bohemia contain moſt ſorts of glimmer, and they are ſometimes very rich in tin-ſtone. *Braun.*

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. 262.): the mica does the ſame, when it is interſperſed in an apyrous clay; and this is the reaſon why the ollaris ſo ſtrongly reſiſts the fire [*w*].

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 the 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.

[*w*] Mr. Margraff aſſerts that he has obtained Epſom ſalt from talc; and Mr. Fabroni obſerves that in decompoſing the acid of nitre by means of a micaceous ſubſtance, as ſoon as the acid is diſtilled, there is ſome other ſubſtance as yet unknown, which ſublimes at the end of the operation: he adds that on employing *aqua regia* or *marine acid* with this ſubſtance, the yellow colour which reſults from the ſolution, ſeems to indicate that there is ſome part of iron in it. Finally Mr. Monnet confirms this laſt aſſertion, as he found that phlogiſticated alkali and ſolution of galls produce a blueiſh colour with that of mica: and adds that its component parts are the ſame as thoſe of the aſbeſtos, excepting only that it contains much leſs of iron than this laſt. *Edit.*

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*. But ſince talcs and micas reſemble each other ſo much in other particulars, there is no reaſon for making them two diſtinct genera [x].

The *talc 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 marchaſitical copper ore, and only covered with a very thin coat of mica.

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[x] Many mineral ſubſtances may happen to have that glittering or ſhining appearance of common mica, without really being of the ſame genus. This we are encouraged to aſſert from what is obſerved in ſome artificial productions, one of which I was lately favoured with by my ingenious and worthy friend, Mr. Joſiah Wedgewood, F. R. S. who has carried to ſuch an extraordinary perfection the Engliſh pottery, that it far exceeds whatever is known both of the antient or modern manufactures of the kind, on account of its fine and various texture, hardneſs, and elegant forms. The production I ſpeak of as reſembling mica, was an unexpected reſult from vitriol calcined to redneſs, then mixed (without being waſhed) with common ſalt: and calcined again, under a muffle, with a ſomewhat ſtronger heat, about the tenth degree of his new and uſeful thermometer deſcribed in the volume of the Philoſophical Tranſactions for 1782. It was of a dark purple colour, and the ſhining particles were ſo brittle, as to ſhow their glaſſy form, very different from theſe of the real mica. *The Editor.*

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 Hardol in Jemtland, is there manufactured into kettles and other veſſels, as alſo for hearths of chimnies; and the powder which falls in the working, may be mixed with the common ſalt for the diſtillation of the muriatic acid.

SECT. 67. (102.)

The Aſbeſtus kind, Aſbeſtinae.

Theſe are only yet diſcovered in an indurated ſtate: their characters are as follows;

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 or alkaly.

In this order are included both thoſe varieties which by foſſilogiſts have been mentioned under

under the names of *Amiantus* and *Aſbeſtus*, and have often been confounded together [y].

SECT. 68. (103.)

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

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

1. Pure.
   a. White, from Salberg in Weſtmanland.
2. Martial.
   a. Yellowiſh brown, from Storrginningen, at Dannemora, in the province of Upland.
   This melts pretty eaſily in the fire to a black ſlag, or glaſs.

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[y] The ſpecific gravity of the aſbeſtus is from 2,500 to 2,800. It conſiſts of *magneſian* earth, with a larger quantity of the *ſiliceous*, and a leſſer of *calcareous* and *argillaceous* earths, contaminated with a ſmall quantity of iron. *Bergman's Diſſert. de Asbeſto.*

The amiantus conſiſts of *magneſian* earth, with a larger quantity of *ſiliceous* and a leſſer of *calcareous*, *ponderous* and *argillaceous* earths, contaminated with a ſmall portion of iron. Its ſpecific gravity is 2,913. *Kirwan* and *Bergman.* See the *Table* at the end of § 72.

SECT. 69. (104.)

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.

SECT. 70. (105.)

2. Of fine and flexible fibres, *Aſbeſtus fibroſus: Aſbeſtus*, or earth flax, *Aſbeſtus Wallerii.*

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

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.

SECT. 71. (106.)

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

1. Martial.

a. Light green, from Baſtnas Grufva at Riddarhyttan [z].

SECT. 72. (107.)

Obſervations on the Aſbeſtus kind.

I am much inclined to believe that the Aſbeſti, as well as the Micæ, are produced from an argillaceous earth, both becauſe they become brittle in the fire, which is a proof that they harden, and becauſe they become more fuſible by the admixture of a martial earth: but as the method nature makes uſe of for this change is unknown, 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 Aſbeſtus, which may be conſidered as the principal and chief of the fibrous kind, is, as it were, conſumed by the flame of a blowpipe, and does not leave any certain mark of fuſion; but it melts readily with borax to a clear and colourleſs glaſs.

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[z] It will be obſerved in a Note under the title of Cockle, or Shirl, that the aſbeſtus is often confounded with it. *The Author.*

The

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 [*a*] 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 from fire; but the queſtion is, if the aſbeſti can be of more ſervice than pounded mica, or other earthy duſt employed to the ſame purpoſe.

[*a*] Some of the Romans did the ſame. In the year 1756 or 1757 I ſaw a large piece of aſbeſtus-cloth, found in a ſtone tomb, with the aſhes of a Roman, as appeared by the epitaph, but I have forgotten the name. It was kept (and I think the tomb likewiſe) in the right-hand wing of the Vatican library at Rome, among other antient and modern curioſities. The under librarian, in order to ſhew that it was incombuſtible, lighted a candle, and let ſome drops of wax fall on the cloth, which he ſet on fire with the candle in my preſence, without any detriment to the cloth. Its texture was coarſe, but much ſofter than I could expect. *Edit.*

Table of thirteen ſubſtances belonging to the *Magneſian* earth, with the contents of each, that have been analyſed by Sir T. Bergman.

	Ponderous vitriolated earth.	Calcareous earth.	Magneſian earth.	Argillaceous earth.	Siliceous earth.	Calx of iron.
1. Amiantus from Tarentaiſe in Savoy, compoſed of ſhining long fibres, opaque, and very ſoft, which may eaſily be ſeparated from one another	6	6,9	18,6	3,3	64	1,2
2. Asbeſtus from Coricy in the Aſturies in Spain, white, and its fibres very fine and ſoft, eaſily ſeparable from one another		10,5	12,9	3,3	72	1,3
3. Ditto from Baſtanaes at Riddarhyttan, of a greeniſh brown colour: its fibres very fine and ſoft, and brittle		6	16,8	6	67	4,2
4. Ditto from Groenge in Dalecarlia, its fibres are of a dark brown, parallel, pretty rough, diſpoſed in little bundles, differently inclined to one another		12,8	16	1,3	63,9	6
5 Ditto from the iſland of Crete, white and rough, its fibres are ſhort, and applied over one another like the tiles of a houſe		14,3	28,8	1	53,9	2
6. Ditto from Pehsberg in Vermeland, it is brown, the fibres being parallel, and rough: and not eaſily ſeparable		12	13,7	1,7	62	10,6

	Ponderous vitriolated earth.	Calcareous earth.	Magneſian earth.	Argillaceous earth.	Siliceous earth.	Calx of iron.
7. Ditto from Sverdſiœ at Swartwik in Dalecarlia, one ſpecies found there, is white with very fine ſoft fibres, intermixed with ſome little bundles of hard fibres, which were ſeparated as impure and greatly ferrugineous		13,9	17,2	2,7	64	2,2
8. Ditto from the ſilver-mine at Sahlberg, is white, compact, and as elaſtic as cork: it is the *ſuber montanum*, its fibres are interwoven in different directions		10	22	2,8	62	3,2
9. Ditto from the ſame place, of a lamellated ſoft texture like leather, called *corium montanum*		12,7	26,1	2	56,2	3
10. Ditto ſteatiforme from Swartwik in Dalecarlia, is of a pale green, of a ſhining rough ſtriated ſurface, compoſed of fine long white fibres ſo joined together as not to be diſtinguiſhable eaſily in their joints		7,7	13,6	2,7	74	2
11. Steatites from Swartvik, is found with the above asbeſtus, of a green colour, with irregular thin cracks		0	17,1	2	80	0,9
12. Schörl from Groenge of a white greeniſh colour, compoſed of ſmall parallel ſhining, and brittle fibres, like the above asbeſt from Baſtanaes, N°. 3. § 74 of Cronſtedt		6	12,7	2	72	7,3
13. Schörl from Zillerthal in Tirol, is green, and ſo hard as to act on glaſs: it is compoſed of parallel fibres in different diverging bundles as deſcribed by Cronſtedt in § 74. *b.*		9,3	20	2,7	64	4

ORDER THE FOURTH,

SILICEOUS EARTHS.

SECT. 73. (40 and 41.)

Terrae Siliciae.

THE 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 earth 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 alcaline 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 [b].

The

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[b] To the above we may add the following properties:

6. It is not ſoluble in any of the known acids, the fluor-acid only excepted. But
7. It may be diſſolved by the fixed alkali, both in the dry and wet way.
8. If the fixt alkaly is only half the weight of the ſiliceous earth, it produces a diaphanous and hard glaſs: but when it is in a double or triple proportion, then the glaſs deliqueſces of itſelf by attracting the humidity of the atmoſphere.
9. It melts eaſily with borax; but
10. With microſcomic ſalt, it is more difficult, and requires a longer time to melt.
11. This earth has a great analogy to acids, as it is perfectly diſſolved in that wonderful natural hot-water-ſpout above ninety feet high at Geyſer in Iceland, where by cooling it forms a ſiliceous maſs. *Editor* chiefly from *Bergman*.

It is not yet known, whether there be any looſe earth of this kind to be found, or whether 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. I have

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 decompounding 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 the concave mirror; and to continue ſuch experiments which Mr. Pott has ingeniouſly begun, as a baſis for his *Lithogeognesia*. 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.

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have not yet, at leaſt for my own part, found any looſe earth that I can ſuppoſe 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. *The Author.*

SECT. 74. (42.)

A. Diamond. *Lat.* Adamas gemma. *Swed.* and *Germ.* Demant. *Fr.* Diamant [c].

1. Of all ſtones is the hardeſt [d].

2. It is commonly clear, or tranſparent [e], which quality, however, may perhaps only belong to its cryſtals: but not to the rock itſelf from which they have their origin [f].

3. Its

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[c] This precious ſtone ought to be ranged in a ſeparate order by itſelf, under the title of *precious earth*, or *terra praeciosa incognita phlogiſto combinata*, as its baſis does not belong properly to any of thoſe earths we know at preſent. *Fabr.*

[d] But it is deſtructible by the joint action of fire and air; even in cloſe veſſels according to Mr. Darcet, who has much inlarged our knowledge of this ſubject.

If diamonds be reduced to an impalpable powder (by means of rubbing one againſt the other, which is the only way to powder them) the inflammable principle may be extracted by digeſtion in the vitriolic acid.

The microcoſmic ſalt penetrates with difficulty the ſubſtance of diamonds in fuſion. They are ſtill leſs affected by borax. *Fabr.*

[e] Yet diamond powder is of a grey or blackiſh colour; but this proceeds from extraneous ſubſtances, as it becomes whitiſh on being waſhed by acids, unleſs it has been made out of the cruſt of diamonds, or of thoſe which are black. *Berg.*

[f] Diamonds never are found, as far as I know, ſtuck to any rock, nor in cluſters like rock criſtals. Tavernier ſays (page 327 of his ſecond volume), that they are found in a ſandy earth, and in the looſe earth that fills the clefts of ſome rocks. That their mines at *Gani*, otherwiſe called *Coulour*, where

3. Its ſpecific weight is neareſt 3,500 [g]. When brought to Europe in its rough ſtate, it is in a form either of roundiſh pebbles, with ſhining ſurfaces, or of cryſtals, of an octoedral form [h].

a. Colourleſs,

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where ſix thouſand people were at work, are in a marſhy ground. At *Soumelpour* the diamonds are found in the bed of the river *Gouel*, whoſe waters are turned with great labour, into another channel for this purpoſe: and I am informed by very good authority, that the Braſilian mines of diamonds are worked in the ſame manner. At *Borneo* it is alſo in the river *Succadan* that diamonds are found, according to the ſame Tavernier. But what this famous traveller ſays of certain diamonds which have a greeniſh cruſt, is very remarkable indeed! Theſe green diamonds burſt into pieces either whilſt they are in working to receive a proper ſhape, or when in the very act of being poliſhed on the wheel (ſee note *h*): and he mentions a large diamond, bought by a Jew, named Edward, for which 25 thouſand piaſtres (about 5200 *pounds ſterling)* had been offered when brought to Leghorn, that on being ſent to Venice, in order to be cut there, burſt into nine pieces whilſt poliſhing on the wheel. This conveys, it ſeems, the idea of ſome ſimilarity between diamonds and the *lachryma batavica*, which may perhaps be extended to all hard criſtalliſations like thoſe of gems. My worthy friend John Whitehurſt, F. R. S. who viſited (in this ſummer of 1783) the giants cauſeway in Ireland, found within the lava of this antient and unrecorded Volcano, ſome cavities or hollows, filled with well formed cryſtals of quartz. This ſeems to indicate, that, for the formation of hard cryſtaline ſubſtances, the action of a ſtrong heat is required in one way or other. *The Edit.*

[g] The ſpecific gravity of diamonds, according to Wallerius, is from 3,100 to 3,400: Hauksbee judges it to be 3,666: Ellicot 3,519. Briſſon 3,5212.

[h] Diamonds commonly cryſtallize into octoedral forms, which, however, are often found ſomewhat irregular, eſpecially

a. Colourleſs, or the diamond properly ſo called [i]. But it alſo retains this name when it is tinged ſomewhat red, or yellow

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cially 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 it angles truncated or cut off. *Eng.*

Diamonds of a dodecaedral form are not uncommon: thoſe of Malaca are rhomboidal and cubic: and ſome have been found of fourteen ſides or planes.

The ſubſtance of diamonds is lamellated, conſiſting of very thin plates like thoſe of talc, but extremely hard and intimately united, whoſe direction lapidaries muſt find out, not only to cleave the ill-ſhaped diamonds, but to cut and ſhape them properly. This laſt operation is performed by rubbing a diamond with another, till it has the required ſhape. It is afterwards poliſhed in an horizontal wheel of ſteel, employing the ſame powder that falls from their rubbings, with common olive oil. But diamonds, whoſe foliated ſubſtance is like wood knots, viz. not in a flat poſition, cannot be well ſhaped: and lapidaries call them by the nick name of *diamonds of nature*. See Bomare's Mineralogy, p. 393, vol. I. The art of cutting diamonds was invented in 1476, by Louis de Berquen, a native of Bruges in the Auſtrian Netherlands. *The Edit.*

[i] The names *oriental* and *ocidental* given by Jewelers to this and to all other precious ſtones, have a different acceptation from the obvious ſenſe, that is to ſay, the hardeſt and fineſt gems are called *oriental*; though many, that are produced in the Eaſt, go by the name of *ocidental*, when of an inferior kind. And in fact a prodigious number of the fineſt diamonds and other precious ſtones have been found in Braſil, which cannot but be reckoned *oriental* ones. This is a general opinion followed both by the great Bergman, Mr. Dutens, Mr. Romè de l'Iſle, Valmont de Bomare, &c.

The

low [k]. Being rubbed, it diſcovers an electrical quality by attracting the maſtil [l].

The famous Jeweller Mr. Jeffries in his *Treatiſe on Diamonds*, aſſerts very poſitively that, upon the ſtricteſt examination, there is not the leaſt difference between the beſt Oriental and Braſilian diamonds. *The Edit.*

[k] There are diamonds of all colours, though not deeply ſo, viz. ſome incline to the *roſe* colour, others to *green*, *blue*, *brown*, *black*: and ſome have black ſpecks. Tavernier ſaw one of this laſt kind weighing about 56 karats in the treaſure of the Mogul: he ſays alſo, that the mines of Carnatica produce yellow and black diamonds: and Mr. Dutens ſays (page 13 of his Treatiſe) that he ſaw a black diamond at Vienna, in the collection of the Prince de Lichtenſtein. *The Edit.*

[l] The diamond becomes phoſphoric, either by being expoſed to the ſolar rays, or by being made red hot in a crucible on the fire. When rubbed, it attracts ſmall bits of *ſtraw*, *paper*, *feathers*, *hairs* of animals, *ſilk*, &c. But as to its ſuppoſed quality of attracting the maſtick, it ſeems not to be more peculiar to diamonds, than to any other gem, or rather to be an imaginary quality. *Edit. from R. de l'Iſle.*

SECT.

SECT. 75. (Note to § 42.)

Obſervations on Diamonds.

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 criſtals, with more propriety looked upon to be produced from their own ſeparate principle [m], rather than

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[m] The phenomena of the diamond during its decompoſition clearly ſhew that it is compoſed of principles which are peculiar to itſelf, as the earth which is its baſis is reducible to none of the five known earths, already mentioned, Sect. 3. Note *m*. Mr. Bergman kept diamond powder for three hours in a violent fire in contact with the mineral alkali without finding any ſenſible change in it; but having afterwards extracted the alcali by ſpirit of ſalt, the ſolution afforded by the addition of the vegetable fixed alcali a white precipitate earth, ſoluble in all the acids, but which with the vitriolic acid, afforded neither allum, nor Epſom ſalt, nor ſelenite, nor ponderous ſpar, and conſequently was neither argillaceous, magneſian, calcareous, nor ponderous, or ſiliceous earth (ſince it is ſoluble in all the acids), but a new and diſtinct ſpecies which with the vitriolic acid forms a ſalt irregularly cryſtallizable, of a harſh acid taſte, and very ſoluble in water. The phlogiſton is united to this earth in a very ſingular manner; the vitriolic acid takes it up by digeſtion with diamond powder without becoming ſulphureous; but the inflammable matter may be ſeparated from the acid by evaporation: it then forms

than to be ranked among the quartz criſtals; being either formed in a ſingle drop, or criſtallized out of their matrix; for if the heat of the ſun, or the climate, were the cauſe of the hardneſs of the diamonds, why is not a quartz criſtal 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 criſtals? The account which Tavernier has given us, about the digging of diamonds at Golconda, agrees with that of the criſtals in Jemtland, viz. that they lye bedded in clay within cluſters of criſtals, and in clefts [n]. Now ſuch of our criſtals

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forms black combuſtible pellicles which burn away almoſt intirely, leaving only a ſmall quantity of white earth. *Berg.* See Note *o*.

There was a report that Mr. Morveau of the Academy of Dijon, had found a ſolvent for diamonds. At my requeſt Mr. Bochart de Saron, Preſident of Parliament and honorary member of the Royal Academy of Sciences at Paris, aſked Mr. Morveau about it, but he anſwered in the negative: and added that having thrown a diamond of *one grain* weight into a crucible with fuſed nitre over the fire, where he left it for a while; after it was cold, he waſhed the contents in cold water; but inſtead of the diamond, he only found 10 or 12 grains of earth, which in all probability had been diſſolved from the crucible during the operation. *The Edit.*

[n] The chief mines of diamonds are in the Aſiatic Peninſule on this ſide of the Ganges towards the *Gatte* mountains, not only at *Golconda* but in many other parts, as *Coulour*, *Raolconda*, *Biſnagar*, *Nouſtafunagar*, *Parteal*, *Latawar*, *Soumalpour*,

criſtals 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

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Soumalpour and *Malaca*; ſome of which are now exhauſted: beſides theſe, diamonds are found in the iſland of Borneo; and above all in Braſil, in the province of *Serra do frio* in the place called *Cay de Marin* near the river of *Milho-verde*. *See Bomare's Mineralogy*, vol. the firſt, and *Romè de l'Iſle's Criſtallographie*, vol. the ſecond. As to the ſoil or mine in which diamonds are found, Mr. Bomare ſays, that they are ſometimes found ſtuck to rocks, and in cluſters like rock-criſtals; but this ſeems to be very ſeldom the caſe. *See the above Note* f *to this Section*. Edit.

The mean value of diamonds may be eaſily calculated by the general rule of Jewellers, viz. by multiplying the ſquare of their weight in *carats* by two *pounds ſterling*, when the diamond is rough or uncut: but if it is already cut, the ſquare of the double of their weight is to be multiplied by the ſame value of *two pounds* (or *louis d'or*); or in other words, the ſimple ſquare of their weight muſt be multiplied by *eight pounds ſterling*. This great difference of price proceeds from the great loſs which a diamond ſuffers in being cut; which comes to the half (and ſometimes more than a half) of its weight. N. B. The expence of cutting a diamond amounts to 3 ¾ *pounds ſterling* per *carat:* this is not reckoned in the following evaluations. N. B. 2°. each *carat* is generally divided into four *grains*; but each of theſe grains are ſmaller than thoſe of the *troy weight*; becauſe, according to Dav. Jeffries, five of them are equal to four *grains* of the *troy weight:* ſo that one ounce of this laſt weight contains 150 *carats*, and no more than 480 *grains*. N. B. 3°. The above price of two *pounds ſterling* for the *carat*, is for com-common diamonds without any flaw, colour, or blemiſh, otherwiſe their value is much reduced; ſometimes to its half; but no diamond is worth cutting, under *one pound* the carat.

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

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Thoſe of a greater brilliancy, and perfection, may be reckoned at the rate of three pounds the carat, multiplied by the ſquare of the double of their weight, if cut; or elſe by the ſquare of their ſimple weight, if they are uncut. N. B. 4. The firſt of the following diamonds, is *uncut:* the other ſix are *cut* diamonds.

1. The greateſt diamond ever known in the world is one belonging to the king of Portugal, which was found in Braſil: it is ſtill uncut: and I am informed from good authority, that it was of a larger ſize; but a piece was cleaved or broken off by the ignorant country-man, who chanced to find this great gem, and tried its hardneſs by the ſtroke of a large hammer upon the anvil.

This prodigious diamond weighs 1680 *carats:* and although it is uncut, Mr. Romè de l'Iſle ſays (page 208) that it is valued at 224 millions ſterling; which gives the eſtimation of 79,36 or about 80 pounds ſterling for each *carat:* viz. for the *multiplicand* of the *ſquare* of its whole weight. But even in caſe of any error of the preſs in this evaluation, if we employ the general rule abovementioned, this great gem muſt be worth at leaſt 5,644,800 pounds ſterling, which are the product of 1680^2 by two pounds, viz. much above 5 millions and a half ſterling.

2. The famous diamond which adorns the ſceptre of the Empreſs of Ruſſia under the Eagle at the top of it, weighs 779 carats, and is worth at leaſt 4,854,728 pounds ſterling, although it hardly coſt 135,417 guineas. This diamond was one of the eyes of a Malabarian idol, named Scheringham. A French grenadier, who had deſerted from the Indian ſervice, contrived ſo well as to become one of the prieſts of that idol, from which he had the opportunity to ſteal its eye: he run away to the Engliſh at Trichinapeuty, and thence to Madras. A ſhip-captain bought it for twenty thouſand roupees: afterwards a Jew gave ſeventeen or eighteen thouſand pounds ſterling for it;

cluſters or groupes of criſtals from Schneckenſtein in Saxony, wherein topazes and rock criſtals are found promiſcuouſly mixed, having each their different forms, colours, and hardneſs, fur-

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it: at laſt a Greek merchant, named Gregory Suffras, offered it to ſale at Amſterdam in the year 1766: and the late Prince Orloff made this acquiſition, as he himſelf told me here in London, for his Sovereign, the Empreſs of Ruſſia. Dutens page 19, and Bomare page 389 of his *Mineralogy*, relate the above anecdote. The figure and ſize of this diamond may be ſeen in the Britiſh Muſeum in London: it is far from being of a regular form. *The Edit.*

3. The diamond of the great Mogul is cut in Roſe; weighs 279 $\frac{9}{16}$ carats, and it is worth 380,000 guineas. This diamond has a ſmall flaw underneath near the bottom: and Tavernier, page 389, who examined it, valued the carat at 150 French livres. Before this diamond was cut, it weighed 793 $\frac{5}{8}$ carats according to Romè de l'Iſle: but Tavernier, page 339 of his ſecond volume, ſays that it weighed 900 carats before it was cut. If this is the very ſame diamond, its loſs by being cut was very extraordinary.

4. Another diamond of the king of Portugal, which weighs 215 carats, is extremely fine, and is worth at leaſt 369,800 guineas.

5. The diamond of the grand Duke of Tuſcany, now of the Emperor of Germany, weighs 139 $\frac{1}{2}$ carats: and is worth at leaſt 109,520 guineas. Tavernier ſays that this diamond has a little hue of a citron-colour: and he valued it at 135 *livres tournoiſes* the carat. *Dut.* Robert de Berquen ſays, that this diamond was cut into two: that the Grand Turk had another of the ſame ſize: and that there were at Biſnagar two large diamonds, one of 250, and another of 140 carats. This Robert de Berquen was the grand-ſon of Louis de Berquen who invented out the art of cutting diamonds. *The Edit.*

6. The diamond of the king of France, called the *Pitt* or *Regent*, weighs 136 $\frac{3}{4}$ car.: this gem is worth at leaſt 208,333 guineas, although it did not coſt above the half of this value.

7. The other diamond of the ſame Monarch, called the *Sancy*, weighs 55 carats: it did coſt 25,000 guineas: and Mr. Dutens ſays, that it is worth much above that price.

niſh a proof that nature forms the ſo called precious ſtones or gems, each from its particular matter or principle [o].

The round diamonds may be ſuppoſed to have undergone the ſame fate with ſome of the rock criſtals, 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 [o*].

A ſort of diamond is found, which is ſaid to be very ſoft, and is called the Jargon [p]; but this ſort

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[o] It will appear by the following Section, 86, that the other precious ſtones have not ſo great a difference in their component parts, as the author ſeems inclined to think: but as to the diamond, it is evident, by Note *m* to this Section, that its baſis is widely different; ſince in a heat ſomewhat greater than that in which ſilver melts, diamond is intirely volatilized and conſumed; it even produces a ſlight flame, and diminiſhes common air, juſt as phlogiſtic ſubſtances do, and leaves a ſoot: ſo that the extraordinary conjecture of Sir *Iſaac Newton*, of its being an *inflammable ſubſtance coagulated,* is fully confirmed. This is a very proper remark of Mr. Kirwan: and Mr. Ed. H. Delaval made the ſame obſervation to me, long before the publication of Mr. Kirwan's Book. *Edit.*

[o*] Davila had ſuch a piece in his Catalogue N° 725, and Mr. Stieglitz at Leipſig has got it from him, and placed it in his great collection, where I have ſeen it. *Brun.*

[p] The Jargon is 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 ſort is ſtill unknown to me, nor have I found that any experiments have been made relating to its hardneſs and principles [q].

I have ſeen in the collection of the Mine-Maſter M. Van Swab, a diaphanous octoedral criſtal of fluor, which according to thoſe who only mind the figure, ought to be called a diamond.

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neareſt to the ſaphires 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. *Eng.*

[q] Mr. de Bomare ſays that the jargon is found in Braſil: but, according to Mr. Romè de l'Iſle, it is from Ceylan that this hard ſtone comes to Europe: its ſpecific gravity is 4416, viz. nearly equal to that of *ponderous ſpar:* its form conſiſts in two tetrahedral pyramids of equal ſides, ſeparated by a ſhort priſm, ſo that the jargon is properly of a dodecahedral form. On its being expoſed by Mr. d'Arcet to a violent fire, its ſurface was a little vitrified, as it ſtuck to the porcelain-teſt in which it was ſet; from whence it appears that the jargon has not the leaſt affinity to the diamond, which is deſtructible by fire, as may be ſeen in the Notes *m* and *o* to this Section. *The Editor.*

SECT. 76. (43.)

The Ruby.

B. Red ruby. *Adamas ruber.* *Rubinus* [r]. Which, by lapidaries and jewellers, is, in regard to colour [s] divided into,

1. The

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[r] The ruby is criſtalliſed into an octoedral 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 criſtals, which laſt are more regular than any other earthy ſubſtance, as they aſſume, during their criſtalliſation, a determined form, viz. the hexagonal with a point at one or both ends. *The Author.*

But later experiments ſhow how widely diamonds differ from any other gems by their conſtituent parts. This fully appears by the Notes *m* and *o* Sect. 75: and as to the hardneſs of the ruby, as well as of the other ſtrong ſubſtances, the reader may conſult the table of Mr. Quiſt, inſerted at the end of the Siliceous earths. *The Edit.*

[s] According to Tavernier, vol. 2. p. 356, and Dutens, p. 23, all coloured hard ſtones are called *rubies* in the East-Indian mines, adding to each its different colour for diſtinction ſake, but there are alſo ſome ſoft ſtones of this kind which they call *Bacan:* and Wallerius, as well as Romè de l'Iſle, rightly aſſert that the oriental (the hard and brilliant) rubies, ſaphires and topazes are the very ſame ſtone, the co-

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

lour

1. The ruby, of a deep red colour, inclining a little to purple [*t*].

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lour excepted: certainly they have the ſame form, and ſome are partly *red*, and partly *blue*, *yellow*, or quite *colourleſs*. As to their colour, it proceeds from the martial mixture which enters into their compoſition. See § 86 and its Notes. Rubies are found in the Capelan mountain of Pegu, at Caos, Ava, Biſnagar, Calicut, Cananor, Ceilan, and Braſil. They are found in the ſands of rivers of a red colour, in an argillaceous earth of a hard texture, and of a greeniſh colour; and ſometimes they are adherent to red rocks.

Tavernier ſpeaks of 108 rubies in the Mogul's throne, from 100 to 200 carats, and of a round one of almoſt two ounces and a half: and Robert de Berquen ſpeaks of one of 244, another of 123, and another of 209 carats. *The Edit.*

[*t*] This is the *carbunculus* of Pliny; but all red gems were ſo called by the Antients. Thoſe of a deeper colour are called *almandini* according to Wallerius, and the Jewellers call this the *oriental ruby* on account of its hardneſs and brilliancy. See Note *i* to Sect. 74. By the experiments of Mr. d'Arcet the ruby does not loſe its colour in the greateſt fire: but Henckel, by means of a burning glaſs, ſoftened it ſo as to receive the impreſſion of a ſeal of jaſper. *Dutens.* This ruby is the hardeſt gem after the diamond. *Bergm.* And being rubbed becomes electric. *R. J.*

Its ſpecific gravity is from 3,180 to 4,240. *Berg.* According to Briſſon it is = 4,283.

Its texture is foliated like that of diamonds: it is fuſible with borax in a violent and long continued heat; and forms a tranſparent glaſs of a pale green: it does the ſame with *microcoſmic ſalt*: but with ſedative ſalt, or mineral or vegetal alkali, the glaſs is opake and of various colours. *See the various experiments* of Meſſrs. Bergman *and* Achard *on this kind of gems: and the* Table *at the end of* Sect. 86.

A perfect ruby above $3\frac{1}{2}$ carats weight, is more valuable than a diamond equally heavy: if it weighs one carat, is worth 10 *guineas:* if two carats, 40 *guineas:* if three carats, 150 *guineas:* if ſix carats, above 1000 *guineas.* Dutens.

2. Spinell, of a *ponceau red*, (*viz.* of a bright corn-poppy-flower colour) [*u*].
3. The balaſs, pale red, inclining to violet. This is ſuppoſed to be the mother of rubies [*w*].
4. The rubicell, reddiſh yellow. However, all authors do not agree in the characters of theſe ſtones [*x*].

[*u*] The form of the ruby ſpinell is octoedral: its ſpecific gravity is 3,760: of that from Braſil 3,531. *Romè de l'Iſle* from *Briſſon*.

Theſe rubies are found in Hungary, Sileſia, Bohemia, and ſome in Braſil. *Bomare* and *R. de l'Iſle*.

The value of theſe rubies is reckoned at the half of diamonds of the ſame weight. *Dut.*

Rubies are artificially made from topaſes of Braſil, of a ſmoaky appearance, by giving them a gradual heat in a crucible filled with aſhes, until it is red-hot. See R. J. and Dutens, who quote the Hiſtory of the Royal Academy of Sciences of Paris for the year 1747. It was Dumelle, a Jeweller, who communicated this ſecret to Mr. Guetard of the Royal Academy of Sciences at Paris. *The Edit.*

[*w*] This comes chiefly from Braſil, although ſome come alſo from the Eaſt Indies. The value of the balaſs-ruby is at the rate of 30 ſhillings per carat. *Dut.*

[*x*] Theſe come alſo from Braſil, but it is ſaid that their colour is loſt in the fire: if ſo they muſt be of a different nature from the Braſilian topaze, which gets a red colour from fire, as was ſaid Note *u*.

N. B. The *Rubino di rocca* of the Italians, or *rubinus rupium* is a true garnet, of a deep red and violet, or of the amethyſt colour. What is called *ruby of arſenic*, or of *ſulphur*, is the realgar: the *ruby of zinc* is the *red blend*: and the *ruby of ſilver* is the *red ſilver ore*, &c. *Bomare.*

SECT. 77. (44.)

The Sapphire.

C. Saphire. *Sapphirus gema.* It is tranſparent, of a blue colour, and is ſaid to be the hardeſt next to the ruby, or diamond [y].

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 Alſatia, 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 in the drug-

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[y] The ſapphires in their rough or native ſtate criſtallize moſt generally in 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 bluiſh opals. This is however no reaſon why thoſe opals ſhould be marked under the name of ſapphire, and leſs ſo ſince there are alſo agates found of the ſame quality. This 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, though they all belong to the flinty order? *Eng.*

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 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 [z.]

SECT.

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[z] The fine hard ſapphires, or, as jewellers call them, the oriental ones, are of the ſame kind as the ruby and the topaz, their colour excepted. *See note* s *to ſect.* 76.

The King of France has one with a yellow ſtripe of a fine topaz in the middle. *R. J.* & *R. de Berg.* Some are found half green and half red. This ſubſtance is foilated like the ruby. Thoſe from *Puy* in Auvergne ſeem to approach to the true ſapphire, by their form and their ſpecific gravity: but they loſe both their colour and tranſparency by fire, and become black, and even vitrify, according to *R. J.* which proves that they are of a different kind.

It is ſaid that ſapphires looſe their colour by fire, and remain ſo hard and tranſparent as to paſs ſometimes for diamonds. But Mr. Achard found that they are not altered in the leaſt by fire, in colour, hardneſs, nor weight: however, theſe circumſtances may not be common to all ſapphires.

The ſapphire is the third in hardneſs, the ruby being the hardeſt of all after the diamond. *Berg.* And becomes electric by being rubbed. *R. J.* Its name was taken from Σαπφιὶρ, the place where they were found, according to *Lemery*, quoted by *Bomare*. But it is evident from Pliny (Book 37. chap. 9.) that the ſapphire of the antients was our lapis lazuli. *The Edit.*

Its ſpecific gravity is from 3650 to 3940. *Berg.* According to *R. J.* the oriental is = 3.994: the Braſilian = 3.1307: and that from Puy = 4.0769. The ſapphire when powdered is fuſible

SECT. 78. (45.)

The Topaz.

D. Topaz. *Topazius gemmæ* [a].

This is a precious ſtone, which, when rough and perfect, is ſold in a cryſtallized form. At Schneck-

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with *borax*, or with *micorocomic ſalt* into a tranſparent glaſs, as well as with *magneſia alba*. *Berg*. and *Achard* found nearly the ſame reſults from the analyſis of this gem.

They are found in the ſame place as rubies: and thoſe called occidental, are alſo found in Siberia, Bohemia, Alſace, and Auvergne. Romé de l'Iſle ſpeaks of one of this laſt place, which was entirely *green* or *blue*, according as the ſide it was looked through.

A good ſapphire of ten carats is valued at 50 *guineas*. If it weighs 20 carats, its value is 200 *guineas*, but under 10 carats it may be valued by multiplying the carat at 10 *ſhill.* 6 *pence* into the ſquare of its weight. *Dut.*

Sapphires are preferable to common rubies, for jewelling the pallets of eſcapements, and the holes of wheel-pivots, in aſtronomical watches and clocks, on account of the homogeneous hardneſs of their ſubſtance: becauſe there are red ſtones which are called rubies, but are not uniformly hard. The jewelling watch and clock work is a very material Improvement of the Engliſh artiſts, who ſtand unrivalled in the whole world for the regularity of their time-keepers. *The Editor.*

[a] According to Pliny, (book 37. chap. 8.) this gem took its name from an iſland in the Red Sea, where it was firſt found: but it is evident from his words that it was ſome kind of *lapis ollaris*, *fuſible ſpat*, or other kind of ſtone of a green-

Schneckenſtein in Saxony, theſe criſtals are found of a priſmatical octoedral form, with no points, but flat, and with ſome facets at the top; perhaps the oriental topazes have another figure [b].

Ex-

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greeniſh-yellow caſt, that the antients called *Topaz*; ſince he ſpeaks of a topaz of a greeniſh colour, and 4 cubits large, viz. above 6 Engliſh feet (=68.476, French inches=72.978 Engliſh inches;) which cannot be applied either to our topaz or to our chryſolite, as ſome pretend. It appears, however, by the following chapter of this ſame author, that our topaz was called Chryſolite by the antients, as its name indicates: but what he ſays of one Bocchus, who had ſeen one of thoſe gems of 12 Roman pounds weight, or 10.78. pounds troy, is not incredible: ſince there is now a rough topaz in the Princes cabinet at the Hague, of the ſhape of an egg, that is upwards of ſeven inches in length, and muſt conſequently weigh conſiderably more than the above. *Edit.*

[b] I have ſome rough Brazil topazes, which are priſmatical, and of a rhomboidal quadrangular figure, pointed at one end. It is very likely, that they, as well as many other criſtals, may be pointed at both ends, when nothing has impeded them during their cryſtallization.

Beſides theſe, I have 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 others 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. *Eng.* See Note *u* to Sect. 76.

The topaz is of a lamellated ſtructure, like the other gems: it is the third in hardneſs after the diamond, and on being rubbed, becomes electric. Its form is priſmatic of 6 or 8 ſides, ending in two quadrangular pyramids. Some are ſtriated; ſome are of a rhomboidal figure, and ſome are even of a cubic form. *R. J. & Dut.*

Their

Experiments by fire have been made on the Schneckenſtein topazes by Mr. Pott, as may be ſeen in his *Lithogeognesia* [c]. To this kind I refer,

a. The pale yellow topaz, which is almoſt colourleſs, and is found at Schneckenſtein.

Their ſpecific gravity is from 3.460 to 4.560. *Berg*. According to *Briſon* = 4.0106. and thoſe of Braſil = 3.5365. *R. J.*

The Topaz appears white when reduced to powder, it melts eaſily with borax and lime: when calcined it is conſiderably altered, loſes its colour and acquires weight. *Fabr.*

The beſt topazes are called *oriental*: they have the ſame properties as rubies and ſapphires, (Note *s.* § 76): and of courſe have the ſame properties, the colour excepted. They are found in Pegu, Ceylon, Arabia, Egypt, and Braſil, &c.

Thoſe called *occidental*, loſe their *colour*, tranſparency, and hardneſs in the fire. The topazes from Saxony, though they are as hard as the oriental, agree with the occidental in their other properties.

[c] The rock of Schneckenſtein in the valley of Danneberg in Voigtland, of the Upper-Saxony, is about 80 feet high, and about three times as much in its baſe: it is as hard as the topazes themſelves, and its powder is employed in poliſhing them.

But we have ſome topazes from Brazil, whoſe ſubſtance is widely different, as they do not loſe their tranſparency, nor hardneſs by fire: but even turn red like a fine ruby, and are ſold as ſuch (Note *u.* to § 76). Thoſe from Bohemia are in large priſms: their colour inclines to the hyacinth: and ſome are colourleſs, as ſome ſaphires are.

Tavernier ſpeaks of a very fine topaz belonging to the Mogul, of 157$\frac{1}{3}$ carats: and many others are known of a very large ſize.

The oriental topaz is valued by multiplying the ſquare of its weight in carats into 15 or 16 *ſhillings*; and the ocidental one at the rate of 5 or 6 *ſhillings*. *Editor*, from Dutens, R. del' J. Bomare, &c.

b. The

b. The yellow topaz from Schneckenſtein.
c. Deep yellow, or gold coloured topaz, the oriental topaz.
d. Orange coloured topaz.

SECT. 79. (46.)

The Chryſolite.

E. e. The yellowiſh green topaz, or chryſolite [*d*],

Is of a graſs-green colour, and may belong to ſome other ſpecies, which might be diſcovered, if it could be obtained rough, or in its matrix, and large enough or in ſuch quantity as is neceſſary for experiments to be made.

f. The

[*d*] The oriental Cryſolite and Peridot are the very ſame gem. *Dut.* It becomes electric by being rubbed: its form is priſmatic of 6 and ſometimes of 5 ſtriated faces. (*R. J.*). They are found in the Eaſt Indies, Brazil, Bohemia, Saxony, and Spain; in Bourbon and Auvergne in France; and in Derbyſhire in England. Some are likewiſe found with volcanic lavas, as in the Vivarais, where ſome large lumps have been ſeen of 20 and 30 pounds weight. But it is remarkable that ſome of theſe chryſolites are partly decompoſed into an argillaceous ſubſtance.

However, all chryſolites are far from being of the ſame kind: the *oriental* ones only differ on account of their green hue *f.* The yellowiſh green and cloudy topaz, the Chryſopraſe [*e*].

This

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hue from thoſe ſapphires, topazes, and rubies of the ſame denomination. Theſe do not loſe their colour, or their tranſparency in the fire (*R. J.*) : but the common chryſolite either becomes opake by a ſtrong heat (*Berg.*) ; or is entirely fuſible : and it phoſphoriſes in the inſtant it melts, like the baſis of allum and gypſeous ſpar : with borax it produces a thin colourleſs glaſs. (*Fabr.*)

Its ſpecific gravity is between 3.600 and 3.700 (*Fabr.*) : according to Briſſon, quoted by *R. J.* it is = 2.7821, or 2.6923 : and that of the Spaniſh chryſolite = 3.0989.

Its ſubſtance is lamelated in the direction of the axis of its primitive form : but the chryſolite from Saxony is foliated in a perpendicular poſition to the ſame axis. *R. J.*

The chryſolite of the antients was the ſame gem, which is now called Topaz, and the name of itſelf indicates that it ought to be ſo. Pliny very plainly ſays (B. 37. c. 9.) that the colour of the chryſolite is *yellow* like *gold*. *Edit.*

[*e*] Mr. Achard has made the analyſis of the Chryſopraſe from Koſeinitz in Sileſia, which loſt its colour, and tranſparency in the fire, becoming cracked and white in its ſurface, but without melting. Its powder, either with ſalt of tartar, mineral alkali, nitre, or borax gave a diaphanous glaſs : and with other ſubſtances produced opake maſſes of different colours.

The Chryſophraſe is of a green colour, deeper than the Chryſolite, but with a yellowiſh tinge, inclining to blue, like the green leek, as Pliny ſays (B. 37. c. 8.). Mr. Achard ſays, that it never is found cryſtalliſed, and that it is ſemitranſparent. Mr. R. J. reckons it amongſt the quartz, and ſays that its colour is owing to the mixture of cobalt, as it gives a fine blue glaſs when fuſed with borax, or with fixed alkali. But Mr. Achard found the glaſs of a *deep yellow* when the fuſion was made with borax: and that it really contains ſome calx of copper inſtead of cobalt. Mr. *Dut.* ſays that ſome gold has been found in this kind of ſtone : but this laſt, in

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 quartz, called in Swediſh *Milk Cryſtal*, which is of the firſt degree of cryſtallization.

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in all probability, belongs to ſome other claſs of ſubſtances, viz. to the vitrous ſpars.

The Aventurine in all probability is of this laſt kind: its colour in general is of a yellow-brown-red; but ſometimes it inclines more to the *yellow*, or the *green*, than to the *red* colour. They are not quite tranſparent: and ſome ſhine with ſuch a brilliancy, that renders them of a conſiderable value; but theſe are very rare. The common Aventurine is but an artificial glaſs of various colours, with which powder of gold has been mixed: theſe imitated Aventurines make very often a better appearance than the natural ones commonly do, and have lowered their eſteem.

As to the Praſe, its name from πρᾶσον ſhews it to be of a greeniſh-blue colour, like the leaves of a leek: it only differs from the chryſolite in its bluiſh hue. *Edit.*

SECT.

SECT. 80. (47.)

The Beryl.

F. Bluiſh green topaz, or the beryl.

This varies in its colours, and is called, when

1. Of a ſea-green colour, the *aqua marina* [f].
2. When more green, the Beryl [g].

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

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[f] The *aqua marina* found by Pallas in the mountain Adontſcholo of Siberia, the *Peru emerald*, and the *chryſolite* from Brazil, are nearly the ſame, both in their form, and in their ſpecific gravity (*R. J.*). This laſt of the Siberian *aqua marina* is 2,7213 (*Briſſ.*) It does not vitrify in the fire, but becomes opake, and cracks in its ſurface. *Sage*, quoted by *R. J.*

The great Saxon mineralogiſt, and ſuperintendant of the mines, M. Pabſtvon Oheim, who has a very inſtructive collection, likewiſe poſſeſſes ſuch an octoedral *aqua marina*, on a piece of quartz druſe from Shneckenſtein, growing among ſome yellow topazes. It has no points, and the whole cryſtal has a flaw acroſs the priſm. *Brun.*

[g] The *beryl* and *aqua marina* are tranſparent, and of a green blue colour: ſome jewellers wrongly call them by the name of *oriental coralina.* They come from Ceylan, from the ſhores of Euphrates, from the neighbourhood of Mount Taurus, and from Brazil. *Dut.*

SECT. 81. (48.)

The Emerald.

G. Emerald. *Lat.* Smaragdus gemma. *Swed.* and *Germ.* Smaragd. *Fr.* Emeraude [*h*].

Its chief colour is green, and it is tranſparent [*i*]. I believe it to be, or to have been, a criſtal of its own ſeparate principle, ſince in its qualities it differs both from the above-mentioned, and from the rock criſtal [*k*]; but I cannot

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[*h*] The Romans called it the *Neronian* or *Domitian gem.* (Waller.) The Perſians and Indians call it *pachae:* and the Arabians *zamarrut*, from whence it is ſuppoſed the word *ſmaragdus* is derived. (*Hill* in his Notes to *Theophraſtus*, pag. 61.)

The oriental emerald is a true ſapphire of a green colour. *R. J.*

[*i*] The emeralds, in their rough or native ſtate, conſiſt of hexagonal columns, moſtly truncated at both ends. I have ſamples of both tranſparent graſs-green and light-green colours, which in a gentle heat become colourleſs; but white and opaque in a ſtrong fire, without the leaſt mark of any fuſion.

When cryſtalliſed cockle 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 their luſtre; and hence it is that the cockle-ſpar from Egypt is called the mother of 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 (ſiliceous) kind. *Eng.*

[*k*] The emerald, when heated to a white heat, becomes of a deep blue, and phoſphoreſcent. It however recovers its green

not poſitively aſſert this, ſince I know no more of it, than that it is the ſofteſt of precious ſtones [l], 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

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green colour when cold. When pulveriſed it becomes white: and melts with borax to a very thin colourleſs glaſs. *Waller.*

It becomes electric by being rubbed. *R. J.*

Its ſpecific gravity is 2,700, or 2,800 according to Wallerius. Briſſon makes it 2,7755: and Berg. from 2,780 to 3,711.

[l] 1. Pale green emerald,

Comes from the Eaſt, and from Peru; their figure is an hexagonal truncatted priſm. Their baſis is a vein of white quartz. The fineſt druſe of this kind is to be ſeen at Loretto, in the treaſure of the Holy Chapel, near Ancona, conſiſting of more than an hundred great and ſmall emeralds. A fellow to it is made by art, and both are preſents of the king of the two Sicilies, to repreſent two Mount Calvaries. *Brun.*

2. Dark green emerald, Theſe

Are columnar, and ſtriped longitudinally; their colour is very dark, and they are hardly tranſparent. The points are generally broken off, however Davila mentions one in form of a blunted triangular pyramid. There is one with a quinquagonal pyramid in the imperial cabinet at Vienna. Some of them, which muſt be ſelected by trials, have the properties of the tourmalin, (ſee § 85) of attracting aſhes, when they are laid on burning coals, and acquire a certain degree of heat; but I never could diſcover that they repelled them again.

They do not attract ſo ſtrongly as the tourmalin. The Prince of Noja, in his letter on the tourmalin, mentions the Braſilian emeralds among thoſe hard ſtones, which when they are put into the fire, receive no electric power like the tourmalin: but he was poſſeſſed of, and tried ſuch, as really had not that quality. The celebrated inſpector of the Auſtrian mines, M. Jacquin, has been a witneſs of my experiments. *Brun.*

green cockle-ſpar [m], 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. Mailet informs us, that in former times the beſt emeralds were found in Egypt [n].

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[m] The original Swediſh has *ſkiorl ſpat*, that is, *cockle* or *ſhirl ſpar*, of which will be ſpoken hereafter; but the German tranſlation terms it, *ein ſchoen ſpat*, a fine ſpar; that is to ſay (in this ſenſe) a fine fluor. The ſchoerl or ſhirl of the Germans is a ſubſtance called by our Corniſh miners *cockle.* D. C.

[n] Pliny mentions (B. 37. c. 5.) twelve kinds of emeralds: but, by his words, it clearly appears that many of theſe were different green ſtones, ſo called by the Antients. Theophraſtus ſays (pag. 65 of Hill's edit.) that, in the records of the Egyptian kings, mention is made of an emerald 4 cubits long, and 3 broad: and of an obeliſk compoſed of 4 emeralds, which was 40 cubits long, and from 4 to 2 cubits wide. Each *Egyptian cubit*, according to Paucton, is equal to 10 $\frac{273}{1000}$ *French inches*, or near 11 Engliſh inches. If theſe and like accounts of large emeralds are to be depended upon, we muſt think they were ſome ſparry fluors like thoſe we have in Derbyſhire, or ſome green glaſſes, like thoſe manufactured in England, which are as beautiful, as the true emeralds: and of this kind ſeems to be, that large one kept in the Abbey of Reychenaw near the Lac of Conſtance, mentioned by Romè de l'Iſle, pag. 246. vol. II. of his Cryſtallography, which meaſures above two feet and a half in length, &c. *The Edit.*

SECT.

SECT. 82. (Additional from a Note of Mr. Engeſtrom to § 49.)

The Hyacinth.

H. To the precious ſtones belong alſo the Jacinths, or Hyacinths, which are criſtals harder than quartz criſtals, tranſparent, of a fine reddiſh yellow colour, when in their full luſtre [*o*] 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 facetted garnet [*p*].

Theſe

[*o*] The beſt Hyacinths come from Arabia, Calecut and Cambaya. They only differ in colour from rubies. *R. J.* and *Dut.* They are called oriental, when very hard and brilliant; and they are then reckoned among topazes: but when they are ſoft, they belong to the garnet kind: thoſe from Compoſtella in Spain are of this laſt ſort. *Wall.*

According to Dutens, the ſpecific gravity of this gem is 2,631: but Romè de l'Iſle ſays that Briſſon found it to be 3,6873; and thoſe of Europe 3,760.

[*p*] They are of a dodecaedral form like the garnet; but their angles are more obtuſe. *R. J.*

Theſe criſtals loſe their colour, become white, and do not melt in the fire; by which qualities chiefly they may be diſtinguiſhed from garnets, (§ 84) 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 69, 2. *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.

The *Jacinta la bella* of the Italians is a garnet of this yellowiſh hue: but when it is more of a reddiſh colour, it is then called *vermeille* by the French. *R. J.* and *Dut.*

The Chryſolectre is a yellow brown hyacinthe, like *honey*, or *amber*, but very diſtinct from the two above by being leſs hard, and by not having any electric power. *Dut.*

SECT.

SECT. 83. (Additional.)

The Amethyſte.

I. The Amethyſte is a gem of a violet colour, with great brilliancy, and as hard as the beſt kind of rubies or ſapphires, from which it only differs by its colour. This is called the *oriental amethyſte*; and is very rare: when it inclines to the purple, or roſy colour, it is more eſteemed, than when it is nearer to the blue.

Theſe amethyſtes have the ſame figure, hardneſs, ſpecific gravity, and other qualities, as the beſt ſapphires or rubies: and come from the ſame places, particularly from Perſia, Arabia, Armenia and Weſt-India. *Wall. Dut. Bom.* and *R. J.* N. B. This gem muſt not be confounded or miſtaken, with the Syrian garnet. See § 84.

The amethyſtes called *occidental*, are of the ſame nature as rock cryſtals, and have the ſame gradations, viz. of a violet inclining to the purple or roſy colour, or inclining to the blue: very often they are ſemi-tranſparent without any colour in one end, and violet towards the other. The beſt are found in the Vic mountains of Catalonia in Spain, and at Wieſenthal in Saxony, as well as in Bohemia in Germany, in Italy, and in the province of Auvergne in France.

Cryſtals within the geodes, or hollow agathe-balls, are very often found of an amethyſt colour, and ſome are very fine. *R. J.*

What we call now *amethyſte root*, or *mother of amethyſt*, is but a ſparry fluor, of which we have plenty in Derbyſhire; many fine ornamental pieces are made of this ſubſtance in different forms and ſhapes. Theſe ſpars are found in inſulated maſſes, ſometimes pretty large: but never in the form of large rocks. *Edit.*

SECT. 84. (Additional.)

The Garnet.

K. The garnet. *Lat.* Granatus. *Swed.* Aecta *or* Klar Granat. *French*, Granat. *Germ.* Echter *or* Klarer Granat.

This ſtone when tranſparent and of a fine colour is reckoned among the gems: but it varies more than any, both in the form of its criſtals and in its colour, ſome being of a deep and dark red: ſome yellowiſh, and purpliſh: and ſome brown, blackiſh, and quite opake. In general their luſtre is leſs than that of other gems, as well as their hardneſs, which yields to the file although they may ſtrike fire with ſteel. But as to their form, theſe criſtals take almoſt all ſorts of figures, as the rhomboidal, tetradecaedral, and ſome are in an irregular form.

Their ſpecific gravity according to Wallerius is from 3,600 to 3,900 and even to 4,400.

According

According to Briſſon 4,100.

Thoſe of Bohemia according to Cotes 4,360.

And thoſe of Sweden according to the ſame author, 3,978.

Their colour proceeds from the iron which enters into their compoſition, and according to Mr. de Sauſſure even the fineſt oriental garnets attract the magnetic needle at a ſmall diſtance.

The *Syrian garnet* is the fineſt and beſt eſteemed. It is of a fine red inclining to the purple colour, very diaphanous, but leſs brilliant than the oriental amethyſt. It ſeems to be the *amethyſtizontas* of Pliny: the Italians call it *rubino di rocca*, and is found in Syria, Calcutta, Cananor, Camboya, and Ethiopia.

The fine garnet of a red inclining to a yellow colour, is the *ſoranus* of the antients, the *vermeille* of the French; and the *giacinto guarnacino* of the Italians. Its name is taken from *Sorian*, or *Surian*, a capital town of Pegu, from whence theſe gems are brought: when they have a browniſh taint, they are then called hyacinths.

The occidental garnet is of a deep and dark red, and its hardneſs is leſſer. However, ſome very fine hard garnets are found in Bohemia. Garnets are found alſo in Hungary, at Pyrna in Sileſia, at S. Sapho in the Canton of Berne, in Spain, and in Norway.

The garnet melts in the focus of a good burning glaſs into a brown maſs, which is attracted by the load-ſtone, and this ſhows that iron enters conſiderably into its compoſition.

Some garnets are found, which contain a little gold. Thoſe called *zingraupen* by the Germans contain tin.

See Sect. 68 of the Author, where theſe garnetic ſubſtances are treated of at large.

It is probable that the *lapis alabandicus* of Pliny, book xxxvi. c. 8. which was black, and that other he mentions, of a deep purple (B. xxxvii. c. 7.) among the gems, were both true garnets. *Ed.*

SECT. 85. (additional.)

L. Tourmalin. Aſhdrawer. *Tourmalinus, Lapis electricus.* Trip *in germ.*

This is a kind of hard ſtone, lately brought into notice by its electrical properties[q].

1. Its form is a priſm of nine ſides of different breadth, moſtly runcated, and ſeldom terminating in a pyramid at each end, which is either

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[q] This ſtone has been known in Europe ſince the year 1717 only, in which year Lemery firſt ſhewed it in the Royal Academy of Sciences at Paris. Since that time it has been made more known; and the Dutch have ſpread it every where. Moſt of them are flat on one ſide, and convex and poliſhed on the other. There are, however, likewiſe ſome rough ones like pebbles Moſt of them are tranſparent: and the Prince de Noja, in his letter to Count Buffon, affirms, that he likewiſe had an opake one. The largeſt I ever ſaw is in the cabinet of Mr. Steiglitz at Leipzig: its ſize is nearly a ſquare inch, and its thickneſs two lines. Beſides this ſize, it has a very remarkable quality. When you look through the two largeſt ſurfaces, which are but two lines aſunder,

either compoſed of three pentagons, or of nine triangles.

2. When heated in the fire, it gives ſigns of contrary electricity on the two oppoſite ends of their priſmatic form [r]. But many of theſe

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aſunder, it appears wholly opake; but covering theſe, and looking through the ſmall ſurfaces which are near 12 lines aſunder, it is quite pellucid: which muſt neceſſarily ariſe from the peculiar texture of the ſtone. It is only flat on one ſide. We know nothing of the ſpot where the Tourmalin is generated. Aepin and Bergman have written the lateſt diſſertations upon it, and mentioned all its electric qualities. Dr. Pallas, from whom we are now to expect great elucidations on the natural hiſtory of Siberia, ſhewed me a Tourmalin, which was perfectly like the others in colour, hardneſs, and tranſparency, but would not draw aſhes. Wilſon affirms, that when a tourmalin is made red hot, and kept in a violent fire for half an hour, it does not loſe its colour; and if it is cooled of a ſudden in water, it loſes its electric quality for ever. *Brunnich.*

[r] Some ſpeak of *poles of electricity* in theſe ſtones (See R. del, J.) meaning that the power of electricity is the ſtronger in the middle axis of the two oppoſite parts of their priſmatic form. This ſeems to be rather an aukward expreſſion for conveying that idea! Others ſpeak of a certain phoſphoric *corruſcation* in the moment of its fuſion by a ſtrong heat: as if there would be wanting any *phoſphoric* power or quality to ſhine of a ſudden in the very moment of its fuſion, in which the outſide parts paſs into an even ignited ſtate! In the cupellation of gold and ſilver, the corruſcation, or *éclair* as the French call it, appears in the very moment that all heterogeneous particles of the alloy are gone off; and this becomes more remarkable, becauſe the purified metal fixes itſelf immediately after; on account of wanting a higher degree of heat to be kept then in fuſion, than whilſt it was mixed with the other metal of the alloy. *N. B.* Profeſſor Bergman found ſeveral opake ſchoerls of Sweden to poſſeſs the ſame electric qualities of the Tourmaline; but could not find any pellucid ones with the ſame property. *The Editor.*

ſtones

ſtones are not in the leaſt electric. However, on being rubbed, they become electric in their ſides, like other diaphanous gems.

3. They are as hard almoſt as the topaz, and ſtrike fire with ſteel.

4. They melt by themſelves in a ſtrong fire, though with difficulty.

5. With the microcoſmic ſalt they melt perfectly; but only in part with borax.

6. With mineral alkali, they are divided into a kind of powder.

7. The three mineral acids diſſolve them, when firſt reduced to a powder.

8. They bear a greater ſimilarity to ſchoerls, than to any other ſtone: but their component parts ſhew that they may be ranged with propriety in this place, along with other precious ſtones: as the argillaceous earth is alſo the moſt prevalent in their compoſition.

a. The oriental Tourmalines are found in the iſland of Ceylon. They are tranſparent, of a dark brown yellow: and their ſpecific gravity is from 3,062 to 3,295.

b. From Braſil. Tranſparent. Theſe are green, for the moſt part; but there are alſo ſome red, blue, and yellow: their ſpecific gravity is from 3,075 to 3,180.

c. From Tyrol. Of ſo dark a *green* as to appear opake. Their ſpecific gravity is about 3050. Theſe are found in beds of ſteatites, and lapis-ollaris amongſt the micaceous veins, talcs, and hornblende of Schneeberg,

Schneeberg, Jurzagl, and Zillerthal, in the mountains of Tyrol. *The Editor.*

d. From the mountains of Old Caſtile in Spain. Theſe are tranſparent, and have the ſame properties as the preceding ones. *The Editor*, from *Bergman*, *Muller*, *Fabroni*, *Romé de l'Iſle*, *and de Launay*. N. B. According to this laſt able mineralogiſt, the Tourmalin has been already ranged among the precious ſtones in the Copenhagen edition of Cronſtedt, in 1770.

SECT. 86. (55.)

M. The Opal. *Opalus. Paedros Græcorum*[s], the *Giraſole* of the Italians.

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 [t].

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

This appears olive-coloured by reflection, and ſeems then to be opake, but when held

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[s] Wallerius calls this precious ſtone the *Paederos Plinii*, which muſt be underſtood of what he mentions in his book, 37. c. 6. but the ſame naturaliſt, Pliny, gives alſo this name to a different ſtone, as appears by the chap. 9. of the ſame book, 37, where he ſays *Candidarum dux eſt Paederos*, mentioning a leſs valuable gem, *plebeiam gemmam*. The Edit.

[t] It loſes its colour and tranſparency in fire; and in other reſpects is affected by it as a quartz or flint.

It fuſes with borax though difficultly.

Its ſpecific gravity is 1.900. and upwards. *Fabr.* ex *Waller.*

against

againſt the light, is found tranſparent, and of a fine ruby red colour.

That opal is ſuppoſed to have been of this kind, which Pliny mentions in his *Natural Hiſtory*, book 37, chap. 6. and which he ſays, was in the Senator Nonius's poſſeſſion, who rather ſuffered baniſhment than part with it to Anthony.

This ſtone was in Rome at that time valued at 20000 ſeſterces [*u*]. 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 drogoman [*x*] 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 Opal [*y*].

There

[*u*] According to Pauſton (in his *Metrologie*, p. 433,) twenty thouſand ſeſterces were worth 4500 *French livres*, or 187 *Louis* and *a half*. It is remarkable that the ſame author has aſſerted at page 398, that the value of 20000 ſeſterces is only 3906 *French livres*, which hardly amounts to 163 *guineas*. I could wiſh this contradiction might rather be attributed to an error of the preſs, or to my own miſtake, than that ſo uſeful a book ſhould be blotted with ſuch errors. *The Edit.*

[*x*] That is to ſay *Interpreter* and *Broker* in Turkey. *Wern.*

[*y*] This very ſtone was in the year 1763, in the poſſeſſion of his Excellency the Duke de Nivernois, then ambaſſador to the Britiſh Court. D. C.

However, Wallerius thinks, that this opal found in Alexandria, was not that of Nonius, mentioned by Pliny; and adds, that it was ſuppoſed by many to be no more than a counterfeit

There is, however, another of the ſame kind in Sweden, which by reflection appears rather brown; but by refraction it 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, purple, 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 [*z*].
2. Of a milkey colour [*a*]. From Eibenſtock in Saxony.

3. Bluiſh

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feit of fine glaſs, or paſte. Indeed the ſame Pliny, in the above quoted chap. 6. B. 37. aſſerts, that glaſſy compoſitions were made in India quite ſimilar to true opals: but adds, that they might be diſtinguiſhed from one another by expoſing both to the ſolar rays between the fingers, the true opals tranſmitting and throwing the light in different groupes and directions, whilſt the artificial ones only tranſmitted it with an uniform colour. Pliny might as well have added another more certain teſt, viz. that of trying their hardneſs by a hard file. It is a pity that no mention is made of the above Duke's opal being ever tried by theſe two teſts. Perhaps the owner did not wiſh to clear up the matter. *The Edit.*

[z] Wallerius, in his Mineralogy, (Ed. 1778) ſays, that this white opal anſwers much better the deſcription given of it by Pliny, than the olive coloured one, aſſerted by Cronſtedt: and there is no doubt but by an attentive peruſal of the original of Pliny, one cannot fail of preferring the opinion of Wallerius.

As to the irregular compartments of various colours which diſtinguiſh this kind of precious ſtones, they are well accounted for in the manner explained in the firſt Note to the following Section. *The Editor.*

[a] I have lately obtained a ſmall piece of pſeudo-agate, from the Eaſt Indies, which is of a yellowiſh brown, and pale blue, or rather milk colour, with a ſhining brightneſs, exactly like

3. Bluiſh, and ſemi-tranſparent. This is not ſo much valued as thoſe which are more opake; becauſe it is eaſier to be imitated by art [b].

SECT.

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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 of Pſeudo-agates (Baſtard agates), 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 thoſe 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.

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 diſſolve in the acid of nitre. 2. it is not fuſible by itſelf in the fire. 3. But melts pretty eaſily with borax, though without any effervеſcence, 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 opake, as with calcareous ſubſtances. *Engeſt.*

[b] Not only this, but alſo ſome of the other kinds of opals have been well imitated by art, there being found compoſitions

SECT. 87. (49.)

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 ſtones, among which they might elſe have been ranked, as they are already in other ſyſtems: to which I will venture to add, that, as a naturaliſt, I cannot conquer that ge-

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poſitions of glaſs, which ſhew very different colours by refraction from what appear by reflection. A curious ancient 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. I have ſeen alſo glaſs-paſtes, ſome made in London, by Edward Delaval, Eſq; F. R. S. and ſome others by Mr. More, Secretary to the Society of Arts, which appeared of a yellow-brown, or other colour by reflection: but when held againſt the light, tranſmitted a fine blue, or a purple, and red colour, like the *ſapphires*, *rubies*, *garnets*, *hyacinths*, &c. Wallerius points out the proper ingredients to make theſe paſtes: and I found by chance that the *red glaſs* of Kunkel (whoſe compoſition may be ſeen in *Journal de Phyſique* Suppl. to 1782), being overmelted or burned in a common fire, produces the like effect, tranſmiting a colour by refraction, and a different one by reflection. But the fine imitation of the true white opals, made by the Indians and mentioned by Pliny in the above quoted paſſage of his Book 37 C. 6. never were produced, as far as I know, by the moderns. *The Edit.*

neral weakneſs of valuing them ſo highly; for beſides their ſurpriſing 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 that alone it is that they deſerve to have the preference of the other ſtones of this order [*c*].

In regard to their 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

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[*c*] The tranſparency and cryſtallized forms of gems may be added as a further motive for treating of them before the other kinds of hard ſtones: but as to their conſtituent parts, late experiments have ſhewn that for the moſt part it is the *argillaceous* and not the *ſiliceous* earth, which has the greater ſhare in their compoſition, as will be ſeen in the Table annexed to the note in page 165. But even this will ſcarcely be a ſufficient reaſon for claſſing them in the argillaceous order of earths; if it be true that they owe their extreme hardneſs to the portion of ſilex, which enters into their compoſition.

All gems and cryſtals are obſerved to be of a foliated or laminated ſtructure, and of various degrees of hardneſs. Whenever the edges of theſe laminæ are ſenſible to the eye, they have a fibrous appearance, and reflect variegated ſhades of colours, which change ſucceſſively according to their angular poſition to the eye. Theſe are called *chatoiantes* by the French: and what is a blemiſh in the point of tranſparency, often inhances their value on account of their ſcarcity. But when the ſubſtance of a gem is compoſed of a broken texure, conſiſting of various cluſters or ſets of laminæ differently inclined to each other, it emits at the ſame time various irradiations of different colours, which ſucceed one another according to their angle of poſition. This kind of gems are called Opals, which are valued in proportion to the brilliancy, beauty, and variety of their colours. *Edit.*

gem on purpoſe that it may be made uſe of inſtead of the diamond, as it is harder than the quartz cryſtal[*a**]. 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 earths? becauſe we find that metallic earths, which are perfectly well calcined, give no colour to any glaſs, and that the mangeneſe, on the other hand, gives more colour than can be aſcribed to the ſmall quantity of metal which is to be extracted from it[*b*].

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

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[*a**] This is a miſtake. *See note* [*u*] *to* Sect. 76. The Author meant the Sapphire. *Edit.*

[*b*] As to the various colours of gems, no doubt, they proceed chiefly from the mixture of iron which enters into their compoſition, as appears by the reſults of repeated onalyſis of them, which are expoſed in the table at the end of the following Note. The hint given by the noble author in the text of this ſection. viz. that their colours may ariſe from the phlogiſton united with ſome metallic earth, evinces the ſuperiority of his judgment and great ſagacity in mineralogical matters: for it is now well known that calces of iron when dephlogiſticated produce the *red* or *yellow* colour of marbles, and when it is *phlogiſticated* to a certain degree, it produces the *blue* and *green*-colours. *See* § 47. *pag.* 81. The Editor.

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 [a].

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[a] The cryſtallization of gems deſerves to be taken notice of in this place. No doubt but it depends on the ſame cauſe which produces that of *ſalts*, *earths*, and *metals*, and which we are unable to expreſs in any other way but by the mutual attraction of the component parts that conſtitute each maſs. It is highly probable that the moſt minute molecules, or ſtamina, of each kind of cryſtals are poſſeſſed of a determinate angular figure, endowed with reſpective powers of attraction, from which ariſes the aggregation of each compound. Sir Torbern Bergman has written a very valuable treatiſe on this ſubject, which the reader may conſult for his ſatisfaction.

But as to the particular configuration of each ſpecies of gems, we can hardly depend upon any individual form, as a criterion to aſcertain each kind: and when we have attended with the utmoſt care to whatever Mr. Romè de l'Iſle has written with ſingular induſtry on this ſubject, in the 4 large volumes 8vo. of his *Criſtallographie*, we muſt at laſt appeal to the chemical analyſis of each ſubſtance; becauſe it very often aſſumes various forms. Theſe trials and chemical proceſſes muſt require not only much ingenuity and practical knowledge, but alſo a very conſiderable expence, on account of the dearneſs of theſe precious ſubſtances: but their reſults would not probably extend our knowledge much beyond what we already know, by the great ſkill, accuracy, and indefatigable labours of the above celebrated Profeſſor of Upſal, and of the ingenious Mr. Achard of Berlin, to whoſe names we may add thoſe of Scheel, Morveau, Darcet, and Bayen.

SECT. 88. (50.)

Quartz, in general.

Quartz. *Quartzum.*

This ſtone is very common in Europe, and eaſier to be known than deſcribed. It is diſtin-

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In the following table of the component parts of gems, the letter *B* is prefixed to the analyſis of Bergman, and *A* to that of Achard.

		Argillaceous.		Silic.	Calcareous.		Iron.
Red ruby oriental	B.	40		39	9		10
Ditto	A.	37,5		42,5	9		11
Blue ſapphire orient.	B.	58		35	5		2
Ditto	A.	58		33	6		3
Yellow topaz from Saxony	B.	46		39	8		6
Green emerald orient.	B.	60		24	8		6
Ditto	A.	60		23	10		7
Yellow brown Hyacinth orient.	B.	40		25	20		13
Ditto	A.	42		22	20		16
Tourmallin from Ceylon	B.	39		37	15		9
Ditto from Braſil	B.	50		34	11		5
Ditto from Tyrol	B.	42		40	12		6
Garnet from Bohemia	A.	30		48	11		10
			Magneſia.			Copper.	
Chryſopraſe from Koſeinitz in Sileſia	A.	0	1½	94½	2½	1	½

Mr. Achard, who made the analyſis of the Chryſopraſe from Koſeinitz in Sileſia found it to contain 456 grains of ſiliceous earth; 8 of calcareous earth; 5 of ſparry fluor's earth (which is the true calcareous earth, and makes 13 grains of this laſt); 6 grains of magneſian earth; 3 of copper; and 2 grains of iron: which numbers were reduced like thoſe of the Table. This ſeems to be the only gem which contains no argillaceous earth. *Edit.*

guiſhed 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 be eaſily made red hot without cracking ſtill more.
4. It never decays in the air.
5. Melted with potaſhes in a due proportion, 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 cryſtalizes into hexagonal priſms, pointed at 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 [*f*].

[*f*] Quartz neither loſes its hardneſs nor its weight, by calcination. Its texture is lamellar. Theſe ſtones are in general the pureſt of the ſiliceous genus, though moſt contain a ſlight mixture of other earths: the moſt obvious diſtinction among them ariſes from their tranſparency or opacity. *Edit.* from *Kirvan*, &c.

SECT. 89. (51.)

The Quartz is found, 1. Pure, *Quartzum purum.*

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

a. Tranſparent and colourleſs, *Diaphanum,* Is found in the copper mines in the north part of Norway and in Siberia. This has no criſtallized 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 Utto, in the province of Smoland.

d. Violet, from the iſland of Uto.

B. Grained. *Textura granulata,* Dry Quartz.

a. White from the gold mines at Adelfors in the province of Sodermanland, and the copper mines at Louiſberg 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; becauſe it is of a ſmoother appearance, and breaks into larger and more irregular planes.

a. Whitiſh yellow, from the Gold Mines in Hungary.
b. White, from the Iſland of Uto [*g.*]

SECT. 90. (52.)

D. Criſtallized Quartz. *Quartzum Criſtalliſatum.* Rock Cryſtal. Quartz Criſtal. *Criſtallus Montana* [*h*].

Its

[*g*] The Hungarian gold and ſilver veins near Hoderitch, which are often ſome fathoms wide, afford this lamelated and porous quartz. There are *white*, *yellow*, and *blue* ſorts of it; and ſometimes it is finely cryſtallized in pyramidical figures. I have not found this ſpecies any where elſe in Hungary, unleſs at Stolberg, where ſome of the veins have a little of it. *Brun.*

[*h*] When great quantities of quartz are continually agitated by the falls and motions of river and ſea water, they are reduced ſometimes to ſuch very minute parts as to be eaſily carried away, ſuſpended in the water: and there are ſands of ſo minute a ſize as to meaſure leſs than the *two* or *three* hundredth part of an inch. Theſe are called *Quick Sands.* Immenſe tracts of land conſiſt only of looſe ſand, and particularly along the ſea ſhore in many parts of Europe. Some pretend that ſea water has the power of producing this ſand out of its component parts, and their ſurfaces for the moſt part are ſo poliſhed as to ſhew that they could not be reduced in ſize by rubbing againſt each other: but we know not as yet that ſuch a production has ever been demonſtrated. When ſand is about as big as common *peas*, it is called *gravel:* and when it is free from ſaline and heterogeneous particles, it is employed in making mortar, and in other œconomical purpoſes. That which

Its figure is already deſcribed (Sec. 88. N° 6.) and in regard to its colours, the following varieties occur.

1. Opaque, or ſemi-tranſparent, *cryſtallum opacum, vel ſemi-diaphanum.*
   - *a.* White, or of a milk colour.
   - *b.* Red, or of a carnelian colour, from Oran in Barbary.
   - *c.* Black, from the ſame place.
2. Clear, *diaphanus* [i].
   - *a.* Blackiſh brown [k], ſmoaky Topaz, or the *Rauch Topaz* of the Germans, is found at Egern in Norway, and at Loviſa in Finland.
   - *b.* Yellow, found in Bohemia, and ſold inſtead of topazes.
   - *c.* Violet, the Amethiſt, from Saxony, Bohemia, and Dannemore in Upland [l].

d. Co-

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which is very pure ſerves for making *flint glaſs*, with red calces of lead and the proper alkaline flux: but when it has ſome mixture of the ferrugineous black ſand, the glaſs becomes of a greeniſh black colour. This I have ſeen among the various ſpecimens of glaſs, made by Mr. E. Delaval, F. R. S., who produced a very fine tranſparent and colourleſs glaſs, out of the ſame ſand with which he had made ſome of that black glaſs: and this only by ſeparating from it all the ferruginous mixture. *The Edit.*

[i] Its ſpecific gravity is from 2650 to 2700. Profeſſor Bergman has extracted from theſe cryſtals about ſix parts of *Argilla*, and one of *calcareous* earth, per hundred weight: but Mr. Gerhard found ſome ſo pure as to contain neither. *Kirw.*

[k] It is ſaid that brown cryſtals are cleared by boiling them in tallow. 7 Roz. 360. quoted by Kirwan.

[l] The moſt tranſparent are called *falſe diamonds*, *Briſtol*, *Kerry ſtones*, and *Alençon diamonds*, &c. The coloured tranſparent

d. Colourleſs rock cryſtal, properly ſo called, from Bohemia: alſo from the province of Jemtland, and many other places; when theſe coloured cryſtals are not clear, they are called Fluſs, for inſtance *Topaz-fluſs Amethyſt-fluſs*, &c. &c.[*m*].

SECT.

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parent cryſtals derive their tinge generally from metallic calces, though in exceeding ſmall portions: they all loſe their colours when ſtrongly heated. Theſe are what we call falſe gems, viz.

The *red*, from Oran in Barbary, *falſe rubies*.
The *yellow*, from Saxony, *falſe Topazes*.
The *green*, from Dauphiny, (very rare) *falſe emeralds*, or *praſes*.
The *violet*, from Vil, in Catalonia, *falſe amethyſts*.
The *blue*, from Puy in Valay, France, *falſe ſapphires*.

There are alſo *opal*, or *rainbow cryſtals*, ſome of which make a very fine appearance, the various colours of which are thrown out in zones acroſs the ſurface, though they never ſhine like the Oriental opal. *Edit.* from Mongez, in his Notes to Bergman's *Sciagraphia*, and from *Kirwan*.

[*m*] *e*. Pyramidal cryſtal, with one or two points.

Theſe have no priſmatic ſhape; they either ſtand upon a baſe in cavities of quartz veins, have only a ſingle pyramid, and are of various colours; or they lie in a clayey earth, and have both pyramids but no priſm. Found at Blackenburg upon the Hartz, and at Morſeroſh in the Silverland in Tranſilvania. Of this I have only ſeen colourleſs tranſparent ones. *Brun.*

Mr. Fourcroy makes a remarkable difference between the cryſtals and the quartz, by affirming that the former are unalterable in the fire, in which they neither loſe their hardneſs, tranſparency, nor colour, whilſt the quartz loſes the ſame qualities, and is reduced by it to a white and opake earth. The ſame author claſſes the rock cryſtals,

1ſt, According to their *form*, viz. 1. Inſulated-hexagonal-cryſtals, ending in two pyramids of ſix faces, which have a double

SECT. 91. (53.)

E. Impure quartz. *Quartzum heterogeneis intime mixtum.*

A. Mixed with iron in form of a black calx. *Quartzum calce ferri atra 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.

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double refraction, or ſhew two images of the ſame object when looked through. 2. Hexagonal cryſtals united, having one or two points. 3. Tetraedral, dodecaedral, flated cryſtals, and which, though hexagonal, have nevertheleſs their planes irregular. 4. Cryſtals in large maſſes, from the iſland of Madagaſcar, which have a ſimple refraction.

2dly. As to the colour they are either diaphanous, reddiſh, ſmoakey, or blackiſh.

3dly. As to accidental changes, ſome are *hollow:* ſome contain *water* within one or more cavities: ſome are caſed, viz. one within the other: ſome are of a round orm, as the pebbles of the Rhine: ſome have a cruſt of metallic calces, or of a pyrites: ſome are of a geodical form, viz. cryſtallized in the inſide of a cavity: ſome ſeem to contain amianthe, or aſbeſtus, and others contain ſhirls.

The ſame author reckons among cryſtals, the oriental topaz, the hyacinth, the oriental ſaphire, and the amethyſt. Mr. Daubenton has always looked on this laſt, as a quartzous cryſtal. *Edit.*

B. Mixed

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

Red. It is found in Sunnerſkog's copper mine in the province of Smoland.

SECT. 92. (From a Note of the Author.)

Obſervations on Quartz and Rock Cryſtals.

That the colour of quartz 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 aſſerted of the precedent coloured quartz (89, 90) 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 (89.) 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 carefully to be examined, if that which is ſhewn as a graſs be not an aſbeſtos, or a ſtriated cockle; and the moſs, only branched vacuities

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 reaſons which will either readily occur, or are already mentioned in their proper places [*n*].

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[n] Quartz is one of the principal kinds of ſtone which contain metals. Some of the Hungarian veins conſiſt entirely of it, and the gold is ſo minutely diſperſed in it, as not to be diſcernible by the beſt microſcopes, before it is ſeparated by pounding and waſhing. The width of the veins, ſome of which are half a fathom wide, and ſometimes open ſtill wider, repay the pains and expences, which the ſmall quantity of gold contained in it could not otherwiſe counterbalance. Nature has doubtleſs no where produced mountains of pure quartz; for the rocks at Oberſhona and Freudenſtein in Saxony, though they are reckoned among quartzes, according to their exterior character, ſeem to have more conſtituent parts of different nature. Near Lauterberg upon the Hartz

SECT. 93. (54.)

F. The flint. *Silex pyromachus. Lapis corneus*, or the *hornſtein* of the Germans.

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are quartz veins, from one to three fathoms and upwards wide, conſiſting of a looſe ſand, in which they find the copper ore in neſts.

The triangular quartz pebbles of the Daniſh iſle of Anhalt, likewiſe deſerve to be mentioned. Borrichius, in the Act. Hanſ. vol. IV. p. 177, has mentioned them: and they are ſtill found to this day. There are likewiſe quartz cryſtals, in which drops of water are incloſed. The imperial cabinet at Vienna, and ſeveral other cabinets, have ſome fine pieces of this kind. *Brun.*

Mr. Fourcroy mentions the 7 following ſpecies of quartz, viz. 1. Tranſparent, cryſtalliſed in two hexagonal pyramids joined at their baſes without any intermediate priſm, or at leaſt with a very ſhort one. 2. Thoſe which are in one tranſparent maſs. 3. The opake or of a milky colour. 4. Thoſe which look fat or greaſy. 5. Decayed quartz. 6. Thoſe of amethyſt colour. 7. And finally, thoſe of a lamelated texture when broken. He reckons the Braſilian and Saxon topazes among the quartz. See the difference aſſerted by this author between the cryſtals and quartz in the Note *m* to the Section 90.

Rock-cryſtals are generally formed upon or among quartz, which ſhows their great affinity: and are to be found in all parts of the world. Mount Saint Gothard in Switzerland has furniſhed the greateſt quantity to Europe. Large pieces of theſe cryſtals weighing from 5 to 800 pounds were found there at Grimſelberg: another of about 1200 pounds weight was found ſome years ago at Fiſbach in the Wallais: and a large piece 6 feet long four wide and equally thick, was found in the iſland of Madagaſcar, a place where theſe natural productions are of the moſt extraordinary ſize and perfection. *The Editor from* Bomare, &c.

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 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. Whenever 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 made one of its conſtituent parts, and had in 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 tough ſtate like glue or jelly [o].

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[o] 7. When broken it is ſcaly, generally unequal, and cracks into thin lamellae. *Brun.*

8. In a calcining heat they become opaque-white and milky. *F.*

The

The ſeveral varieties of this ſpecies have obtained more diſtinct names 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. 94. (Additional.)

Jade. *Lapis nephriticus, jaſpachates.*

The true lapis nephriticus ſeems to belong to this ſiliceous order; as it gives fire with ſteel, and is ſemi-pellucid like flint; it does not harden in fire, but melts by the ſolar heat in the focus of a burning lens, into a tranſparent green glaſs with ſome bubbles. That called by the name of *circonciſion ſtone*, which comes from the Amazon-river, melts eaſier, in the ſame ſolar fire, into a brown opaque glaſs, which is far leſs hard than the ſtone itſelf. *Macquer*.

This ſtone is ſuperior in hardneſs to quartz, though from its unctuoſity to the touch, one would ſuſpect it to contain a large portion of argillaceous earth, or rather of magneſian earth, as Mr. Kirwan ſeems to ſuſpect.

Its ſpecific gravity is from 2,970 to 3,389. It is of a granular texture, of a greaſy look, and exceedingly hard: is ſcarcely ſoluble in acids, at leaſt without particular management, and is infuſible in the fire. Mr. Sauſſure ſeems to have extracted iron from it.

a. It is ſometimes of a whitiſh milky colour, from China; but moſtly

b. Of a greeniſh, or

c. Deep green colour, from America.

d. Grey, yellowiſh, and olive colour: theſe are the vulgar *lapis nephriticus*, they being ſuppoſed to cure the nephritic pains by their external application to the loins.

The ſemi-pellucidity, hardneſs and ſpecific gravity are the characters by which the lapis nephriticus may be diſtinguiſhed from other ſtones. *Kirwan*, *Fabr.* and *Mongez.*

SECT. 95. (56.)

The Cats eye. *Pſeudopalus.* (The Sun-ſtone of the Turks, called *Guneche*, according to *Bom.* Oeil-de-Chat in *French.*)

This ſtone is opake, and reflects green and yellowiſh rays from its ſurface: it is found in Siberia [*p*].

SECT.

[*p*] It is very hard and ſemitranſparent, and has different points from which light is reflected with a kind of yellow-brown radiation ſomewhat ſimilar to the eyes of cats, from whence it had its name. Jewellers do not fail to cut them round to the greateſt advantage. The beſt of theſe ſtones are very ſcarce. One of theſe of one inch diameter was in the cabinet of the Grand Duke of Tuſcany. *Bomare.*

SECT. 96. (Additional.)

Hydrophanes, or *Oculus Mundi*. Alſo called *Lapis Mutabilis*.

This ſtone, which was formerly of great value, but little known to the moderns before Mr. Boyle had made it the ſubject of his obſervations, is commonly of a whitiſh brown colour, and not tranſparent. It is inſoluble in acids, and is not affected by alkalis. Its ſpecific gravity is about 2,048.

Profeſſor Bergman has made the analyſis of the Eibenſtock-opal, which is a kind of *Cat's-eye*, and found nearly the ſame reſults as thoſe of the Chalcedony from Feroe. It contains above 84 hundredth parts of ſiliceous earth, and leſs than 16 hundredth of argillaceous earth. This ſtone may be conſidered as a purer kind of Chalcedony, but it is too ſoft to ſtrike fire. Its ſpecific gravity is from 1958 to 2075, according to the ſame Profeſſor: however, Mr. Kirwan allows to it a ſpecific gravity from 1790 to 2240. The uſual fluxes act on it as on flints. *Edit.*

See Note *c*. to pag. 162, about thoſe ſtones which reflect various colours ſucceſſively, as their poſition is changed in regard to the eyes; and *Note* a to *Sect*. 86, *pag*. 159, where a kind of pſeudo-opal is deſcribed by Mr. Engeſtrom. N. B. Some Quartz have alſo the ſame property. See Note *l*. to Sect. 90.

The common *Giraſole* of the Italians, and that ſtone called by the name of Iris, only differ from theſe pſeudo-opals in the variety of colours they reflect; the *Iris* appearing of a *reddiſh brown*, upon which the rays of the ſun make the appearance of the *rainbow:* but there are various other ſtones which have the ſame appearance when expoſed to the ſunſhine.

As to the *common Giraſole*, it appears by the deſcription of Mr. Dutens to be nothing elſe but the *Moon-ſtone* of Sect. 99. in which a kind of *yellow* is ſeen intermixed with its *bluiſh-milk-white* colour. *Edit.*

It is eaſily cut and poliſhed.

It ſometimes gives fire with ſteel, and ſometimes not. It is infuſible *per ſe*; but, being urged by the blow-pipe, it changes to a brown brittle ſubſtance.

The principal property which diſtinguiſhes it from all other ſtones, is that it becomes tranſparent by mere infuſion, in any aqueous fluid; but it gradually reſumes its opacity when dry [q].

It is found in beds more or leſs thick over the opals in Hungary, Sileſia, and Saxony: and over the chalcedonies and agates in Iceland. Theſe ſtones are either of a yellowiſh green, or of a milky grey, or of a yellow, like that of amber. *F.*

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[q] There are in the Britiſh Muſæum 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 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, and 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. *Engeſtr.*

The hydrophanes in general belongs to the ſiliceous kind. But ſome ſteatites have the ſame quality, as Bergman affirms: and the cruſt of Chalcedonies and Agates produce often the ſame appearance. *Edit.*

SECT. 97. (Additional.)

Obſervations on the *oculus mundi*.

This ſtone has been long admired, though very little pains have been taken to know from whence it comes, or what the nature of it is. It is to Meſſ. Bruckman and Veltheim that we owe the knowledge of its origin, or at leaſt the mineral in which it is found, beſides ſeveral of its properties equally unknown before.

As ſoon as this ſtone is put into water, it exhales a muſty ſmell, ſeveral bubbles of air ariſe, and it begins to grow gradually tranſparent. Some of theſe ſtones are colourleſs as ſoon as they are thoroughly tranſparent, others have a more or leſs deep yellow colour, others acquire a red ruby colour, and laſtly, others acquire a beautiful mother of pearl colour, or of a bluiſh opal. Whatever be the colour of the liquor in which the hydrophanes is placed, it aſſumes only its uſual degree of diaphaneity, and the colour that is peculiar to it. If while it is yet moiſt, and conſequently tranſparent, it be obliquely looked at, a luminous point is perceived, which varies when its ſituation is altered. This luminous point is not, according to Mr. Bruckman, the immediate image of the ſun, but a reflection of that image refracted in the very ſubſtance of the ſtone, a phenomenon which probably gave riſe to the name of *Oculus Mundi*. The theory of this

this phenomenon has been given by Profeſſor Bergman, in his excellent treatiſe, *de Lapide Hydrophano.* Mr. Bruckman put a dry piece of this ſtone, weighing 35 grains, into water, and left it there ſeven hours, the ſpace of time requiſite to render it perfectly tranſparent; he then found it to have gained three grains in weight.

If the hydrophanes be put into hot water, it becomes tranſparent much ſooner: the ſame happens if it be dipped in a very dilute acid, or which is ſtill better in a very dilute alkali.

If it be dipped in oil of vitriol, it becomes tranſparent very quickly, and will continue ſo, becauſe the acid lodged in the interior part of the ſtone attracts as much moiſture from the air as is neceſſary to keep it tranſparent; but its opacity will return if it be dipped in a hot alkaline liquor.

SECT. 98. (58.)

3. The Chalcedony, or white Agate,

Is a flint of a white colour, like milk diluted with water, more or leſs opake: 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 opake Chalcedony, or *Cacholong*, from the Bukariſh Calmucks. This was firſt made known by one Renat [r], 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 [s].

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

c. Bluiſh grey, from Ceylon and Siberia [t].

SECT.

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[r] He was taken priſoner in 1714, by the Calmucks, and remained with them till 1733, when he returned with an immenſe wealth, having taught the Calmucks to melt iron ore, to make gunpowder, and to caſt cannon, and having been their leader in their wars againſt the Chineſe. *J. R. Forſter.*

[s] The Cacholong is a kind of white agate, very hard and compact: it is ſemi-tranſparent, and this ſeems the only circumſtance by which it differs from the moon-ſtone of Sect. 99, which is of a milky white and blue bottom. It is vitrifiable, and may receive a very good poliſh. It is found in the river *Cache* in the Calmucks country, from whence it takes its name. Theſe ſtones, and almoſt all of the agate kind, as well as ſome of the fine gems, are cut and poliſhed with a convex ſurface, a form which the French call *Cabochon*. Dut.

This ſpecies is found alſo in the Feroe iſle, where it lies on and between the ſtrata of ſemidiaphanous chalcedony. It is never formed in drops: and ſeems to be a coarſer variety of the true chalcedony. *Brun.*

[t] This too comes from the ſame place as the Cacholong, and is ſometimes found in fine drops of conſiderable ſize. Count Thott in his excellent collection has ſuch a one from Feroe *Brun.*

To the above three, a fourth ſpecies of Chalcedony may be added, viz. The Hydropal Chalcedony [*Enhydre*, in *French*], ſo called on account of its being hollow, and almoſt filled with water, which circumſtance renders theſe ſtones of ſome value among the curious: but ſome have ſuch a porous texture that in

SECT. 99. (Additional.)

The Moon Stone is of a clear white colour, approaching to that of milk. When looked at in a certain poſition it reflects a ſtrong light, like the mother of pearl: and in ſome ſpots a carnation colour. It is found in obtuſe-angular pieces, which ſometimes have a quadrangular figure. Its fracture is evidently foliated. It is very hard, and in other reſpects agrees with common feltſpat. Probably it is the *Androdamas* of Pliny: the common *Giraſole* of the Italians: and the *water Opal* of Ceylon. It is ſome times claſſed with the opal, and by others with the *Cat's-eye*. Werner.

This ſtone is of the chalcedony or pſeudo-opal kind: it reflects a whitiſh light, with ſome various ſhades of few intermixed colours on a bluiſh bottom, like the ſhining face of the moon when it is high enough not to become reddiſh by the interference of the earthy vapours.

The Rainbow-ſtone, or *Iris*, ſeems to be no more than a Moon-ſtone, in which the yellow purple and blue reflected rays are the moſt conſpicuous. *See the laſt part of Note* [*p*] *to pag.* 178, *and Note* [*c*] *to pag.* 162.

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in proceſs of time their water is entirely dried. It is ſaid, however, that they may recover it again, if buried in a wet ſoil for a proper length of time. *Edit.*

This Chalcedony is ſemi-tranſparent, of a grey or brown bluiſh colour. Many of this kind are found in a mountain, containing various volcanic productions, near the city of Vicenza, belonging to the Venetian State. *The Edit.* from the Volcanic Mineralogy of Mr. Faujas.

SECT. 100. (57.)

The Onyx. *Onyx Camebuja. Memphites.*

This ſtone is the hardeſt of the flinty tribe, and conſiſts of differently coloured veins, which run parallel to one another, ſometimes in ſtrait, ſometimes in curved lines [u].

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 ſtrait lined onyxes in relief, which they called *Camebuja:* theſe are ſtill counterfeited, and called *Camei*. Thoſe, which conſiſt of concentric circles were called *Memphites*, and we have now of this kind cut to be ſet in rings, under the name of *Occhi di Gatti*, which, however, ought not to be confounded with the pſeudo-opal, (Sect. 95), or Cat's-eye.

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[u] This ſtone loſes its colour in the fire, and cracks or breaks if the heat be ſudden or violent.

Its ſpecific gravity is from 2500 to 2600. *Fabr.*

SECT. 101. (59.)

4. The Carnelian, *Carniolus* [x].

Is of a browniſh red colour, and often entirely brown. Its name was 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.

SECT. 102. (60.)

5. The Sardonyx.

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

a. Striped with white and red ſtrata: this ſerves as well to 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,

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[x] It loſes its colour in the fire.
Its ſpecific gravity is from 2630 or 2700 *Fabr.*

ference, 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. 93 [y].

SECT. 103. (61.)

6. 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 [y*]. Hence alſo they have obtained variety of names, moſtly Greek, as if the buſineſs of the lapidary in cutting of them, and the fondneſs of admiring their ſeveral beauties and figures, had been derived from that nation alone.

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[y] The yellow and the orange coloured agates with a wavey or undulating ſurface like the *Chalcedony*, are now called alſo by the name of *Sardonyx*. Mongez.

[y*] Near the bridge, over the Mulda, not far from Freyberg, in Saxony, a red and white agate breaks in veins. This is called *Coral ſtone* in Italy. The agate of Rochlitz in Saxony is the moſt celebrated, and is found in globules which have a kind of cruſt about them. *Brun.*

As

As it ever was and muſt be very difficult to give intelligible deſcriptions of colours, we are for that reaſon quite at a loſs to underſtand the meaning of the antients in this reſpect; but it 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 languages 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 Calcedoniſans.*

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 agpearance, it is by ſome called *Sardea.*

e. Semi-tranſparent, whith clouds of an orange colour.

f. Deep red, or violet, and ſemi-tranſparent.

g. Of many colours, and variegated.

h. Black.

There

There are in Europe great quantities of moſt varieties of agates [z], 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.

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[z] I have lately obtained a ſpecimen of a hollow agate ball, with pale amethiſts in the inſide, between which is criſtallized a calcareous ſubſtance into a fibrous form. Theſe fibres are parallel, white, ſhining, and very minute, exactly reſembling the fineſt aſbeſtos, 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 gypſum, which ſometimes ſhoots alſo in a fibrous form, but entirely a pure calcareous ſubſtance. The whole maſs does not adhere together, but is 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 obſerved by means of a proper magnifying glaſs, to be of an angular figure. 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 elſewhere, I have likewiſe ſome ſpecimens of native ſilver from Potoſi in the Spaniſh West-Indies, which run in grey and blue tranſparent agate with white opaque veins. This ſeems to confirm the opinion, that agates may form veins in the rocks, as well as other ſorts of ſtones. (See Sect. 106.) *Eng.*

SECT.

SECT. 104. (62.)

7. Common Flint, *Silex communis. Pyromachus,*

Is really of the ſame ſubſtance as the agate, but as the colours are not ſo ſtriking 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* [a].

SECT. 105. (63.)

8. Chert. *Petroſilex*, *Lapis Corneus*, The *Hornſtein* of the Germans.

Is of a coarſer texture than the preceding, and alſo leſs hard, which makes it conſequently not

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[a] Common flint, is the *Kieſel* of the Germans. According to Mr. Weigleb, it contains 80 per cent. of *ſiliceous earth*, 18 of *Argil*, and 2 of calcareous earth. Its ſpecific gravity is from 2650 to 2700. *Kirwan.*

ſo capable of a poliſh. It is ſemi-tranſparent at the edges, or when it is broke into very thin pieces.

a. Chert of a fleſh colour, from Carl-Schakt, at the ſilver-mine of 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 [*b*]

SECT. 106. (Note to Sect. 63.)

Obervations on Cherts.

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 (the

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[*b*] Chert runs in veins through rocks, from whence its name is derived. Its ſpecific gravity is from 2590 to 2700. In the fire, it whitens and decripitates like ſilex, but is generally ſo fuſible as to melt *per ſe.*

It is not totally diſſolved in the *dry way*, by the mineral alkali: but borax and microſcomic ſalt diſſolve it without efferveſcence.

Its appearance is duller and leſs tranſparent than common flint. The reddiſh Petro-ſilex uſed in the Count de Lauragai's porcelain manufacture, and called there *felt ſpat*, contained 72 per cent. of *ſilex*, 22 of *argill*, and 6 of calcareous earth. *Kirvan.*

(the Cherts) appearing tranſparent, and of a fine ſparkling texture, on being broken; whereas the Jaſper is grained, dull, and opake, having the appearance of a dry clay. The Chert is alſo found forming larger or ſmaller veins, or in nodules like kernels in the rocks; whereas the jaſper, on the contrary, ſometimes conſtitutes the chief ſubſtance of the higheſt and moſt extended chain of mountains. The Chert is likewiſe found plentifully in the neighbourhood of ſcaly lime-ſtone, as flints in the ſtrata of chalk. What connection there may be between theſe bodies, perhaps time will diſcover.

But flints and agates being generally found in looſe and ſingle irregular nodules, and hardly in rocks, as the chert, it is a circumſtance very inſufficient to eſtabliſh a difference between them; for there is the agate ſtone, 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, viz. 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 modules, 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; though ſometimes the formation of this cruſt

may

may be 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 had 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 above *agate-gall* or cruſt out of the way.

SECT. 107. (64.)

G. Jaſper, *Jaſpis.* (The Diaſpro of the Italians.)

All the opaque flints are called by this name, whoſe texture reſembles dry clay, and which have no other known quality, whereby they may be diſtinguiſhed from other flints, except that they may be more eaſily melted in the fire; and this quality, perhaps, may proceed

proceed from the heterogeneous mixture, probably of iron [c].

1. Pure jaſper. *Jaſpis pura.*

Which, by no means yet known can be decompounded.

- *a.* Green, with red ſpecks or dots, the *Heliotrope*, or *blood-ſtone*, from Egypt.
- *b.* Green, from Bohemia. (*Pavoniua Aldrovandi*).
- *c.* Red, *Diaſpro roſſo* of the Italians [d].
- *d.* Yellow. (*Melites*) [e].
- *e.* Red with yellow ſpots and veins, *Diaſpro florido* of Sicily, Spain, and Conſtantinople.
- *f.* Black, from Finland and Neſkott, in the provice of Jemtland. (*Paragone antico* of the Italians).

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[c] Theſe ſtones cannot be rendered electrical or phoſphoric, either by friction, percuſſion, or heat.

They do not crackle in the fire, nor eaſily loſe their colour.

They may be brought into fuſion, either by alkalis, borax, or nitre.

They are inſoluble in acids.

[d] Jaſper. The *diaſpro* of the Italians, contains about 75 per cent. of *ſilex*, 20 of *argill*, and about 5 of calx of iron.

Its ſpecific gravity is from 2680 to 2778. *Kirwan.*

[e] *Melites*, i. e. *mali coloris.* See Pliny, B. 37. c. 11. Bomare ſays, that this is the *Terebinthizuſa* of the ſame; but this great Father of Natural Hiſtory very clearly pronounces, that the *Terebinthizuſa* is a variegated jaſper. *See his chap.* 8. of the *ſame Book* 37. The Editor.

SECT. 108. (65.)

2. Jaſper, containing iron, *Jaſpis martialis. Sinople* [e*].

A. Coarſe grained.
  a. Red and reddiſh brown, *Sinople*, from the Hungarian gold mines [f].

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 Colniſh (or Cologne) clay, ſerpentine, &c.

C. Of a cloſe and ſhining texture like a flag.
  a. Liver-coloured, and
  b. Deep red. Both theſe are found at Langbanſhyttan in the province of Wermeland, and at Sponwick in Norway.
  c. Yellow, from Bohemia.

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

[e*] Sinople is a dark red jaſper: this contains 18 or 20 per cent of iron. *Kirwan.*

[f] Near Chemnitz, where it forms very conſiderable veins. It has frequently ſpecks of marcaſite, cubic lead ores, and blend: and the gold it contains is worth working; there is likewiſe a ſtriped Sinople, of various colours. *Brun.*

S E C T. 109. (Note to Sect. 65.)

Obſervations on Jaſpers.

Jaſper, when freſh broken, 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 Dalarne, there is a red bole found reſembling glands or kernels, in that kind of ſandſtone, from which grindſtones are cut; and ſome miles diſtant in the rocks of 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 within ſuch unctuous clefts as Colniſh clay, red chalk and other clays uſually have: 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, has for its baſis 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, enters into the maſs, which, after being diſſolved by a menſtruum not yet determined, forms flint? 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. [g].

Thus

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[g] Jaſper is infuſible *per ſe*, with the blow-pipe: with the mineral alkali it is only partially ſoluble, ſeparating itſelf with effervescence, into ſmall particles: but it melts with *borax* or *microcoſmic ſalt*, without any effervescence.

According to Bergman, in his *Sciagraphia*, it is compoſed of *Siliceous earth* united to an argill very full of iron. The mineral acids have no action upon jaſper in a ſhort time, but at the end of ſome months it is found corroded, if immerſed in them. A ſmall piece of green jaſper having been treated with the vitriolic acid, gave ſome cryſtals of alum, and ſome martial vitriol, which demonſtrates that argill and iron enter into its compoſition.

Mr. Daubenton mentions 15 varieties of jaſper. 1. The *green*, from Bohemia, Sileſia, Siberia, and the ſhores of the Caſpian ſea. This ſeems to be the *Pavonium* of Aldrovandus. 2. The *red*, or the *diaſparo roſſo* of the Italians, which is not ſo common, nor in ſuch great maſſes as the *green*. 3. The *yellow*, from Freyberg and Rochtliz: it is ſometimes of a citron colour, and looks as if compoſed of ſilky filaments. This is called the *Silk Jaſper*. 4. *Brown*, from Dalecarlia, in Finland and Sweden. 5. The *violet*, from Siberia. 6. The *black*, from Sweden, Saxony, and Finland: this is the *Paragone antico* of the Italians. 7. The *bluiſh grey*, which is very rare. 8. The *milky-white*, of which Pliny ſpeaks: it is found in Dalecarlia. 9. The *variegated* with *green*, *red*, and *yellow* clouds. 10. The *Blood-ſtone*, which is green with red ſpecks, from Egypt, and was ſuppoſed to ſtop the blood. 11. The *veined*, with various colours. When theſe veins have the reſemblance of letters, it is then called *jaſpe grammatique*, by the French. Some of this kind are found near Rochelle, in France, and called *polygrammatiques* by the curious in theſe trifling accidental qualities. 12. That which has various coloured zones. 13. That called *fiorito* by the Italians, which has its various colours

Thus one might imagine that jaſper is ſtill 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 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 rock decays into a white cruſt, whenever 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 with them in the form of an earth, which, perhaps, we do not know again in that ſtate. It may likewiſe be aſked, whether this earth will be ductile like clay, or rough to the touch like powder of bricks? Perhaps Tripoli is produced in this manner.

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colours promiſcuouſly, without any order. 14. When the jaſper has a great number of colours together, it is then (very improperly) called *univerſal*, 15. Finally, when the jaſper is found to contain ſome portions of agate, it is then called *agatiſed jaſper*. The *Editor*, chiefly from *Mongez*, in his *Notes* to Bergman's *Sciagraphia*.

SECT. 110. (66.)

Rhombic Quartz, *Spatum Scintillans. Felt-ſpatum.* (The Chineſe *Petuntſe*) [b].

This has its name from its figure [i], 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. This occurs in the Swediſh, and alſo the foreign granites.
   - *c.* Pale yellow.
   - *d.* Greeniſh.

     This laſt mentioned reſembles very much the ſchörl or cockle-ſpar, but is neither ſo eaſy to melt in the fire, nor of ſo regular a figure.
2. Criſtalliſed.

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[b] This ſpar gives fire with ſteel, and melts in a violent heat. —By means of acids, a large quantity of argillaceous and ſiliceous earths may be ſeparated from it; alſo a ſmaller proportion of magneſia, and a ſtill ſmaller of calcareous earth and iron, according to Mr. Bayen's analyſis.

[i] The German word *feld* ſignifies a *field*, and likewiſe a *compartment*, or *regular ſurface* Thus *feld-ſpat* means a *ſpar* compoſed of *little compartments of rhombic* or *other figures.* J. R. Forſter.

A. In ſeparate or diſtinct rhomboidal criſtals, from the iron mine called Moſſgrufvan, at Norbery in Weſtmanland [*k*].

SECT. III. (Additional.)

Labrador Stone. *Spatum rutilum verſicolor.* It is but a few years ago (9 or 12) that this beautiful ſtone began to be known in Europe: it is brought from the coaſt of Labrador, where the Moravians, who have a colony among the Eſkimaux, firſt diſcovered it. Its colour is commonly of a light or of a deep grey, and moſtly of a blackiſh grey: but when held in certain poſitions to the light, diſcovers different varieties of

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[*k*] 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, when it is called Granite, in Swediſh Gräberg; or with jaſper, having ſome occaſional concurring particles of quartz, cockle, and hornblende, in which caſe the compound is called 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.

It is however obſervable on old monuments, which are expoſed to the open air, that though porphyry had 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; the calcareous ſpar, for inſtance, is found to bear the weather, and even fire, better than the limeſtone. *The Author.*

beautiful ſhining colours, as lazuly-blue, graſs-green, apple-green, pea-green; and ſeldom a citron-yellow; ſome have an intermediate colour betwixt red-copper and tomback-grey; beſides other colours between grey and violet. Theſe colours are ſeen for the moſt part in ſpots; but ſometimes in ſtripes, on the ſame piece.

Theſe ſtones are found of an angular form, in pretty large pieces. Their ſpecific gravity is 2,755. Their fracture appears foliated: and the broken parts are rhomboidal: they are ſemi-tranſparent: and in other reſpects agree with the felt-ſpar.

The beſt deſcription of this ſtone has been given by Meſſrs. Leſk and Brukman. I have ſeen at Geyer a piece of feldpar, which diſplayed a great variety of colours: but very pale. *Werner.*

SECT. 112. (Additional.)

White feltſpar. *Terra Silicea Magneſia & ferro intimè mixta.*

This ſtone has been deſcribed by Mr. Bayen: and it is found at *St. Marie aux mines* in Lorrain.

It is of a white opake colour, ſpotted with ochre on the out-ſide. Its texture is ſolid and opake, conſiſting of ſhining particles, which give it a ſparry appearance. It is very hard, and ſtrikes fire with ſteel: it is attacked by acids, and

and it appears by the analyſis that ſiliceous earth compoſes half its weight, magneſia and and iron compoſe the other half. That from Alençon contains ſome calcareous earth, and more iron than any other of the kind.

S E C T. 113. (Additional.)

Obſervations on Felt Spar, (from Kirwan.)

This ſtone, which is generally opake, is found of all colours, white, red, yellow, brown, green, violet, or virideſcent; ſometimes cryſtallized in rhombic, cubic, or parallelipipedal forms, and often amorphous. Its texture is cloſe but lamelar and it breaks like ſpar. Its ſpecific gravity is from 2400 to 2600. Mr. Gerhard ſays he found it even 3500, but it was then probably loaded with metallic particles. It is harder than fluors, but not ſo hard as quartz.

It melts *per ſe* more quickly and perfectly than fluors, into a whitiſh glaſs, and does not, like them, attack the crucibles. Borax and microcoſmic ſalt entirely diſſolve it without effervеſcence, but it does not eaſily enter into fixed alkalis. When criſtallized it decrepitates in a moderate heat, otherwiſe not.

It never conſtitutes veins, or ſtrata, but is either found in looſe maſſes, at moſt two inches long, or mixed with ſand or clay, or imbodied in other ſtones, as granites, &c.

One

One hundred parts of the white contain about 67 of ſiliceous earth, 14 of argillaceous, 11 of ponderous, and 8 of magneſia.

Felt ſpar is undoubtedly the ſtone which the Saxons uſe as Petuntſe in their porcelain manufactories.

SECT. 114. (69.)

The Garnet kind: *Terræ Granateæ.*

The matter compoſing the ſubſtance of *Garnets*, and *Schörls* or cockles, except the 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 very willingly have followed the opinion commonly reecived, 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 [*l*].

[*l*] The ſubſtances of this order are analogous to gems: ſince all theſe are compoſed of the *ſiliceous*, *calcareous*, and *argillaceous* earths, with a greater or leſs proportion of iron. The opake and black garnets contain about 20 hundredths of iron: but the diaphanous ones only 2 hundredths of their weight, according to Bergman. The garnets, properly ſo called, contain a greater quantity of ſiliceous earth than the ſhirls, and both are now juſtly ranked with the *ſiliceous* earths. *Edit.*

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 opake 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 [*h*].
5. The garnet matter, during the criſtallization, has either been formed in ſmall detached quantities; or elſe has had the power of ſhooting into criſtals, though 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 [*i*].

SECT.

[*h*] The garnet is eaſily melted with borax, or with the vegetable alcali. *F.*

Its ſpecific gravity is greater in general than that of precious ſtones, viz. from 3600, and even from 4400 to 1000. *F.*

Moſt of the garnets ſtrike fire with ſteel. *Brun.*

[*i*] It is certain that the metallic calces being mixed with other earthy ſubſtances, make great alteration in reſpect to their

SECT. 115. (69.)

1. Garnet, *Granatus.*

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

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

1. Coarſe grained garnet-ſtones, without any particular figure. *Granatus particulis granulatis, figura indeterminata:* in Swediſh called *Granat-berg:* in German *Granatſtein.*

a. Rediſh brown garnet, from the mine called Granate-ſkierpningen, at Nya Kopparberg, in Weſtmanland.

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their fuſibility; and we know from experience, that the preſence of iron, particularly in the argillaceous, and 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 is not ſo eaſily ſubdued by any addition of iron, of which the Swediſh *Torſtein*, a martial ore, commonly mixed with quartz, is an inſtance; and as even the ſpecies of quartz naturally mixed with that metal, are far leſs eaſily fuſible than the garnet; it will, 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 them in this reſpect, perhaps the œconomical 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 criſtals, 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. *The Author.*

b. Whitiſh yellow, from Torrakeberget, in the pariſh of Gorborn, in Wermeland.

c. Pale yellow, from Sikſioberget, and Weſter Silfverberget, in Kopparbergſlan in Sweden [*k*].

SECT. 116. (69.)

2. Criſtallized. *Granatus Cryſtallizatus.*

a. Tranſparent, *Granatus Gemma. See Sect.* 84, *where a new article has been added on this gem.*

b. Reddiſh yellow tranſparent, the jacinth, or hyacinth. *Hyacinthus gemma* [*l*]*:* from Greenland, and Bergens Stift, in Norway. *See Sect.* 82.

c. Red ſemi-tranſparent, and cracked, from Engſo, at the Lake Malaren, in Weſtmanland.

d. Rediſh brown, from Kalmora and Stripas, at Norberg, in Weſtmanland.

e. Green, from Eibenſtock in Saxony; and Gellebeck in Norway.

[*k*] Garnets, though ſmall, are often found in micaceous ſtones in England; but extremely good garnets are found in great plenty alſo in like ſtones in Scotland. D. C.

Near Zoeblitz, in Saxony, a number of garnets ſtick in a ſerpentine rock, which baſſets to the day. *Brun.*

[*l*] I am not certain whether the oriental jacinth, and that from Siberia are of the ſame kind: but this garnet from Greenland is ſold by the jewellers as a hyacinth. *Author.*

f. Yel-

f. Yellowiſh green, from Gellebeck.
g. Black, from Swappawari, in Lapland [*m*].

SECT. 117. (70.)

B. Garnet mixed with iron and tin, *Granatus crocis 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.

[*m*] The criſtallization of 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 dependance 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 dodecaearos ex rhombis* of Linneus, is diſperſed every where in the rocks at Konigſberg in Norway. *The Author*.

SECT. 118. (71.)

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 Foderyd, in the province of Smoland.

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

SECT. 92. (119. (72.)

Cockle or Shirl, (*Schoerlus* of *Bergman*). *Lapis Corneus Cryſtalliſatus Wallerii.*

Stannum Criſtallis Columnaribus nigris. Linnæi (*n*).

It is a heavy and hard kind of ſtone, which ſhoots into criſtals of a priſmatic figure, and whoſe chief colours are black or green.

[*n*] According to Sir Tobern Bergman, ſhirls or ſchoerls ought not to be confounded with baſaltes. This laſt name does not fit the ſubſtances, the author deſcribes in this and the three following ſections. *Edit.*

2. Its

2. Its ſpecific gravity is the ſame as the garnets, viz. between 3000 and 3400, though always proportional to their different ſolidity [o].

A. Cockle or ſhirl [p], mixed with iron, *(Shoerlus martialis.)*

1. Coarſe, without any determined figure, *particulis palpabilibus figura indeterminata.*
   a. Green, found in moſt of the Swediſh iron mines.

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[o] 3. It cracks in the fire: and,

4. Is very difficult to be fuſed: neither the microcoſmic ſalt nor the mineral alkali can effect its fuſion.

5. It is not totally ſoluble in *aqua fortis.*

6. But whatever is diſſolved, may be reduced into a jelly, by the addition of an alkali.

7. It is a compound of a ſiliceous earth, argill, calcareous earth and iron: this laſt is found in a greater quantity when the cockle is opake than when it is tranſparent. *F.*

8. Some ſhirls contain 55 parts of ſiliceous earth: 39 of argillaceous, and 6 of pure calcareous earth; but ſome contain 12 or 20 parts of magneſian earth, &c. *Berg. See the Table after Sect.* 72. N° 12 and 13.

[p] The name Cockle for theſe ſubſtances is an old Corniſh mineral name; but it is alſo given ſometimes to other very different matters.

The name of ſhirl is now adopted in Engliſh, from the German mineral term. We have not in England any great quantity of ſpecies of cockles; the chief are found in the tin mines in Cornwall, and I have ſeen ſome fine criſtallized kinds from Scotland. D. C.

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

SECT. 120. (73.)

2. Sparry, *Schoerlus Spatoſus* [q].
   - *a.* Deep green, (the mother of emeralds) from Egypt [*r*].
   - *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. [*s*].

This occurs very frequently in the ſcaly limeſtones, and the colour of the ſparry ſchoerl changes from deep green to white, in proportion as it contains more or leſs of iron.

SECT. 121. (74.)

3. Fibrous, *Schoerlus particulis fibroſis*; ſtriated cockle, or ſhirl: it reſembles fibres or threads of glaſs.

[*q*] Its ſpecific character is, that it always breaks in a cubic or in a rhomboidal form. *Fabr.*

[*r*] The Plaſma, or mother of emeralds of authors, is a fine pellucid true ſhirl, or cockle, as it has been ſaid in Sect. 81. pag. 147. *Editor.*

[*s*] *d.* Brown, from Weſtmorland.
e. Black, from Kailmora in Norberg. *Fabr.*

A. Of parallel fibres, *ſchoerlus fibris parallelis* [t].

- *a.* Black, from Guſtavſberget, in the province of Jemtland, the iſland of 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.

B. Of concentrated fibres, *Schoerlus fibris concentratis*; 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 metal is alſo found at Uto, in Malaren.
- *b.* Light green from Kerrbo, at Skinſkatteberg in Weſtmanland.

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[t] 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 ſurprizing, 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. 67). *The Author.*

c. White, at Lillkyrkie in Nerike, Weſterſilfverberget in Weſtmanland, and Pargas in Finland.

SECT. 122. (75.)

4. Criſtallized cockle, or ſhirl, *ſchoerlus cryſtalliſatus.*
   a. Black, from France, Yxſio at Nya Kopparberg, in the province of Weſtmanland, Umea in Lapland, Oſterbottn in Sweden.
   b. Deep green from Salberg in Weſtmanland.
   c. Light green, from Enighets-grufvan, at at Norberg in Weſtmanland.
   d. Reddiſh brown, from Sorwik, at Grengie in Weſtmanland, and Glanſhammar, in the province of Nerike [*u*].

   The Tauffſtein, from Baſil [*x*], is of this colour, and conſiſts of two hexagonal criſtals of

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[*u*] The bar-ſhoerl, or *Stangen ſhoerl* of the Germans was lately found in the Carpathian mountains, by M. Fichtel, embodied in lime-ſtone and cryſtalliſed in priſms. It ſlightly effervesces with acids: and contains 61,6 of *ſilex*: 21,6 of *calx*: 6,6 of *argil*: 5 of *magneſia*: 1,6 of *iron*: and 3. of *water*. Kirwan.

[*x*] It is found, though very rarely, near Baſil, a known town of Switzerland.

N. B. Mountain criſtal is ſometimes found in the form of a Croſs: ſo that this figure is not peculiar to the ſhirl kind. *Werner.*

of cockle grown together in form of a croſs: this the Roman Catholics wear as an amulet, and is called in Latin, *Lapis crucifier*, or the croſs ſtone [y].

SECT. 123. (76.)

Obſervations on the Granet and Schorl or Cockle 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

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Werner. Some of this form are found in Germany, mentioned by Bergman, (*de form Cryſtall.* p. 7.) which have the appearance of calcareous, though in reality they belong to the ſiliceous kind. *Ed.*

The reddiſh brown priſmatic ſhirl from Mount Veſuvius, contains 48 per cent. of *ſilex*: 40 of *argilla*: 5 of *calx*: 1 of *magneſia*: and 5 of *iron*. But other ſorts of ſhirl have afforded 50 per cent. of *ſiliceous earth*: 30 of *argillaceous*: 1 or 2 of *magneſian earth*: and 18 or 20 of *iron*. Bergman.

The white ſort probably contain leſs iron.

But all ſhirls become reddiſh by calcination. *Kirwan*.

[y] 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 in a greater degree than any ſort of ſtone whatſoever: theſe are always of a glaſſy texture, and ſemi-tranſparent.

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

of

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, till they acquire the appearance of 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 being a mere earth, it muſt in a natural hiſtory be conſidered and ranked among the earths [z].

The tin grains ſhould have obtained 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 tin calx might by itſelf take a

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[z] 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 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 Author.*

ſpherical polygonal figure, at its induration, as well as the garnet. The white tin grains, 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 of the author, 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. 124. (Additional from Kirwan.)

Rowly Rag.

This ſtone is of a duſky or dark grey colour, with numerous minute ſhining criſtals.

Its texture is granular: by expoſure to the air it acquires an ochry cruſt.

Its ſpecific gravity is 2748.

Heated in an open fire it becomes magnetic.

In ſtrong heat it melts *per ſe*, but with more difficulty than baſaltes.

According to Dr. Withering's analyſis, 100 parts of it contain 47,5 of *ſiliceous* earth, 32,5 of *argil*, and 20 of *iron*.

SECT. 125. (Additional from Kirwan.)

Siliceous muriatic ſpar.

This ſtone is of a hard, ſolid, and ſparry texture: of a grey, ochry, dull colour, but internally bright.

It gives fire with ſteel. Yet

It efferveſces with acids.

In a ſtrong heat it grows brown: but at laſt it melts *per ſe*.

100 parts of this ſtone contain 50 of *ſilex*; the remainder is mild *magneſia* and *iron*; but in what proportion is not mentioned. See *Journal de Phyſique*, Supplement, vol. 13, p. 216.

SECT. 126. (Additional from Kirwan.)

Turky Stone. (Cos Turcica.)

This ſtone is of a dull white colour, and often of an uneven colour, ſome parts appearing more compact than others, ſo that it is in ſome meaſure ſhattery. It is uſed as a whetſtone: and thoſe of the fineſt grain are the beſt hones for the moſt delicate cutting tools, and even for *razors*, *lancets*, &c.

Its ſpecific gravity is 2598.

It gives fire with ſteel, yet

Efferveſces with acids.

Mr. Kirwan found that 100 parts of it contains 25 of mild *calcareous* earth, and no *iron*.

There probably are two ſorts of ſtones known by this name, as Mr. Wallerius affirms that, which he deſcribes, neither to give fire with ſteel, nor efferveſce with acids [a].

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[a] Workmen affirm that this ſtone hardens with oil; but this is a circumſtance that I never could obſerve. *Editor*.

SECT. 127. (Additional from Kirwan.)

Ragg Stone.

The colour of this ſtone is grey. Its texture is obſcurely laminar, or rather fibrous, but the laminæ or fibres conſiſt of a congeries of grains of a quartzy appearance, coarſe and rough.

Its ſpecific gravity is 2729.

It effervefces with acids, and

Gives fire with ſteel.

Mr. Kirwan found it to contain a portion of mild *calcareous* earth, and a ſmall proportion of iron.

It is uſed as a whet-ſtone for coarſe cutting tools.

The ſiliceous grit, cos arenarius, *and other compounds of the ſiliceous earth, &c. will be found in the* Appendix, *at the end of this Mineralogy.*

SECT. 128. (67.)

Obſervations 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 [*b*].

The

[*b*] This, like the other primitive earths, is ſeldom found pure, as have been mentioned, (Note *f* to Sect. 88]. And of courſe

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 Eaſt Indies: in which latter circumſtances they are called *Labora:* and it may be obſerved, that for

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courſe it will be very proper to give here the method of purifying this earth, as it is only in this ſtate of purity that we can reaſon about its peculiar properties. The following is the proceſs given by Profeſſor Bergman for this purpoſe. Reduce clear *quartz cryſtals* into powder: melt it with four times the weight of *fixed alkali:* diſſolve the whole in water: precipitate it by a large quantity of ſtrong acid: waſh carefully, and dry the precipitate.

The acid muſt be uſed in a ſuperfluous quantity, that any other earths there contained may be diſſolved.

The ſpecific gravity of this earth ſo purified, is 1975. The particles, when firſt precipitated, occupy, in water, at leaſt twelve times the ſpace they do when dried. So that, when ſufficiently fine, they remain ſuſpended therein: Nay, when vehemently heated in a cloſe veſſel, as in the *Papin's digeſter*, they may be diſſolved; as it will appear by the phenomenon obſerved at Geyſer in Iceland, of which mention will be made hereafter at Note [*f*], *pag.* 223.

No acid, except that of the *ſparry fluor*, mentioned Sect 22, has any action upon this earth. Fixed alkalis unite with it in the *humid way:* but in the *dry way*, they ſeize it with great vehemence, and convert twice their weight of it into a permanent tranſparent glaſs. Such is its affinity to alkalies, that it imparts to clay, which is always loaded with this kind of earth, the power of ſeparating the alkaline baſes from the acid of *nitre* and *common ſalt*.

When ſiliceous earth is quite pure, it is refractory in the fire: but although it is not found altogether ſimple, yet, in mineralogy, it muſt be conſidered as primitive, until deciſive experiments ſhew us from which of the preceding or following earths it is derived. *The Editor, from* Bergman's Sciagraphia.

It

for cutting the ruby, ſpinell, ballas, and chryſolite, the *oil of olive* is required inſtead of any other liquid, to be mixed with the diamond powder, in the ſame manner as for cutting the diamond itſelf [*c*].

If

It ſeems that a further knowledge on this ſubject may be obtained, if a ſet of proper experiments was inſtituted on the earth that is precipitated from the *liquor ſilicum*. This has not yet been purſued by any one that we know. But the reſults which are reported in the French abridgment of G. Newman's chemical works, by the late Mr. Roux (printed in 4to, 1781, pag. 46,) ſeem to indicate that *ſiliceous earth* is a compound: as it is aſſerted there, that half an ounce of vitriolic acid has diſſolved 20 *grs.* of this *earth*, precipitated from the *liquor ſilicum*. The ſame quantity of nitrous acid only diſſolved 16 *gr.*: the ſame of muriatic acid diſſolved 15 *gr.*: as much of *aqua regia* diſſolved the like quantity: and the ſame of diſtilled vinegar diſſolved only *two gr*. And that each of theſe ſolutions were differently coloured, viz. that made by the vitriolic acid, was *reddiſh*; that by the nitrous acid was *yellow*; that by the marine acid was only of a *yellowiſh colour*: that by the aqua regia was of a full *yellow* like gold: and that by the diſtilled vinegar did not change to any colour. But it is not ſaid what was the proportion of each ſolution, an object which could be eaſily obtained by attempting the precipitation of each, with ſubſtances of a ſtronger affinity to each acid, and by a proper evaporation and cryſtallization of their reſpective reſidues. *The Editor, from* Mongez.

[*c*] This article, in the firſt Engliſh edition runs ſo, *And it may be obſerved, that for cutting the ruby, ſpinell, balaſs and chryſolite, the oil of vitriol is required, inſtead of any other liquid, to be mixed with the diamond powder.* This certainly ſeems to be a miſtake of the *printer* or of the *editor*, as it is well known that no oil of vitriol is, nor can be, employed by the lapidaries for cutting theſe hard ſtones with metallic wheels, without corroding their tools in a ſhort time, as well as producing many other obvious and inſufferable inconveniencies.

I have

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 trade, which by degrees produces a general idleneſs and ignorance through 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 aqua-marines 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 common opal, the onyx, the chalcedony, the cornelian, and the coloured and colourleſs rock criſtals, have been employed for ornaments, and œcomical utenſils, in which the price of the workmanſhip greatly exceeds the intrinſic value of the ſtones. The antients uſed to engrave concave and convex figures on them, which now-a-days are very highly valued,

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I have ſeen how lapidaries cut diamonds: I have procured all the information I could: and I have read the article *Lapidary*, both in the *Engliſh Cyclopedia*, and in Jaubert's *Dictionary of Arts*: But I do not find the leaſt intimation concerning the uſe of oil of vitriol in this operation. *Edit.*

lued, but often with leſs reaſon than modern performances of the ſame kind. Theſe ſtones are worked by means of emery on plates and tools of lead, copper, and tin; or with other inſtruments: but the common work on agates is performed at Oberſtein, with grind-ſtones at a very cheap rate. When once ſuch a 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 howmuch 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 become ſmooth, nor are they of too looſe a compoſition.

Moſt part of the flinty tribe is employed for making glaſs, as the quartz, the flints, the pebbles, and the quartzoſe ſands[*d*]. The quartz, however, is the beſt: and if uſed in due proportion

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[*d*] None of the ſiliceous ſtones are found cryſtallized in cavities, and if there are cryſtallizations, they conſiſt of minute quartz cryſtals. Common flints ſome times contain impreſſions of marine productions, the hollows being often filled with them. This ſpecies is generated in the clefts of chalk-hills, as quartz is in the *Saxum* or rock-ſtone. The chalcedony-like agate, on the Italian Alps, have penetrated ſome ſhells, and filled their windings or thalami. Agates in wood, cornelians in ſhells, and flints in corals, have been mentioned by the author, Sect. 282 of the Appendix. *Brun.*

portion 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; of which we had an inſtance of bottles filled with Rheniſh and Moſelle wines, during the time of a voyage to China [*f*].

In

[*f*] The ſiliceous earth, is it a ſimple ſubſtance or a compound one? And, in general, are all earths true elementary ſubſtances, or are they formed from other elements?—— We have already mentioned the erroneous opinion of the ſiliceous earth being produced, in certain circumſtances, by the intimate combination of the ſparry-acid with water (Note *b* to Sect. 26): and as to the metallic earths, it is certain that the calx of arſenic is a compound of an acid with phlogiſton: but we know not as yet with certainty, whether other earths are in the ſame caſe. Thus a few facts, however, may induce us to ſuſpect, as the great Bergman does, that perhaps all other metallic earths are but ſo many compounds from acids and phlogiſton: and that the other earths are but the reſult of different combinations in which the acids and phlogiſton are the chief ingredients.

Our knowledge does not yet extend to the determining how hard cryſtals are formed, though it is certain that they muſt have been at ſome period of their formation in a ſoft ſtate, ſince ſome are found to include water in their cavities, as has already been obſerved. Profeſſor Bergman obtained thirteen regular formed cryſtals, by ſuffering the powder of quartz to remain in a veſſel with the fluor acid for two years. Theſe cryſtals were about the ſize of ſmall peas, and were not ſo hard as quartz. (*See Opuſc. de terra ſilicea*, p. 33.) Mr. Achard, in a letter dated the 6th of April, 1778, ſent me two cryſtals, one of the ſparry kind, and the other as hard and tranſparent as rock cryſtal. The firſt he procured by means of calcareous earth, and the latter from the earth of alum, both diſſolved in water impregnated with fixed air, the water filtrating very ſlowly through a porous bottom of baked clay. The deſcription of

this

In the ſmelting of copper ores, quartz is uſed, to render the ſlag glaſſy, or to vitrify the iron; quartz

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this apparatus invented by Mr. Achard, may be ſeen in the *Journal de Phyſique* for January, 1778. I ſhewed theſe cryſtals to the Aſſembly of the Royal Academy at Paris in the ſame year, and I ſtill keep them by me, together with the letter in which they were incloſed. The proceſs has been ſince attempted by myſelf, as well as by many others, though without the deſired effect. This muſt be attributed to ſome unheeded circumſtance that eſcaped the author, as I have not yet heard that he has been himſelf able to ſucceed a ſecond time. *Edit.*

But although the attempts to repeat the formation of hard cryſtals by the method of Mr. Achard have been unſucceſsful till this day, we cannot doubt of the ſolubility of ſiliceous earth in very hot water, as there is a very remarkable phænomenon of the kind which deſerves to be noticed: and the more ſo, as we ſhould be intirely ignorant what would be the event, had not Nature herſelf ſpontaneouſly aſſiſted our ignorance and ſloth, in the inveſtigation of her powers.

At *Geyſer* in Iceland there ſpouts up a hot water, which, upon cooling, depoſits *ſiliceous* earth: and of this very matter a flinty baſſin or crater has been formed by itſelf, having 59 feet in diameter. This ſpout is of a ſtupendous bulk, as the opening through which it guſhes out at various intervals has 19 feet in diameter: and ſometimes it was obſerved by Dr. Van Troil to reach the height of 92 feet, though ſeveral affirm it has ſpouted to the hight of ſixty fathoms. The heat of the water during its exploſion cannot be aſcertained; but after it has been thrown through a ſtratum of air 90 feet thick, it riſes ſtill the thermometer to 212 degrees of Fahrenheit, which is ſtill the utmoſt heat that water can hold in the open air. It is obvious therefore that ſiliceous earth may be diſſolved in water, when it has a far greater degree of heat than that with which it boils. Perhaps ſuch experiment may ſtill ſucceed by employing a good Papin's digeſter: but I do not know that any ſuch trial was ever executed with ſucceſs. See the account of this phænomenon in Van Troil's *Letters on Iceland*, pag. 259, and in Profeſſor Bergman's treatiſe de *Terra Silicea*. Edit.

This

quartz being more uſeful than any other ſtone to prevent the calcination of the metal.

The quartzoſe ſand which conſtitutes part of many ſtones, and is alſo uſed in making crucibles, and ſuch veſſels, contributes moſt of all to their power of reſiſting fire.

It appears likewiſe probable that the quartzoſe matter makes the grind and whetſtone fit for their intended purpoſes[g].

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[g] This ſeems to be the moſt proper place to inſert the Table in which Mr. Quiſt has ſhewn the comparative hardneſs of various ſubſtances, as thoſe belonging to the ſilicious earths are more numerous on account of this property than thoſe of the other kinds of earths. Mr. Quiſt determined the hardneſs of theſe ſubſtances, by obſerving the order in which they were able to cut and make an impreſſion on each other; the firſt are able to cut or ſcratch the ſucceeding; but not *vice verſa.* He added, the ſpecific gravity of almoſt all the ſpecimens he uſed. The *firſt column* ſhews the *hardneſs*: and the *ſecond* their *ſpecific gravity.* The laſt four ſpecies were added by Mr. Kirwan, after his own obſervation: and the ſpecific gravities marked with a * were added by the Editor, chiefly from Profeſſor Bergman. *The Edit.*

TABLE of the comparative hardneſs of various mineral ſubſtances.

Names.	*Degree of hardneſs.*	*Specific gravity.*
Diamond from Ormus	20	3,7 *
Pink diamond	19	3,4
Bluiſh diamond	19	3,3
Yellowiſh diamond	19	3,3
Cubic diamond	18	3,2
Ruby	17	4,2
Pale Ruby from Brazil	16	3,5
Ruby Spinell	13	3,4
Deep blue Sapphire	16	3,8
Ditto paler	17	3,8
Topaz	15	4,2
Whitiſh ditto	14	3,5
Bohemian ditto	11	2,8
Emerald	12	2,8
Garnet	12	4,4
Agate	12	2,6
Onyx	12	2,6
Sardonyx	12	2,6
Occid. Amethyſt	11	2,7
Cryſtal	11	2,6
Carnelian	11	2,7
Green Jaſper	11	2,7
Reddiſh yellow ditto	9	2,6
Schoerl	10	3,6 *
Tourmaline	10	3,0
Quartz	10	2,7
Opal	10	2,6
Chryſolite	10	3,7
Zeolyte	8	2,1
Fluor	7	3,5*
Calcareous Spar	6	2,7*
Gypſum	5	2,3*
Chalk	3	2,7 *

N. B. 1. Artificial gems are eaſily diſtinguiſhed from the natural, by their ſoftneſs, fuſibility, ſolubility in acids, and in many caſes by their ſpecific gravity.

2. Stones whoſe hardneſs does not exceed 11, may be ſcratched with ſteel.

3. The opal mentioned in the Table, muſt be a Pſeudo-opal of the kind mentioned in the Note to § 95, as Mr. Quiſt, in a letter to Mr. Rinman, mentions his having ſeen opals nearly as hard as diamonds. *Edit.* chiefly from *Kirwan.*

ORDER THE FIFTH,

ARGILLACEOUS EARTHS.

SECT. 129. (77.)

The Argillaceous Kind. *Argillæ*, Lat. *Leror*, Swed. *Thon*, Germ. *Argilles*, French.

The principal character whereby theſe may be diſtinguiſhed from other earths, is, that they harden in the fire, and are compounded of particles ſo diſpoſed, that they exhibit a dead or dull appearance when broken [a].

Moreover

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[a] By *argillaceous earth* is not meant common clay, which is never free from *ſiliceous* matter; but a pure clay, unmixed at leaſt with any other earth. This may be readily obtained by diſſolving Roman, or rock allum in diſtilled water, filtering and precipitating it by mild volatile alkali.

1. The ſpecific gravity of this pure clay, or argill, is 1305. 2. It diſſolves in acids, with a little efferveſcence. 3. With the vitriolic acid it forms *alum*: 4. but with the nitrous, muriatic, and vegetable acids it forms deliqueſcent ſalts.

5. When

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[b]. Some crack in 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

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5. When dry it abſorbs water greedily: becomes ſoft: 6. and, with a due quantity of water, acquires ſuch a tenacity that it may be moulded at pleaſure. 7. This maſs contracts greatly in the fire, from whence ariſe numerous cracks: 8. and with a due degree of heat it becomes hard enough to ſtrike fire with ſteel. 9. By thus burning, it loſes its glutinous tenacity: and the water is excluded by the approach of its particles to one another: 10. nor does it again aſſume its former properties, but by a chemical proceſs of ſolution and precipitation, &c. 11. It may be diſſolved in the *dry way*, by means of fixed alkali, as well as in the *humid* by acids. The vitriolic acid is better than the others for this purpoſe, becauſe it may be more eaſily concentrated.

12. Earth of alum, viz. pure argill, neither diſſolves ſulphur, nor decompoſes ſal ammoniac. *The Editor, from* Bergman's Sciagraphia.

[b] 13. The ſpecific gravity of argill, when pure, does not exceed 2000. 14. It is exceedingly diffuſible in water, though ſcarcely more ſoluble than pure magneſia. 15. It is combinable with acids, and when combined with the nitrous or marine it is ſeparable, like magneſia, but ſcarcely precepitable by the vitriolic acid with which it forms alum, a ſalt that always contains an exceſs of acid, and has an aſtringent taſte. 16. When combined with any of theſe acids it is not precipitable by the acid of ſugar, a criterion that diſtinguiſhes it from the other earths, all which (except the ponderous when united to the vitriolic acid and the ſiliceous, which is not acted on by

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

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by any acid hitherto known but the ſparry) are precipitable from the vitriolic, nitrous, and marine acids, by that of ſugar, though the precipitation is not always apparent before the liquors be evaporated, nor at all if there be an exceſs of the mineral acids. 17. The ſtrongeſt heat barely hardens it, but does not give it the qualities of lime, while ſingle or accompanied only with magneſia or ſilex; 18. but mixed with calcareous it runs into fuſion very readily; and hence Mr. Gerhard has found it fuſible in a crucible of chalk, but not in one of clay. 19. Fixed alkalis do not promote its fuſion, but borax or microcoſmic ſalt diſſolves it, the firſt with ſcarce any, and the latter with a more notable effervеſcence. 20. Calces of lead affect it ſomething leſs than they do calcareous earths. *Kirwan.*

Mr. Joſiah Wedgwood, F. R. S. has conſtructed an ingenious thermometer for the admeaſurement of the higher degrees of heat upon the above 7th property of Argill. He has obſerved that the contraction of baked clay increaſes accordingly as the heat to which it is expoſed is greater. He therefore purpoſes a number of ſmall bricks of a native clay of conſiderable purity, found in Cornwall, which after a ſlight hardening are cut by an inſtrument, ſo that their dimenſions are reſpectively equal to a great degree of accuracy. Each of theſe ſmall bricks is *five tenths* of an inch in breadth, with the ſides exactly parallel, this being the dimenſion intended to be meaſured; about *four tenths* of an inch deep and *one* inch long.

Some of theſe bricks being placed in the fire whoſe heat is required to be found, become ignited in a very ſhort time. The brick is then taken out and ſuffered to cool, or cooled by immerſion in water, no difference being obſerved to ariſe from this ſudden refrigeration. When cool it is ſuffered to ſlide gently down an inclined plane of braſs, between two upright graduated ſtrait rules of the ſame metal, that are inclined to each other in a very ſmall angle. This braſs gage or ſcale is 24 *inches* long with the two ſide-pieces exactly ſtrait divided into *inches* all theſe circumſtances is eaſily diſcovered to be the ſame, one may with great reaſon conclude, that the hardneſs of the jaſper may perhaps

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inches and *tenths*; fixed *five tenths* of an inch aſunder at one end, and *three tenths* at the other, upon the braſs flat plate above mentioned; ſo that one of the thermometric pieces of clay, when pared down on the cutting mould of metal, will juſt fit the wider end of the gage. Theſe ſmall bricks are dried, and afterwards baked with a low red-heat, to give them a proper firmneſs, that they may bear package and carriage. It is evident that if any of theſe bricks diminiſhes *one tenth* in breadth, it will then paſs to one half of the above ſcale: and if *two tenths*, it will go on to the narroweſt end.

As a ſcale of two feet long may appear inconvenient, it may be divided into two parts, the firſt and ſecond ſide-pieces being fixed 5 tenths aſunder on the plate, at one end; and 4 tenths at the other: and the third piece at the ſame diſtance of *four tenths* at one end, and *three tenths* at the other.

The operator, in uſing this new thermometer, muſt be careful to expoſe its bricks to an equal action of the fire with the body whoſe heat he wants to meaſure by them. In three minutes time they receive the full contraction which that degree of heat is capable of producing: and it is remarkable that ſtrong degrees of heat are communicated to them with greater celerity than weaker degrees: perhaps the heat is more readily tranſmitted, in proportion as the texture of the clay becomes more compact.

By a chemical analyſis, this kind of porcelain clay from Cornwall, has been found to contain three parts of pure *argillaceous* or *aluminous earth*, and two only of pure *ſilicious earth*. See *Phil. Tranſ.* part 2. for 1782.

A paper was lately read at a meeting of the Royal Society, containing the further ſteps taken by the ſame ingenious gentleman for carrying the ſcale of Fahrenheit's thermometer up to that of his new one, by means of intermediate ſubſtances, which ſhould connect the upper extremity of the one with the lower degree of the other. This was at laſt obtained with great nicety, as will be ſeen in that paper, which, it is hoped, will haps be the laſt degree of hardneſs, and that this ſtone conſequently conſiſts of an argillaceous ſubſtance, (Sect. 107.) that already poſſeſs a quality

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will be printed in the Philoſophical Tranſactions for the preſent year, 1784. In the mean while it will be ſufficient in this place to announce that each degree of his thermometer is equal to 130 degrees of Fahrenheit's thermometer: and by a proper calculation the following table was made, ſhewing the correſpondence, or value of the degrees of each thermometer, anſwering to one another.

Degrees of Heat expreſſed by the two Thermometers.

Wedgewood's.		*Fahrenheit's.*	*Phenomena already obſerved.*
240	=	32277	greateſt heat of Mr. Wedgwood's furnace.
160	=	21877	Heat of his ſmall air-furnace.
130	=	17977	Caſt iron melts.
125	=	17327	Heat of a common ſmith's forge.
95	=	13427	the greateſt welding heat of iron.
90	=	12777	leaſt ditto.
32	=	5237	fine gold melts.
28	=	4717	fine ſilver melts.
27	=	4587	Swediſh copper melts.
21	=	3807	Braſs melts.
6	=	1857	enamel colours melt.
0	=	1077	red heat viſible by day light.
—1	=	947	red heat viſible in the dark.
—3,673	=	600	Mercury boils.
—6,658	=	212	water boils.
—7,542	=	97	vital heat.
—8,142	=	32	water freezes.
—8,289	=	0	proof ſpirit freezes.
—8,596	=	—40	Mercury freezes.

N. B. It appears by the above, that from the freezing point to that of vital heat, is hardly $\frac{1}{500}$ part of the whole ſcale in our globe: how far extended that of the inhabitants of lity which the other clays cannot acquire but in the fire; having, beſides, the ſame effect as the leſs ferrugineous boles, when melted in the fire together with calcareous or other earths.

SECT. 130. (Additional.)

Argilla aerata, Lac Lunae.

A. This fanciful name was heretofore thought to denote a very fine ſpecies of calcareous earth (Sect. 5.); but Mr. Schreber has lately ſhewn that the earth to which this name is given, is a very uncommon ſpecies of argill. It is generally found in ſmall cakes of the hardneſs of chalk: and like that, it marks white. Its hardneſs is nearly as that of ſteatites, and it does not feel ſo fat as common clay does. Its ſpecific gravity is 1669: its colour ſnow white. When examined with a microſcope, it is found to conſiſt of ſmall tranſparent criſtals; and by his experiments, it appears plainly to be an argill ſaturated with fixed air. It effervеſces with acids and contains a very ſmall proportion of calca-

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of other planets may be, from the remoteſt Herſchel's planet to that of Mercury, the neareſt neighbour of the Sun, is, I apprehend, out of the reach of the human mind to decide. *The Editor.*

SECT. 132. (78.)

C. Combined with phlogiſton. *Terra porcellanea phlogiſto aliiſque heterogeneis minima portione mixta* [e].

Diffuſible in water.

- *a.* White and fat pipe clay, from Cologne and Maeſtricht (called *colniſh* or *pipe clay*.)
  Leſs unctuous is found in ſmall fiſſures in a vein of *lapis ollaris*, at Swartwik, in the pariſh of Swerdſio, in the province of Dalarne [f].
- *b.* Of a pearl colour, from Maeſtricht.
- *c.* Bluiſh grey, *La belle terre glaiſe* from Montmartre, near Paris in France.
- *d.* Grey, from France, Heſſe, Boſempin, Skone.
- *e.* Black, *La terre noire*, at Montmartre.
- *f.* Violet, alſo from Montmartre [g].

SECT.

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[e] With *ſulphur*. Such is the aluminous earth from *Tolfa* in Italy, according to Monet: it appears like chalk, and has a ſenſible flavour, before it is calcined. *Fabroni.*

[f] Many of theſe clays become grey in a weak degree of heat, becauſe the mineral oil with which they are mixed, burns to a kind of coal and tinges them: but in a ſtronger heat they again become white, this coal being conſumed. *Kirwan.*

[g] Theſe *clays* contain a phlogiſton, which is diſcovered by expoſing them to a quick and ſtrong fire, in which they become quite black internally, aſſuming the appearance of common flints, not only in regard to colour, but alſo in regard to hardneſs:

a. White, from Japan.

I have ſeen a root of a tree changed into this clay, (Appendix, Section 283 of the Author).

2. Friable and lean.

White, is found in clefts of rocks at Weſterſilfverberget in Weſtmanland and between the coal in the coal-pits at Boſerup in the province of Skone [*d*].

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

We muſt be aware of the difference between the pipe clay, mentioned in the following Section, of which kind we have plenty in Devonſhire, and that clay which is uſed in the manufactures of porcelain. The former, in an open fire, burns to a bluiſh grey, or pigeon colour; but the latter remains white. *See* Note *f in the following page* 234. The former ſeems to be the ſame as the Cologne and Maeſtricht pipe clay of the next ſection: but the latter ſeems to be but a decayed felt ſpar: and conſequently, according to Bergman (Sect 130 of his Sciagraphia) contains *magneſian earth*. It is chiefly from theſe mixtures that thoſe various properties mentioned by the Noble author in Sect. 129 proceed. Our porcelain clay contains, likewiſe, *quartz cryſtals* and *mica* mixed with it, parts of the granite which it originally compoſed. Before it is uſed, the *quartz* is ſeparated; but the *mica* remains, according to the obſervation of Mr. James Watt to Doctor Withering. *See the Engliſh Edition of the Sciagraphia.* Sect. 113. p. 54. *The Editor.*

SECT. 132. (78.)

C. Combined with phlogiſton. *Terra porcellanea phlogiſto aliiſque heterogeneis minima portione mixta* [e].

Diffuſible in water.

a. White and fat pipe clay, from Cologne and Maeſtricht (called *colniſh* or *pipe clay*.)

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

b. Of a pearl colour, from Maeſtricht.

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

d. Grey, from France, Heſſe, Boſempin, Skone.

e. Black, *La terre noire*, at Montmartre.

f. Violet, alſo from Montmartre [*g*].

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[e] With *ſulphur*. Such is the aluminous earth from *Tolfa* in Italy, according to Monet: it appears like chalk, and has a ſenſible flavour, before it is calcined. *Fabroni.*

[*f*] Many of theſe clays become grey in a weak degree of heat, becauſe the mineral oil with which they are mixed, burns to a kind of coal and tinges them: but in a ſtronger heat they again become white, this coal being conſumed. *Kirwan.*

[*g*] Theſe *clays* contain a phlogiſton, which is diſcovered by expoſing them to a quick and ſtrong fire, in which they become quite black internally, aſſuming the appearance of common flints, not only in regard to colour, but alſo in regard to hardneſs:

SECT. 133. (84.)

D. Stone Marrow, *Lithomarga:* 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 maſſes, or in ſuch a manner as to aſſume the appearance of curds.

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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 abovementioned 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 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.* 1. *page* 9.

I have found likewiſe that this ſort, upon certain occaſions, attracts 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 on account of their œconomical uſes. *Author.*

3. In the fire it eaſily melts to a white or reddiſh frothy ſlag, which in conſequence of its internal vacuities is then of a larger volume than it originally was.

4. It breaks into irregular ſcaly pieces.

A. Of coarſe particles: coarſe ſtone marrow.

a. Grey, from Oſmundſberget, in the pariſh of Rettwik, in Dalarne, and is there called *Walklera*, that is, fullers 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 *Keſſekil:* (ſee Sect 56): and it is ſaid to be uſed for waſhing inſtead of ſoap[*b*].

B. Of very fine particles: fine Stone Marrow.

a. Yellowiſh brown, *Terra Lemmia* [*i*].

It

[*b*] This kind of earth is found alſo, and uſed likewiſe by the country people for waſhing, inſtead of ſoap, in the Barony of Hierges, near Niverlé, belonging to his Highneſs the Duke of Arenberg, in the Auſtrian Flanders. His Chancellor, who by the uprightneſs of his behaviour has obtained the honourable ſurname of *Jean De bien*, ſhewed me various ſpecimens of this earth, which he affirmed to be only found in ſeparate maſſes: but it is probable that ſome conſiderable ſtrata of it may be found, if properly ſearched for on the ſpot, by digging the ground to a conſiderable depth. *Editor*.

[*i*] This is a compound of the argillaceous, ſiliceous, and magneſian earths. Its component parts are the ſame as thoſe of the talc, but looſer, and in different doſes. *Berg*. Sciag. § 116.

The

It is of a ſhining texture, and falls to pieces in the water with a crackling noiſe; and is more indurated than the foregoing, but has the ſame qualities in other reſpects [j].

SECT.

The *terra lemnia* 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, whether it is not a Zeolites, or at leaſt very nearly approaching to it, in regard to the effects both undergo in the fire. *The Author.*

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 abovementioned properties; and in regard to the texture and colour, it comes neareſt to the above deſcribed coarſe ſtone marrow. *Engeſt.*

[j] *Terra Lemnia* is ſo called from the iſland Lemnos now Statimane in the Egean ſea, from whence it is procured. It is likewiſe called the *Turkiſh earth*, on account of its being impreſſed with the ſeal of the Grand Signior. It is of a luteous colour.

The Oſmundian Argilla is found in the mountain Oſmund at Ratwick in Eaſt Dalecarlia. The ſtratum is three feet thick, and the mountain itſelf is chiefly calcareous. This is harder, and of finer particles than the Lemnian earth, and is of an aſh colour.

The Hampſhire fuller's earth is of a duſky brown inclining to green, with veins of faint yellow. It contains a ſmall portion of muriatic acid, and an oily and volatile matter.

Theſe ſubſtances are akin to zeolites, and likewiſe reſemble ſome marles. But in the Oſmundian earths, the connection of the parts is not merely mechanical as in marles, which on that account effervesce ſtrongly with acids, though they often contain a leſs quantity of calcareous earth or magneſia, than the lithomarga here mentioned.

Every

SECT. 134. (85.)

E. Bole, (Iron Clay.) *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 ſpecifical qualities of the bole itſelf, by any eaſy method hitherto in uſe. It is not eaſily ſoftened in water, when indurated, as the porcelain and the common

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Every fine clay that does not communicate a colour, is in general proper for the buſineſs of fulling. Even hog's excrements mixed with human urine, are uſed inſtead of fuller's earth in various woolen manufactures.

The properties required in a good *fuller's earth* are that it ſhall carry off the oily impurities of the woolen cloth, and at the ſame time thicken it by cauſing the hairs or fibres to curl up. The fineſt ſiliceous earth with argilla and a little calcareous earth without the vitriolic acid, conſtitute the beſt fuller's earth. A little martial calx is not noxious, if no active menſtruum be preſent, as is evinced in the Argilla Hampſhirenſis, which is an excellent fuller's earth.

The following table exhibits the component parts of the three ſubſtances juſt mentioned.

A Centenary of contain	*Argilla lemnia.*	*Oſmundica.*	*Hampſhirenſis.*
Siliceous earth	47.0	60.0	51.8
Chalk or calx aerata	5.4	5.7	3.3
Magneſia aerata	6.2	0.5	0.7
Argilla	19.0	11.1	25.0
Calx of iron	5.4	4.7	3.7
Water or volatile matter	17.0	18.0	15.5

The Editor from Bergman's *Treatiſe* de Analyſi Lithomargæ.

common clays are, 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 bad-ſtone [k].

SECT. 135. (86)

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

- *a.* Fleſh-coloured bole, from Kritierſberg, at Nya Kopparberg in Weſtmanland.
- *b.* Red.
  1. Fine, *Bolus Armenus.*

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[k] Bole is a term of uncertain ſignification, and ſhould therefore be baniſhed from common uſe, and ſtill more from Mineralogical Treatiſes. Some beſtow this name on very ſmooth compact clays, conſiſting of the fineſt particles others require beſides, that their colour ſhould be red, yellow, or brown, and that they ſhould contain iron. The red generally blacken in the fire; yet, according to Rinman, they do not become magnetic. The yellow, when heated, become firſt red: and in a ſtrong heat, brown or black.

What the Italians call *calamita bianca*, is a white bole, ſtriated like aſbeſtos, according to Ferber.

The true *ſigillata rubra* contains calcareous earth, and according to Rinman it becomes magnetic, after torrefaction.

The yellow, red, and brown clays contain moſt iron, ſometimes diſperſed through them, and ſometimes united to the ſiliceous part: in this caſe they are more difficultly fuſible. The *yellow calx of iron* is more dephlogiſticated than the *red*: and the *red* more ſo than the *brown*. When theſe clays contain about 14 or 15 per cent. of iron, they become magnetic after calcination. *Editor, from* Kirwan.

2. Coarſe

2. Coarſe, *Bolus communis officinalis*, from the ſand-ſtone quarries at Orſa, in the province of Dalarne.
3. Hard, *Terra rubrica*, (the *red pencil.*)

c. Green, *Terre verte.*

1. Fine, from Italy.
2. Coarſe, from Stenſtorp, in the province of Weſtergottland.

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

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

e. Grey.

1. Cryſtaliſed in a ſpherical polygonal figure: from Swappawari, in Lapland.
2. Of an undetermined figure, from Grengerberget in Weſtmanland [*l*].

SECT.

[*l*] At the time when the *terrae ſigillatae*, 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 only 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 is ſtill thought to comprehend ſo many varieties. Thus the Cologne clay (Sect. 13[illegible]) is by the druggiſts ranked among the white ſealed earths, and is called a *white bole*: 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

SECT. 136. (87.)

B. Indurated Bole, *Bolus indurata.*

A. Of no viſible particles, *Particulis impalpabilibus* [*m*].

This occurs very often in form of ſlate, or layers in the earth, and then is called *flitſmalm*, when uſed 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 [*n*].

b. Grey, from Coalbrookdale, in Shropſhire, and moſt collieries of England [*o*].

---

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. *Author.*

[*m*] It is a true clay united to ſiliceous and martial earths. Berg. Sciag. § 114.

[*n*] In moſt collieries between the ſeams of coal, as at Hannam, in Kingſwood, near Briſtol, Blanavon, in Monmouthſhire, &c. D. C.

[*o*] This bole is found frequently in pieces like nuts, of different ſizes, that exhibit impreſſions of plants, when broken in two; in the ſame manner as the nodules of copper ſlate from Ilmenau contain fiſh. *Brun.*

SECT. 137. (88.)

F. Of ſcaly particles, *Particulis ſquamoſis*: The hornblende of the Swedes [p].

It is diſtinguiſhed from the martial glimmer or mica (Sect. 65.) by the ſcales being leſs ſhining, thicker, and rectangular.

a. Black. This, when rubbed fine, gives a green powder [q].

b. Green-

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[p] 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 (Sect. 119) *Engeſtr.* This kind Wallerius calls horn-rockſtone (hornfels ſteen) and places it among the apyrous ſtones; but Linnæus has put it among the calcareous ſtones, by the name of horn-ſlag, *talcum corneum.* Brun.

The general character of this ſtone, which Rinman calls *Talcum ſtriatum*, beſides a partial ſolubility (though without effervescence in acids and ſuch a hardneſs never ſufficient to ſtrike fire with ſteel, properties which are common to it with the preceding ſpecies) are,

1ſt. a ſpecific gravity never leſs than 2660, and frequently riſing to 3880.

2d. A ſtrong earthy ſmell, which it exhales on being breathed upon, or having hot water poured on it.

3d. A toughneſs and viſcidity perceived in pounding it in a mortar, like *mica* or *horn*, from which laſt is derived its name.

4th. Its affording a greeniſh grey powder, when pounded.

5th. Its being fuſible *per ſe*, as it is ſaid, though Mr. Kirwan acknowledges thas he never could melt this ſtone with a blow-pipe. N. B. The horn-ſtone is frequently mixed with pyrites. *The Editor from Kirwan.*

[q] This is the *Corneus nitens* of Wallerius.

Its texture is either lamellated, or granular. The former is ſometimes ſo ſoft, as to be ſcraped with the nail.

Its ſurface is frequently as gloſſy as if it had been greaſed.

Its ſpecific gravity is from 3600 to 3880.

It

b. Greeniſh[r].

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

It poſſeſſes, beſides, all the ſpecific properties abovementioned in the preceding ſection in a high degree.

It does not detonate with nitre.

When heated, it becomes of a ſnuff colour.

And then ſlightly effervesces with diluted nitrous acid.

Its ſolution in this acid, the nitrous, is of a greeniſh colour.

In order to diſcover the principle on which the ſmell of this ſtone depends, Mr. Kirwan boiled its powder in water; but did not find the water altered in taſte, nor did any teſt he applied, ſhew any change in it.

The lamellar ſort contains in an hundred, 37 parts of *ſilex* 22 of *argill*, 16 of *magneſia*, 2 of *calcareous* earth, both in a mild ſtate: and 23 of *calx of iron*, not much dephlogiſticated. *Kirwan.*

[r] This is of a granular texture, or ſtriated.

The ſpecific gravity of a ſpecimen of the preſent ſort examined by Mr. Kirwan, was 2683.

It is not ſo ſoft as the ſofteſt horn ſtone of the preceding Sections.

It ſeems that the common pale greeniſh grey whetſtone belongs to this ſpecies.

It is of a cloſe granular texture.

Exhales an earthy ſmell.

Affords a greeniſh powder.

Does not effervesce with acids;

Nor gives fire with ſteel.

Its ſpecific gravity is 2664.

And contains 65 per cent. of *ſiliceous* earth. *Kirwan.*

SECT. 138. (108.)

Zeolyte. *Zeolythus* [s].

G. 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 [t].

1. It

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[s] The noble author was the firſt who made this kind of mineral ſubſtances known to the world: and claſſed them as a diſtinct ſpecies from any other, in the eighth order of earths of this Mineralogy. But, after their true component parts were diſcovered by a proper chymical analyſis, Profeſſor Bergman and Mr. Kirwan have both ranged theſe ſubſtances among the *argillaceous* earths, on account, as it ſeems, of their ſoft texture and greaſy feel, notwithſtanding that the *Siliceous* earth has been found to be the moſt predominant in their compoſition. By a ſimilar motive, precious ſtones have been ranged among the *ſiliceous* earths, on account of their hardneſs, although the *Argillaceous* be the moſt predominant in their compoſition. (*See Note* [c] *page* 162.) In fact it is not ſo much the quantity, as the intenſity, or predominancy of property that ſhould in general direct us in the claſſification of mineral bodies: not to mention, that if the rule reſpecting quantity were rigorouſly adhered to, the two primitive earths, *argill* and *magneſia*, would not be found among the earths, which would doubtleſs be an abſurdity, as Bergman has rightly obſerved in his *Sciagraphia*, Sect. 16. *The Editor.*

[t] Monſ. Bayen believes that zeolites is compoſed of argillaceous and ſiliceous earth in equal parts. And the ſame reſults appeared by the analyſis of Mr. Guettard. *Fabroni.*

But,

1. It is a little harder than the fluors, and the other calcareous ſpars; it receives however ſcratches from the ſteel, but does not ſtrike fire with it [*u*].
2. It melts eaſily by itſelf in the fire, with a like ebullition as borax does, into a white frothy ſlag, which cannot without great difficulty be brought to a ſolidity, and tranſparency.
3. It is more eaſily diſſolved in the fire by the mineral alcali (*ſal ſodæ*) [*v*], than by borax or the microcoſmic ſalt.

But, according to Bergman's analyſis, the red zeolyte of *Adelfors* contains 80 per cent. of *ſiliceous* earth: 9, 5 of *argillaceous*: 6, 5 of *pure calcareous* earth: and 4 of *water*. The white oval radiated zeolyte of *Feroe* in Iceland, contains, according to Mr. Pelletier, 50 of *ſilex*: 20 of *argil*: 8 of pure *calcareous* earth: and 22 of *water*. Mr. Meyer found another of the radiated ſort to contain 58,33 per cent. of *ſilex*: 17,5 of *argill*: 6,66 of *lime*: and 17,5 of *water*. In general the cryſtallized ſort contains more water than the amorphous zeolytes. Thoſe of *Jemtland* contain 16 per cent. of *calcareous* earth: and that of *Feroe* contains 25 per cent. of *argill*: ſo that the proportions are very variable: but it is evident that the *ſiliceous* earth is the predominant among the component parts. *Edit.*

[*u*] Generally they are of a cryſtalline form, compoſed of imperfect pyramids, turned towards a common centre. They are ſometimes globular: and ſeldom in a priſmatic form. *Brun.*

Meſſrs. Faujas and Romé de L'Iſle mention various zeolites of a cubic and other forms, found in Iceland, in the Cyclops iſlands, near Etna in Sicily; in the iſland of Bourbon, &c. *Edit.*

The ſpecific gravity of the zeolytes is from 2100 to 3150; but this laſt is very rare. *Kirwan.*

[*v*] By which a great ebullition is made, without being totally diſſolved. *Fabr.*

4. It does not ferment with this laſt ſalt, as lime does [w]; 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 be poured on pounded zeolites, a heat ariſes, and the powder unites into a maſs [x].

6. In the very moment of fuſion it gives a phoſphoric light [y].

SECT. 139. (109.)

The zeolyte is found in an indurated ſtate.

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

A. Pure, *Zeolythus Purus.*

  a. White, from Feroe, in Iceland; it has the appearance of a cacholong [y*].

B. Mixed with ſilver and iron.

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[w] But ſwells, and diſſolves, though ſlowly, with it. *Fabr.*

[x] Since the publication of this Eſſay, there have 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. *Engeſt.*

[y] Diſtilled with nitrous acid it produces fixed air (or aerial acid) and ſome dephlogiſticated air. *Fabr.* from *Prieſtley.*

[y*] *b.* Zeolite half tranſparent from Garphyttan: which has an electric power. *Fabroni.*

a. Blue, *Lapis lazuli*, from the Buckarian Calmucks [z].

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.
5. By ſcorification with lead, there has been extracted two ounces of ſilver out of one hundred pounds weight of this ſtone.
6. The preſence of ſilver is not diſcoverod with the ſame certainty by the ſpirit of nitre, as by the oil of vitriol.

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[z] Its ſpecific gravity is hardly above 2100. *Berg*. The lapis lazuli, called by the fanciful name of *Oriental*, is of a fine blue colour inclining to purple: that of a pale blue is not ſo much eſteemed. It is often variegated with yellow and white ſhining veins and ſpeckles, which the common people think to be true gold and ſilver, though in reality they are nothing elſe but martial marcaſites. *Edit.*

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[a].

9. The lapis lazuli, when perfectly calcined, is a little attracted by the load-ſtone; 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 [b].

SECT.

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[a] Some of its parts however ſtrike fire with ſteel. *Mongez.*

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

SECT. 140. (110.)

2. Sparry Zeolites, *Zeolites ſpatoſus.*

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

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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 alcali. 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 alcali, 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 earths than this (the zeolites). *The Author.*

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 particularly 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 hath 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 expreſly 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, or of nitre, it turned all thoſe acids into a jelly. However, he does not take any notice of its containing 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. *Eng.*

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

SECT. 141. (111.)

3. Criſtalliſed 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 Jemptland.

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; 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 [*c*].

SECT. 142. (112.)

Obſervation on Zeolites.

This kind of ſtone has nearly the ſame qualities in the fire as the boles; ſo that both 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

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[*c*] The zeolites have here in the North, the ſame country with the chalcedony and caſholong. Pieces are ſhewn here as curioſities, where the zeolite is incloſed in the chalcedony; but this is inſufficient to prove that the former aroſe from the latter, or *vice verſa*. Brun.

opaque

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 cryſtaliſed (Sect. 141), becauſe the other varieties riſe only in 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 [d].

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[d] The zeolites have great affinity to the ſhoerls; but their component parts are not ſo ſtrongly connected as to hinder the action of acids, which can deſtroy their combination without being previouſly treated with the fixed alkali; this laſt being a neceſſary requiſite which muſt precede the analyſis of ſhoerls. *Berg. Sciag.*

Mr. Pazumot thinks that the zeolites cannot be a volcanic production, but only a ſecondary production formed by the decompoſition of volcanic earths. Certainly pure baſaltes, and volcanic lavas have the ſame component parts as thoſe of the zeolites: and theſe laſt have not yet been found but among volcanic matters; but, as Mr. Faujas obſerves, there are many inſtances of the true zeolites being quite buried within the bodies of ſolid baſaltes, ſome being only fragments of zeolites, and ſome having a complete form; which prove that they have been already formed, before theſe volcanic maſſes were produced by ſubterraneous fires. *The Editor.*

SECT.

SECT. 143. (89.)

Tripoli, *Terra Tripolitana* [e].

H. Is known by its quality of rubbing or wearing hard bodies, and making their ſurfaces to ſhine,

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[e] This earth was formerly brought to us from Tripoli in Barbary, from whence this name was given to it.

1. This earth does not efferveſce with any of the acids : and
2. Becomes not only *hard* in the fire ; but when conſiderable heat is applied, its ſurface becomes vitrified.
3. All Tripolis, except thoſe found in England, obtain a red colour by being burnt.
4. They are fuſible with the calcareous earth, as well as with the borax, and with the microcoſmic ſal. But
5. When waſhed in water, no other ſubſtance ſeparates from them. However
6. Sometimes the marine acid and the vitriolic may be extracted by diſtillation from theſe earths.

1. Solid: of a rough texture.
    - *a.* Brown.
    - *b.* Yellowiſh.
    - *c.* Spotted like marble.
2. Friable and compact.
    - *a.* Granulated.
    - *b.* Brown.
    - *c.* Yellowiſh.

It is this laſt ſort which is found in England. *Fabroni,*

I have procured that kind of yellow Tripoli mentioned by the author, from Scotland, where it had lately been diſcouered. But the *rotten ſtone*, ſo called, is another ſort, found in England, viz. Derbyſhire. It is in common uſed here among workmen for all ſorts of finer grinding and poliſhing, and is alſo ſometimes uſed by lapidaries for cutting of ſtones, &c. D. C.

The rotten ſtone of Derbyſhire is, according to Ferber, a Tripoli mixed with calcareous earth.

Tripoli

ſhine, the particles of the Tripoli being ſo fine, as to leave even no perceptible 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 with ſtill greater difficulty by the microcoſmic ſalt: it becomes white by ignition: 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 in common with other kind of earths 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.

SECT. 144. (90.)

I. Common clay, or brick clay, *Argilla communis vulgaris plaſtica.*

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

Tripoli is evidently a volcanic product. For a coal mine at St. Eſtienne having accidentally taken fire, and the fire in its progreſs having extended to ſome ſtrata of ſhiſtus, and bitumen, Tripoli was found in thoſe parts of the ſtrata that the fire had acted upon, but not in any other *Mem. Par.* 1769, *p.* 276, *quoted by* Kirwan.

Tripoli is found alſo of grey, white, and red colour. It contains 90 parts of ſiliceous earth, 7 of argill, and 3 of iron. Some times a little of magneſia has been extracted from it.

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 [*f*]. 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.
   - *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 other provinces. It is often found in a ſlaty form, with fine ſand between its ſtrata. It does not cake well together in the fire. When it is burnt, it is of a pale 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 are not uncommon in ſeveral of our mine countries, they ſeem to be different in regard to the fermenting quality of this variety.

[*f*] It is alſo a compound of pure clay, ſiliceous and martial earth. *Berg. Sciag.*

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, Sect. 30.

S E C T. 145. (91.)

B. Indurated.

1. Pure.
   a. Grey ſlatey.
   b. Red ſlaty, from Kinnekulle, in the province of Weſtergottland.
2. Mixed with phlogiſton, and a large portion of the vitriolic acid. See *Alum ores*, Sect. 124 of the Author.
3. Mixed with lime. See *Lime*, Sect. 33.

S E C T. 146. (Additional, from Kirwan.)

Argillaceous fiſſile ſtones.

K. Theſe and many other of different kinds of earth, have been comprehended under the denomination of *Schiſti*; but to avoid ambiguity we will confine this name to ſtones of the argillaceous kind.

The

The bluiſh purple ſhiſtus, or common roof ſlate, *ſchiſtus tegularis*. It does not ſtrike fire with ſteel, and may be ſlightly ſcraped with the nail.

It is very brittle, and of a lamellar texture.

Its ſpecific gravity is 2876.

When in pieces of half an inch thick, it gives a clear ſound if ſtruck.

Its grain is moderately fine: and it never is tranſparent.

Effervesces ſlightly with acids when powdered, otherwiſe not.

When made red hot, loſes more than two per cent of its weight.

It detonates ſlightly with nitre, and then aſſumes a browniſh red colour.

But calcination does not render it magnetic.

In a ſtronger heat it is fuſible *per ſe*, and forms a black ſcoria. It is difficultly diſſolved by mineral alkali, in the dry way, but more eaſily by borax and microcoſmic ſalt with little efferveſcence.

It melts with equal eaſe in chalk or clay veſſels.

Dephlogiſticated ſpirit of nitre, after ſtanding on it two months in the cold, aſſumes a green colour.

It contains 26 parts of *Argill*: 46 of *ſilex*: 8 of *Magneſia*: 4 of *calcareous* earth: and 14 of *iron*.

Part of its iron ſeems to be in a phlogiſticated ſtate, from its union with a mineral oil that is contained in it:

And part in a dephlogiſticated ſtate, or in that of *red* calx: this is united to the argillaceous part and to the ſiliceous alſo: and is very difficultly ſeparated.

Its colour varies to the pale, to the ſlightly purple, and to the bluiſh.

The lamina of theſe laſt are thicker, and their texture is coarſer.

They contain more of the ſiliceous earth, and leſs of the iron calces.

Other ſtones are alſo uſed for covering houſes in various countries: but they are eaſily diſtinguiſhed, as their lamina are much thicker, their ſurface more uneven, and their texture coarſer. They chiefly belong to the ſand ſtones, or to the calcareous kind.

The dark blue ſlate, *ſchiſtus ſcriptorius*, effervesces more briſkly with acids; it contains more *magneſia* and leſs *iron* than the preceding.

Its ſpecific gravity is 2701.

SECT. 147. (Additional.)

The Pyritaceous Shiſtus.

It is of a grey colour, brown, blue, or black.

It is more or leſs decompoſable by its expoſure to air, according to the quantity of the pyritous ingredient and the ſtate of the iron in the pyrites.

If this iron be in a ſemi-phlogiſticated ſtate, it is eaſily decompoſed.

But

But if the calx of iron be already much dephlogiſticated, it will be decompoſed but ſlowly, if at all.

The aluminous Schiſtus is of this ſpecies. *Kirwan.*

SECT. 148. (Additional.)

The Bituminous Schiſtus,

Is generally black [x], of a lamellar texture, and of diferent degrees of hardneſs.

But never gives fire with ſteel.

It emits a ſtrong ſmell, when heated.

And ſometimes without being heated.

When ſcraped, it does not ſhew any white mark like the other ſchiſtus. *Kirwan.*

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[x] I have a ſpecimen of the bituminous ſchiſtus, which burns like coal, with a ſtrong ſmell of mineral bitumen, but it is of a yellowiſh brown, or rather of a dark aſh colour: this was found on the eſtate of Mr. Smith, near Thirſk, in Yorkſhire. *The Editor.*

SECT. 149. (Additional.)

The Flag Stone.

It is of a grey, yellowiſh, or reddiſh white colour.

Does not give fire with ſteel.

Nor efferveſces with acids.

Its ſpecific gravity is from 2600 to 2780.

It is uſed in ſome places for covering of houſes; but moſtly for flooring.

It is ſometimes compact and ſometimes is like the argillaceous grit: and then its ſpecific gravity is ſmaller. *Kirwan.*

SECT. 150. (Additional.)

The Argillaceous Grit.

This is called alſo *Sand Stone*, and *Free Stone*, becauſe it may be cut eaſily in all directions.

Its texture is more or leſs porous, equable, and rough to the touch.

It exhales an earthy ſmell when freſh broken and breathed upon.

Does not give fire with ſteel.

Nor efferveſces with acids.

That from *Hollington*, near *Utoxeter*, is of a whitiſh or yellowiſh grey, and its ſpecific gravity is 2288.

That from *Kniperſly* in *Staffordſhire*, is of a grey colour, and ſo infuſible as to be uſed for fire-ſtones. Its ſpecific gravity is 2568. *Kirwan*.

SECT. 151. (Additional.)

Killas.

This ſtone is of a pale grey, or greeniſh colour; either lamellar or coarſely granular. It is found chiefly in Cornwall. The lamellar ſort is ſofter and has leſs iron than the roof ſhiſtus; its ſpecific gravity is from 2630 to 2666. Out of one hundred parts, 60 are ſiliceous earth, 25 argillaceous, 9 of the magneſian earth, and 6 of iron. The greeniſh Killas contains more iron, and gives a greeniſh colour to nitrous acid. *Kirwan*.

SECT. 152. (Additional from the Philoſophical Tranſactions for 1782.)

Toadſtone.

Dr. Withering, who has given an analyſis of this ſtone, deſcribes it as being of a dark browniſh grey colour of a granular texture, not giving fire with ſteel, nor effervescing with acids. It has cavities filled with cryſtalized ſpar, and is fuſible *per ſe* in a ſtrong heat. It is found in Derbyſhire.

Mr. Whitehurſt obſerves, that this is probably a volcanic product; and that the maſſes of ſpar it contains, appear to have filled the cavities ſubſequent to its original formation. For the toadſtone, contiguous to a ſtratum of clay, is found to have baked it to a certain thickneſs. At 100 fathoms beneath the ſurface of the earth this ſtratum is quite ſolid, and is more and more porous at leſs depths. Theſe pores in ſome ſpecimens are quite empty, in others they are lined with regular cryſtallizations, and in others entirely filled.

The toadſtone contains from 56 to 63,5 centeſimal parts of ſiliceous earth, near 15 of the argillaceous: 7,5 of calcareous earth, and 16 of iron. *See Dr. Withering's account in the* Phil. Tranſ. for 1782, p. 2.

N. B. Mr. Kirwan remarks, that this ſtone differs but little from baſaltes, than which it is ſofter; contains a ſmaller portion of *iron*, and a larger of *ſiliceous* earth: ſo that it may be reckoned among the volcanic ſubſtances, at leaſt among thoſe which have undergone ſome change by volcanic fires. *The Editor.*

The compounds of this and other earths will be mentioned in the General Appendix of this Mineralogy, as well as the volcanic ſubſtances, according to the Author's idea in the firſt edition of this Mineralogy.

SECT.

S E C T. 153. (From a Note of the Author to his Section 91.)

Thoughts of the Author on the formation of Clays.

There is ſome probability, though not eaſily demonſtrable, that 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 but a mould, or *humus ater*, ſomewhat altered by means of water, after a length of time [a].

The

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[a] Theſe conjectures of the Noble Author abundantly ſhew his great ſagacity in the inveſtigation of phenomena that have any relation to mineralogical ſubſtances. But now that the *Argillaceous* is acknowledged to be a ſimple primitive earth, which cannot be decompoſed into any other principles, nor formed by the combination of any other ſimple ſubſtances we know, we ought to reſt ſatisfied at preſent, without endeavouring to account for its formation.

Profeſſor Bergman has likewiſe hinted that *Argilla* might perhaps be a calcareous earth combined with ſome acid not yet diſcovered: but, ſays he, ſect. 83 of his excellent treatiſe, intitled *Meditationes de Syſtemate Foſſilium Naturali*, which he favoured me with, ſome few months before his death—" Sed, donec tales compoſitiones experimentis fuerint nudatæ, reſpectu

noſtræ

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 the 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 overgrown 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.

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noſtræ cognitionis, inſtar primitivarum conſiderari & poſſunt & debent; e ſola namque poſſibilitate in Philoſophia Naturali nihil ſtabilire convenit. Quotidiana ſatis edocet experientia, quæ maxime probabilia videntur, alio tempore revera falſa reperiri."—In Engliſh. *But compoſitions of this kind may and even ought to be conſidered as primitive ſubſtances with reſpect to our knowledge of them, till they ſhall be experimentally decompoſed. For no ſound knowledge in natural philoſophy can be obtained from the conſideration of mere poſſibilities, ſince daily experience ſhews that even the moſt probable ſuppoſitions have proved falſe, when the means of putting them to the teſt have afterwards been found out.* Edit.

The

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. In the mean while it may be ſome confirmation to this doctrine to mention that I have in dry ſummers obſerved on the ſea-ſhore, that a perfect iron vitriol bas been growing out of the mud, clays, and vegetables not yet rotted, that have been thrown up there together.

When this opinion is once proved to be true, we 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 theſe ſtrata have afterwards been indurated by themſelves or with calcareous earth, by which means they became converted into the above ſlaty and limy clays[b]: and when

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[b] The argillaceous earth being a primitive one, and the ſubverſions and changes of this terraqueous globe being evidently demonſtrated to every one that attentively conſiders its interior ſtructure, we may eaſily conceive how thoſe various ſtrata of this *argillaceous* earth might happen to be formed, like thoſe of the *calcareous* and of other foſſils in various parts of

when they have been mixed with a great quantity of vegetables, and of the inflammable ſubſtance, they may in length of time have been 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 moreover, 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, through edulcoration 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 more recent formation.

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of the globe, without having recourſe to the change of any previous ſubſtance into this kind of earth, as hinted by the Author.

We may allow, nevertheleſs, without great heſitation, that in ſome particular circumſtances, ſimilar changes may have taken place; if we can rely on the obſervations of Meſſrs. Targioni, Ferber, and Maſcagni in various parts of Toſcany and Naples, chiefly near the lagoons, or lakes, which in all probability are the craters of old and unrecorded volcanos, and round which ſulphureous vapours, and ammoniacal exhalations, are ſtill ruſhing out of the neighbouring places, that not only the *ſchiſti* or *ſlatey* ſubſtances, but the *hornblendes* (lapides cornei) the *albareſe marbles* and even the *quartzous ſtones* are found partly reduced into the argillaceous kind. *See the Treatiſe of Mr. Maſcagni on the* Lagoni del Seneſe & del Volaterrano, Art. 6. *printed at Siena*, 1779, 8vo. *The Editor.*

SECT.

The ſteatites (Sect. 57), is purer and more ſolid in China than 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, is uſed under the name of *French Clay*, at the glaſs-houſes, ſteel-furnaces, and other works of the ſame nature, for the ſame reaſons as it is the 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.

Clay is of the moſt indiſpenſable advantage to agriculture. We muſt however except the white clay and the fermenting clay, both of Sect. 144, varieties whoſe utility has not been diſcovered. By virtue of its coherency, clay retains humidity, on which, perhaps, its chief power of promoting the growth of vegetables depends, its other effects being adventitious either from natural or artificial circumſtances; unleſs the clay has formerly been a mould or *humus ater*, in which caſe it is reaſonable to conclude that part of it will enter again into the formation of new vegetables. The clay uſed in the refining of ſugar requires no other quality than

CLASS II.

SALINE SUBSTANCES.

SECT. 155. (119.)

General Properties of Salts.

The Salts. *Salia.* Lat.

By this name thoſe mineral bodies are called, which can be diſſolved in water, and give 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 in ſolution; which quality is called Cryſtalliſation [e].

In

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[e] The general character, or the definition of ſalts given by Bergman, has been inſerted in Note *g*, page 10: but Dr. Withering has obſerved that the ſame definition does not apply perfectly well to ſome of the ſimple ſalts. Dr. Black, of Edinburgh, defines ſalts by ſaying that *ſaline ſubſtances are ſapid, mixible with water, and not inflammable:* but the ſame Dr. Withering rightly remarks, that this definition is alſo exceptionable: ſince it has been found, that volatil alkali, in an aerial form, is in a certain degree inflammable. *The Editor.*

No

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

1. Acid Salts, or Mineral Acids, *Salia Acida*,
2. Alkaline Salts, or Mineral Alcalis, *Salia Alkalina*.

Till

No other ſalts ought to be conſidered and ranked in a mineral ſyſtem, than thoſe which are found natural in the earth; and for this reaſon a great number of Salts will be in vain looked for here, viz. all ſuch as are either natural or prepared by art in the other two kingdoms of nature, and from ſubſtances belonging to them. *The Author.*

I muſt confeſs that the noble author's reaſon for excluding many ſubſtances out of his mineral ſyſtem that are not formed in the earth, does not appear to me ſatisfactory. For if thoſe ſubſtances ought to be excluded which are never found but in a ſtate of combination or mixture, the earths and metals will preſent us with no ſmall number of even primitive ſubſtances that demand rejection. And with regard to ſuch matters as are ſaid not to be formed in the earth at all, though they ſtrongly reſemble other mineral ſubſtances, ſuch for example as the nitrous acid and fixed vegetable alkali, the firſt of which has been ſaid to require the putrefactive fermentation to produce it, and the latter to be produced by calcination, we cannot be too cautious in rejecting them. For, without mentioning the great probability that future reſearches may find ſuch in the bowels of the earth, it does not ſeem conſiſtent with the laws of a rational mineralogy to place a greater dependance on the original exiſtence than on the external characters of bodies, which laſt our illuſtrious author has reduced to their true value by claſſing them according to the chemical analyſis of each ſubſtance. It is not in fact *what* a foſſil might have been formerly; but *what it is*, that muſt determine its right to enter into a ſyſtem of natural knowledge. The mineral kingdom is as it were the receptacle for all bodies that are not either in the vegetable or animal ſtate. *The Editor.*

Till of late no more mineral acids were known than the vitriolic *and* marine; *the* boracic *or* ſedative *ſalt being reckoned as produced artificially: but later diſcoveries have proved that we may reckon at leaſt* eleven mineral acids, *out of which only*

There have, indeed, been many attempts made to reduce moſt of the mineral acids to the vitriolic, which by many is called the univerſal acid: but experiments ſeem not to agree with it; at leaſt nobody has yet been able, by uniting a phlogiſton with any other acid than the true vitriolic, to produce a ſubſtance in every particular reſembling the true brimſtone or ſulphur. For this reaſon I cannot yet give my aſſent to Doctor Pietſch's opinion, who endeavours to prove, that the acid of nitre is derived from the vitriolic acid, that is, before his theory is confirmed in the large way, and the analyſis has been more plainly laid open; but I think the queſtion remains ſtill undecided, whether 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 mineral acids, which are 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

only two or three have been found in an uncombined ſtate. Thoſe hitherto known are the following, viz. the vitriolic, *the* nitrous, *the* marine, *the* ſparry, *the* arſenical, *the* molybdenic, *the* tungſtenic, *the* phoſphoric, *the* boracic, *the* ſuccinous, *and the* aerial: *of which will be treated ſeparately in the following ſections.* The Editor, *chiefly from* Bergman.

It has been obſerved before (Note *k* to Sect 2.) that the qualities of arſenic in form of a calx, may agree with the definition of 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. *The Author.*

I learn by a letter from Chevalier Landriani, Profeſſor of Natural Philoſophy at Milan, dated the 2d of June, 1782, that Count de Saluces of Turin has converted vitriolic acid into nitrous and muriatic. There is alſo an experiment of J. G. Wallerius, quoted by Dr. Lewis on Nieuman, II. 265, where ſalt of tartar being mixed with ſome dulcified ſpirit of vitriol (or perhaps unrectified ether) produced, after ſtanding corked for four months, a priſmatic ſalt in ſome reſpects reſembling nitre, particularly in that of detonating. The greateſt part of the ſpirit of vitriol had made its eſcape.

The ſame Profeſſor Wallerius affirms (page 13 of his Mineralogy, edit. 1778) that, according to the common opinion of chemiſts, the three mineral acids, viz. the *vitriolic*, the *nitrous*, and the *muriatic*, are identic, the two laſt originating from the firſt. But Chevalier Landriani, in one of his Opuſcula, printed at Milan, where he treats profeſſedly of this queſtion, aſſerts that all acids derive their origin from the *aerial acid* or *fixed air*, as this aeriform ſubſtance is generally produced from almoſt all other acids, when treated by the proper chemical proceſſes, which he deſcribes in the treatiſe. See *Note* u *to Sect* 158, concerning the production of *Nitrous acid*, by Count de Saluces already mentioned. *The Editor.*

ORDER THE FIRST.

SECT. 156. (120.)

Acid Salts. *Salia Acida.*

The characters of theſe ſalts are, that they,

1. Have a ſour taſte [*f*].
2. Are corroſive; that is to ſay, have a power of diſſolving a great number of bodies.
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.

[*f*] Sapidity or taſte is ſo inherent a quality in ſalts, that we need not heſitate in affirming that this ſenſation is always cauſed by the action of ſaline matters on our organs. This ſenſation is infinitely varied from the moſt agreeable excitation of the perception to the moſt deſtructive and painful degree of cauſticity. Among acids the concentrated vitriolic and the mild tartneſs of vegetables form the two extremes; and the action of ſalts varies in every ſtate of combination, ſo that in ſome its efficacy is ſo ſmall as to be ſcarcely perceptible. *The Editor from Mongez.*

4. They change moſt of the expreſſed blue juices of vegetables into red[g].

5. They

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[g] As the tincture of *h liotropium* is the niceſt teſt of the preſence of an uncombined acid, it may not be amiſs to mention that it may be had from dyers under the name of *Litmus*. It is very cheap, and generally requires to be greatly diluted with diſtilled water before it can be uſed. *Withering*.

The infuſion of *litmus* is ſenſible to the preſence of *one grain* of common oil of vitriol, though mixed with 100,000 grains of water: but as this infuſion does not change colour on being mixed with alkaline liquors, ſome vinegar muſt be mixed with it, ſo as juſt to turn the infuſion *red*, which will then be reſtored to its *blue* colour by being mixed with any alkaline liquor.

This blue infuſion turns red alſo, when mixed with water impregnated with *fixed air* (or *aerial acid*). But Mr. James Watt obſerved that a mixture of *phlogiſticated nitrous acid*, with an *alkali*, will appear to be *acid* by the teſt of *litmus*, when other teſts, ſuch as the infuſion of the petals of *ſcarlet roſe*, *blue iris*, *violets*, &c. will ſhew the ſame to be alkaline: and I recollect that Mr. Ed. Huſſey Delaval, F. R. S. ſhewed to me ſome years ago that whenever phlogiſton was contained in the liquors to be tried, we could not depend at all on this teſt.

As the above flowers mentioned by Mr. Watt, cannot be had but in a particular time of the year, he had recourſe to another ſubſtitute, which is equally as good and nice a teſt for the ſame purpoſe as they are.

This ſubſtitute is the extract of the *red Cabbage* (*Braſſica rubra*). A blue liquid is obtained by cutting off the ſtems, and mincing the thin parts of the leaves very ſmall; afterwards digeſting them in water, about the heat of 120 degrees of Farhenheit's thermometer, for a few hours, and the clear blue liquor will be the moſt nice teſt, both for acid or alkaline ſubſtances, as it turns *red* with the firſt, and *green* with theſe laſt.

But as this liquid turns acid and putrid by long keeping, the above infuſion of minced leaves of *red Cabbage* may be made in water acidulated with vitriolic acid not ſtronger than common

5. They ſeparate the alcali from the fat, when they have been united in ſoap; which effect is called to *curdle*, or coagulate.

6. They

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mon vinegar, which may be neutralized when wanted, by means of *chalk*, or of *fixed* or *volatil alkali*, till it turns blue, taking care not to add too much of it, ſo as to become yellow, as it then cannot be reſtored back to blue. N. B. This infuſion may be prevented from moulding in ſummer, by adding to it by a little at a time ſome ſpirit of wine. *See Mr. Watt's paper, read to the Royal Society in May 27 laſt, printed in the 2d part of Phil. Tranſact. for the preſent year*, 1784.

Acids not only turn theſe *blue* vegetable juices to a red, but they recover their blue colour after they have been made *green* by the mixture of an *alkaline liquor*. In general, almoſt all *red* vegetable juices are turned *purple*, then *blue*, and afterwards *green* by the mixture of an alkaline liquor, from whence they may be brought up ſucceſſively in a retrogade order to the *red* colour, by the addition of an acid: and this may be repeatedly done with the very ſame vegetable extract many times, as I have repeatedly tried after the method of Mr. Delaval, F. R. S. above mentioned. This able philoſopher points out the cauſe of theſe phenomena in his very elaborate and ingenious work, intituled, *An Inquiry into the Cauſe of the change of Colours*, &c. printed in 1774, and publiſhed in 1777, of which two different tranſlations have been made in Italy, beſide the French and other tranſlations. The author explains theſe phenomena on the principles of Sir Iſaac Newton, viz. that the aſcending ſucceſſion of colours, from the *green* to the *blue*, and ſo on to the *red* and *yellow*, as they appear in the rainbow, depend on the gradual diminution in ſize of the colouring particles: in conſequence of which a ſmall addition of *diluting* acid at a time, produces thoſe ſucceſſive changes according to the above order. On the contrary, by a gradual addition of a *condenſing* (or ſaturating) alkali, the ſame change muſt take place, as it really does, but in an inverſe order, from the *red* to the *purple*, then to the *blue*, and the *green*: but if *acid* enough is added ſo as to turn

the

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 [b].

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the juices *yellow*, then they cannot be brought back again by the alkali to the *purple* or any other colour.

Thus far *theory* is ſupported by facts, and perhaps when our knowledge can be carried further, we may determine how the *acid* and the *alkali* produce the contrary effects of *attenuating* and *increaſing* the bulk of the very ſame colouring particles of theſe vegetable juices, only to a certain degree, beyond which they are no more able to effect it.

We are alſo indebted to the ſame very able philoſopher, Mr. Delaval, for the diſcovery, that colours are generally produced by *tranſmitted* or *refracted rays*, even from ſolid bodies, and not by the ſimply reflected light, as was commonly judged. This is the ſubject of a very elaborate Diſſertation which the ſame gentleman ſent to the literary and philoſophical Society of Mancheſter: and will be inſerted in the firſt volume of its Tranſactions to be publiſhed about the beginning of the next year 1785. *The Editor.*

[b] The author's words apply only to that caſe in which common acids aſſume an *aerial form*; but the contrary muſt happen, when they are in a concrete form, as will be mentioned at the end of Note *k* and Note *u* to the two following Sections: beſides that ſome of the new acids (lately diſcovered) always appear in a concrete form, as will be obſerved in their reſpective Sections.

To this I may add, that on opening a few days ago a ſmall phial I had almoſt forgotten in the corner of a ſhelf during theſe five or ſix years laſt, more than half filled with concentrated vitriolic acid, well covered with a ground glaſs ſtopple, I found that ſome ſmall pieces of the concrete acid were ſticking to the bottom of the ſtopple and to the upper part of the inſide of the phial. Theſe concretions were of various ſizes and ſhapes: without any appearance of a regular cryſtallization. *Editor.*

S E C T. 157. (108.)

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

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

Is, in abſtract, conſidered as poſſible to occur in nature [*i*]: 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* [*j*].

[*i*] Dr. Baltaſſari ſays that he found ſome dry concentrated acid, adhering to ſelenite in a grotto in *Monte Zaccbelino* near *Sienna*: but this has been fully diſproved by the ſubſequent obſervations of Mr. Murray. *Kirwan.*

And Mr. de Dolomieu has affirmed that he found alſo the pure concrete acid of vitriol in a grotto near Mount Etna, as Mr. Mongez relates. This requires to be confirmed by further obſervations. *See however Note* h *to Sect.* 156. *Edit.*

Dr. Vandelli ſays that it is ſometimes mixed with the ſtreams from the hills in the neighbourhood of Sienna and Viterbo in Italy, raiſed no doubt by ſubterraneous fires.

Phlogiſticated or volatile vitriolic acid is frequently thrown out by the craters of volcanos: its ſmell is ſuffocating and penetrating: its union with phlogiſton, and the matter of heat gives it an aerial form, but does not prevent its union with water. *Berg. Sciag.* § 27.

[*j*] The unctuous feel of the vitriolic acid ſeems to be produced by its action on the oily matter of the ſkin, with which it produces a ſaponaceous compound. *Editor.*

2. It

2. It has in that ſtate a conſiderable ſpecific gravity, viz. in compariſon to water, as 1700 to 1000 [k].
3. It diſſolves ſilver, tin, the regulus of antimony, and quickſilver [l], but,

4. When

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[k] Vitriolic acid, when moſt concentrated by artificial means, has a ſpecific gravity of 2125, according to Bergman: in this caſe it has 1698,1 parts of water mixed with 426,9 of *pure vitriolic* acid: whoſe ſpecific gravity, if deprived of all the water, is equal to 4226: in other words, 1000 parts of this acid mentioned by Bergman, which is perhaps the moſt concentrated ever made, contains ſtill 1698,1 parts of water mixed with 426,9 parts of the pure vitriolic acid according to the *Formula* of Cotes quoted by Kirwan in the *Phil. Tranſ.* 1782. *Editor.* This acid, when well concentrated, has neither colour nor ſmell. Mr. Helot, by the diſtillation of green vitriol in an extreme heat, obtained a concentrated vitriolic acid in a concrete and cryſtalline form. Meyer ſpeaks of ſimilar cryſtals, obtained by Nordhaus which were fuming. When this acid is well concentrated, it will freeze at a degree of cold between the 5th and 3d of Fahrenheit, as the Duc d'Ayen ſhewed in 1779. But M. de Morveau has frozen the vitriolic acid, with a leſs degree of cold. *Mongez. See alſo Note* h *to* Sect. 156.

[l] It diſſolves cobalt, but only partially biſmuth, antimony, or arſenic. As to quickſilver it is only corroded by this acid.

Gold itſelf is not exempted from the action of this acid, which diſſolves it after precipitation from the *aqua regia.* It is even ſoluble in its metallic ſtate by particular management. Both theſe ſolutions are cryſtallizable. *Fabroni.*

But, according to Mr. Kirwan's maſterly experiments and deductions inſerted in the *Philoſophical Tranſactions* 1782, *one hundred* grains of meer vitriolic acid diſſolve, and require to be ſaturated with, the following quantities of theſe metals, viz.

Mercury.

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 gypſeus Druſen, *Selenites et cryſtalli gypſei* of Sect. 18 and 19 [m].
6. It unites with a pure argillaceous earth, and diſſolving it without any fermentation, makes alum [n].
7. It has a ſtronger attraction to the inflammable ſubſtance, than to the alkaline ſalt, and forms with it a body,

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Mercury.	Lead.	Silver.	Cobalt.	Wiſmuth.	Nickel.
432 gr.	412 gr.	390 gr.	360 gr.	250 to 310 gr.	320 gr.

Zink.	Iron.	Copper.	Reg. of Arſen.	Reg. of Ant.	Tin.
318 gr.	270 gr.	360 gr.	260 gr.	200 gr.	138 gr.

See the end of a ſimilar Note to Sect. 159.

[m] With *ponderous earth*, it forms the *marmor metallicum*, or baro-ſelenite of Sect. 50.

According to Mr. Kirwan, *one hundred* grains of *pure vitriolic acid*, require for ſaturation the following quantities of the following ſubſtances, viz.

Fixed vegetable alk.	Mineral alkali	Volatil alkali	Calcareous earth,	Magneſian earth	Argill. earth
215 *gr.*	165 *gr.*	90 *gr.*	110 *gr.*	80 *gr.*	75 *gr.*

[n] It was ſaid in the text, that vitriolic acid unites with the *earth of quartz*, when diſſolved in the *liquor ſilicum*, with which and with *argillaceous earth*, it forms alum. But it is now fully demonſtrated that the baſis of alum conſiſts only in the pure argillaceous earth. *See* Macquer's Dictionary *at the article* Alum. *The Editor.*

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 *Pyrophorus* [o].
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 [p].
10. It unites readily and eaſily with the alkalis, whereby, according to their nature, different compounds are produced, which have obtained the names of *Tartarus vitriolatus*, *ſal mirabile*, and *ſal ammoniacum fixum*.

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[o] The various theories of the pyrophori, none of which are yet incontrovertibly eſtabliſhed, ſeem to render this character rather doubtful, or at leaſt too remote to be offered as one of the vitriolic acid. *Editor*.

[p] The vitriolic acid not only expels the *aerial acid* or *fixed air* from calcareous or abſorbent earth to unite with; but likewiſe the fluor or ſparry acid from the ſubſtances of Sect. 32, and alſo the marine acid, in form of air. It diſengages the inflammable air from different metals as iron, zink, &c. of which, according to Meſſrs. Prieſtley, Kirwan, and other philoſophers, this air is the true phlogiſton. *Edit*.

SECT.

SECT. 158. (Additional.)

Nitrous acid. *Acidum Nitri*, Lat. *Acide Nitreux*, French.

Nitrous acid is by ſome excluded from the mineral kingdom, becauſe they ſuppoſe it to be produced from putrefaction of organic bodies. But theſe bodies, when deprived of life, are again received amongſt foſſils, from whence their more fixed parts were originally derived [q].

1. In the moſt concentrated ſtate that art can procure this acid, its ſpecific gravity is 1.580. *Bergman* [r].
2. It is colourleſs when pure, but its ſtrong attraction to phlogiſton cauſes it uſually to be of a yellow topaz colour. This ſuperabundant phlogiſton may however be dri-

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[q] It is known by the important experiments of Doctor Thouvenel, that the nitrous acid is formed out of almoſt every ſubſtance, and therefore may be ſaid to be common to all the three kingdoms of nature. *Mongez.*

[r] By the accurate experiments of Mr. Kirwan, it appears that the ſpecific gravity of *mere nitrous acid* muſt be = 5530: but when it is found to be only 1580, in that caſe it contains 708,1 parts of *mere acid*, and 871,9 parts of water. *See Note* k *to Sect.* 157. *Editor.*

ven off, and the acid rendered colourleſs [s].

3. United with an alkali it forms a ſalt which when in contact with a phlogiſtic ſubſtance in a red heat (either of itſelf or of the ſaid ſubſtance) is rapidly decompoſed, the acid flying off, or becoming deſtroyed in a peculiarly luminous flame, with a noiſe called *Detonation*, and the alkali, if fixed, remaining behind.
4. With different proportions of phlogiſton, it forms *phlogiſticated acid* and *nitrous acid* [t].
5. It has never, as far as we know, been met with diſengaged, unleſs perhaps in water precipitated out of the atmoſphere; but is found united to alkalis, or to earths. *Berg. Sciagr.* [u].

6. It

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[s] The moſt highly coloured and fuming nitrous acid may readily be rendered colourleſs, by boiling it haſtily in an open veſſel. Part of the acid flies off, carrying the ſuperabundant phlogiſton along with it, in the form of *nitrous air*. Withering.

[t] Some modern chemiſts regard nitrous air as a principle *ſui generis*, which requires only to be united to dephlogiſticated air and water to produce the *nitrous acid*. This new etiology is the production of M. Lavoiſier. *Mongez*.

An idea of the theory of M. Lavoiſier may be had from the *Leçons de Chymie* of M. Fourcroy, pp. 53—64, vol. I. *Editor*.

[u] It appears by the experiments of Margraff (Memoirs of the Berlin Acad. for 1751) that rain and ſnow water contain uncombined nitrous acid. Burghart, in his treatiſe on *ſalt de ſeignete*, ſays that native nitrous acid is found in ſome mines, and

6. It acts very powerfully on all animal and vegetable

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and particularly in thoſe of Ukrania. Mr. Kirwan allows that it may, perhaps, be found in charnels and privies: and it was lately reported that a mine of nitre was found by Abbé Fortis at Malfette in the kingdom of Naples. *Editor.*

Mr. Le Comte de Saluces, Preſident of the Royal Academy of Sciences at Turin, wrote me a letter dated the 21th of March 1783, including a printed one, directed to Meſſieurs Macquer and Cigna, in which he affirms that *the conſtituent parts of nitrous acid are an accidulous empyreumatic liquor, the volatil alkali, the calcareous earth, and a little vitrifiable earth: that, in conſequence of thoſe* data, *he* had produced a *real nitre*, by combining theſe principles ſynthetically; that he had formed a *true nitrous acid* without the introduction of any matter that could be ſuſpected of containing it: and that he has ſtrictly demonſtrated the converſion of the *vitriolic* into the *nitrous acid:* a little after, the noble author adds that the proceſs for producing the nitrous acid conſiſts in precipitating the earth of iron from a ſolution of green coperas by a volatile alkali. This precipitation is made with various phenomena, according to the *intermedium* made uſe of in decompoſing the ſal ammoniac: thus he has procured it by employing the volatil alkali obtained by means of oil of tartar, ſoap lees, and the liquor of flints. Theſe liquors muſt at length become combined with the fixed alkali after a long repoſe, and after filtration be evaporated or diſtilled.

The ſame noble author (in his letter directed to me) makes the following remarks.

1°. A recent ſolution of martial vitriol does not paſs to the ſtate of nitroſity. But, ſays he, an old ſolution appearing to me to differ from the other but in containing leſs martial particles, I boiled the recent ſolution, and having treated it like the other, it afforded no nitrous ſubſtance. Here, Sir, is a circumſtance that has given me much trouble, namely to diſcover the deciſive modification of this metamorphoſis with regard to the acid. However, I flatter myſelf that I have ſucceeded in cutting this Gordian knot, &c.

2°. So-vegetable ſubſtances; and even produces actual

2°. Solutions of the vitriols of copper or of zink, or the vitriolic acid in a fluid ſtate, were not proper for effecting this metamorphoſis.

3. The cauſtic or fluor volatile alkali has not ſucceeded, nor even the volatile ſalt obtained by *intermediums* under a fluid form.

The author concludes with the following propoſitions, which he promiſes to demonſtrate at large in an elaborate work which he is about to publiſh, and which the public, no doubt, will anxiouſly expect. They are,

1. That efferveſcences do not depend on the prealable exiſtence of a pneumatic gas.
2. That quick lime is not inefferveſcent with acids, nor even the volatile cauſtic ſpirit.
3. That the privation of gas in quick lime is not the cauſe of its cauſticity: and what is the cauſe of this property.
4. That nitrous gas is nothing elſe but the moſt volatile and concentrated part of the nitrous acid diſguiſed by phlogiſton.
5. That there is always a vacuum made in the veſſels in which the operations are performed, and that the air expelled has often been taken for generated air.
6. That metallic calces do not contain air, and that the augmentation of their weight is owing to the part of an acid that combines with their phlogiſton: and that mercury is augmented (in weight) in proportion to the loſs of the nitrous acid.
7. That the air is the vehicle and ſpecific menſtruum of the volatile principles of bodies: that there is a part that forms a combination with them, another which is not in the ſtate of aggregation: and laſtly, another in which theſe new compounds are in a ſtate of ſuſpenſion.
8. That the pretended reduction of minium without an intermedium is not a true revival.
9. That red precipitate and minium decompoſe iron by their modification, each becoming reduced after its own manner.

10. That

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

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undertook this labour with the greateſt attention, have proved fruitleſs. The Comte de Saluces, perpetual Preſident of the Academy of Sciences at Turin, ſays expreſsly in the letter he has honoured me with, that he has converted the vitriolic into nitrous and afterwards into the marine acid.

It was likewiſe by the means of iron that this metamorphoſis took place. *See Note* u *to the preceding Section.* But while the Stahls, the Potts, and the Saluces do not give us their proceſſes ſo as to enable us to comprehend and repeat them, they muſt expect to be regarded as viſionary enthuſiaſts, by the bulk of mankind. *Editor.*

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SECT.

SECT. 160. (Additional.)

The *Fluor acid*, or *ſparry fluor acid.* Acidum fluoris mineralis. *Lat.*

This acid is obtained by art, as it has never been found diſengaged, but united to calcareous earth forming a ſparry fluor, called *Derbyſhire fluor*, *Corniſh fluor*, *Blue John*, or *Amethiſt root*, when of a purple colour. *See Sect.* 22, *and following*, *concerning the* ſubſtances ariſing from the combination of this acid with calcareous earth [a].

1. This acid is found in great quantity in all the fluor or phoſphoric ſpars. It is diſengaged from its calcareous baſe by diſtilla-

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[a] This acid has not been long known. It was diſcovered by Mr. Scheele, the celebrated Swediſh chemiſt. Doctor John Reinhold Forſter publiſhed an Engliſh tranſlation of Mr. Scheele's memoir, which had been inſerted in the Memoirs of the Swediſh Academy for the year 1771. Many chemiſts oppoſed this diſcovery, pretending that it was only a modification of the marine; and others, under the name of Boulanger, affirmed, that it was nothing elſe but the marine acid combined with an earthy matter. But at length the famous Bergman demonſtrated that it was a true acid *ſui generis*, and the reſults of its combinations ſhew the thing evidently. For clay, ponderous earth, magneſia, quick lime, and alkalies, furniſh in combination with this acid, mineral ſalts very different from thoſe produced with other acids.

7. This air has a great tendency to combine with water, and produces heat during the time of combining.
8. It is colourleſs.
9. Its ſmell reſembles that of the marine acid.
10. It mixes equally well with water or ardent ſpirit, the laſt not being ſenſibly altered by the mixture.
11. Its affinity is ſtronger to calcareous earth than any other ſubſtance: for that earth diſengages it from any other ſubſtance it may be united with.
12. But being added to lime water, no precipitation takes place till it is fully ſaturated, when a regenerated ſpar is precipitated.
13. With pure ſiliceous earth, a ſolution is made of a ſweet taſte: which by ſtanding becomes gelatinous [c].
14. Magneſian earth is diſſolved by this acid: but by ſtanding, part of the magneſia is precipitated, and the remainder takes the form of a gelatinous ſubſtance.
15. It diſſolves iron, and its calx as well as zink, with great violence, and inflammable air is produced by theſe ſolutions: the ſolution of this laſt ſemi-metal is partly cryſtalizable.

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[c] It was thought that ſiliceous earth was produced by the union of this acid with water: but this miſtake has been rectified by Mr. Meyer of Stetin; ſee Note *b* to page 45.

16. Neither gold nor ſilver, quickſilver, lead, tin, wiſmuth, cobalt or regulus of antimony are at all diſſolved by this acid: but copper is partly diſſolved: the calces of the above metals, gold excepted, are alſo diſſolved by it.

SECT. 161. (Additional.)

The acid of Arſenic. Acidum Arſenici. *Lat.*

This acid is prepared by art. It is dry, and has a ſpecific gravity of 3391. It is fixed and fuſible in the fire until it has acquired ſo much phlogiſton as is neceſſary to convert it into white arſenic. In a moiſt air it deliqueſces. It is not found uncombined but connected to the calx of cobalt and alſo to phlogiſton, forming either a brittle metal or its calx. *Bergman.*

The arſenical acid ſuſpected by Stahl and by Kunkel, and almoſt demonſtrated by Macquer, was at laſt eſtabliſhed, developed, and exhibited by Scheele, and after him by the academicians of Dijon, and by Bertholet and Pelletier.

It is obtained pure by diſtilling, from the calx of arſenic, four times its weight of nitrous acid: or otherwiſe a mixture of the calx of arſenic with nitrous ammoniac is to be diſtilled very ſlowly. A vitreous maſs is left at the bottom of the retort, which attracts the humidity of the

the air and becomes fluid. This liquor is the arſenical acid in a fluid ſtate, and the vitreous maſs, before it deliqueſces, is the arſenical acid in a ſolid ſtate [a]. Its properties are as follow:

1. It turns the blue vegetable colours to red.
2. It combines eaſily with calcareous earth.

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[a] The arſenical acid may be extracted either from white arſenic or its regulus by either of the three acids, the nitrous, the marine, or the vitriolic. It is even very poſſible to prepare it *per ſe*, as appears from the memoirs on the ſubject, inſerted in the Journal de Milan, intituled *Racolta d'Opuſculi*. Whatever may be the manner of its ſeparation, it may again be reduced into white arſenic or its regulus, by the addition of phlogiſton.

To have this acid diſengaged, nothing more is neceſſary than to ſeparate it from the phlogiſton that neutralizes it. The following method is the moſt eaſy and cheap that I have tried for this purpoſe.

Take two parts of white arſenic reduced to a groſs powder, and put them in a glaſs retort. Upon this pour twelve parts of aqua fortis of a light ſtraw colour and of a ſpecific gravity to water of about 11 : 8 or 1375 : 1000. Join a receiver, and proceed to diſtillation. A ſort of efferveſcence will take place, red vapours will ariſe copiouſly, and the nitrous acid will paſs over at firſt yellow, and afterwards of a beautiful emerald green, and at laſt tranſparent and colourleſs, which ſhews the diſſipation of the phlogiſton. Continue the fire till the liquor in the retort becomes white and of an earthy conſiſtence. This is nothing elſe but the dry arſenical acid in a ſufficient degree of purity, and which ſhould be made red hot for greater precaution.

Afterwards expoſe this maſs to the air to fall in deliqueſcence: or, which is ſhorter, diſſolve it in four times its weight of diſtilled water, and let it boil in the diſtillatory veſſel till no more than half the water employed remains. It will then be the arſenical acid in a fluid form, and of a ſufficient degree of concentration. *Fabroni.*

3. It is a powerful ſolvent of clay, particularly when heated, but it has leſs action on other earths.

It ſtrongly efferveſces with alkalis, and

4. Combined with the vegetable alkali, regenerates the neutral arſenical ſalt of the late Mr. Macquer.

5. When this acid is in a concrete ſtate, if it be urged with the flame of a candle directed on charcoal with the blow pipe, it reſumes its phlogiſton with great rapidity and regenerates white arſenic. And,

6. Gives a ſmoke, the odor of which ſtrongly reſembles that of garlick.

7. It melts in the ſpoon, and does not fume, except in proportion as it receives phlogiſton either from the flame or the metal it reſts on, which is found corroded by the action of this acid. *Mongez.*

8. This is the only mineral acid that, being in a liquid form, makes no efferveſcence with any of the metals, except zink.

9. It precipitates the calcareous earth from lime water, forming with it a white ſalt almoſt inſoluble in water, but which is ſoon taken up by an exceſs of this acid.

10. Quick lime takes this acid from alkalis, which ſhews its ſtronger affinity. *Fabroni.*

11. It diſſolves metallic calces; and Bergman (*de Attract. Elec.*) remarks that,

12. In diſſolving iron it produces no inflammable air, becauſe the phlogiſton is immediately abſorbed by the acid, and produces white arſenic. *The Editor.*

SECT. 162. (Additional.)

The acid of Molybdena. *Acidum Molybdenæ.* Lat.

This is very probably of metallic origin, though it does not yet appear to which metal it belongs. Seeing that arſenic, a brittle metal, by dephlogiſtication only is changed into an acid different from all other acids, it is not improbable that other metals may have an acid baſis, although their phlogiſton adhering more ſtrongly has not yet been completely ſeparated [*a*].

That this acid has a metallic nature, and has not yet been perfectly freed from phlogiſton, is probable from the following conſiderations of its properties in conſequence of the chemical analyſis of molibdena made by the celebrated

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[*a*] Mr. Hielm, by the perſuaſion of the late Profeſſor Bergman, attempted the reduction of the acid of molybdena into a metallic form, and at laſt obtained a regulus ſeemingly different from any other metal: although its further examination has not yet been ſufficiently purſued. *Bergman's* Sciagraph. § 32.

brated Mr. Scheele and the late Profeſſor Bergman [b].

1. Its taſte is acid, and at the ſame time metallic.

2. Microcoſmic ſalt and borax are coloured by it: and theſe ſalts are hardly coloured by any thing but metallic calces.

3. It is decompoſed, by means of the phlogiſticated fixed alkali, which always indicates the preſence of a metal.

4. It is in a concrete form and does not deliqueſce analogous to white arſenic.

5. Its ſpecific gravity is 3460.

6. Its ſolution in diſtilled water reddens the blue tincture of turnſole; curdles ſoap-water, and

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[b] It is but a few years ago that Mr. Scheele diſcovered this acid, in the courſe of ſome reſearches he was buſied in upon Molybdena. The account of the proceſs may be ſeen in the Journal de Phyſique for 1782, tom. 20, page 442. The following is the ſubſtance of one of them. On an ounce and a half of pulveriſed molybdena is poured ſix ounces of diluted nitrous acid, the whole is put into a glaſs retort, luted with its recepient, on a ſand bed. The acid at firſt has no action, but when the ebullition commences, it riſes in red elaſtic vapours with a ſtrong frothing. The diſtillation being carried on to dryneſs, the reſidue is of a cinereous colour.

On this reſidue is to be poured a like quantity of diluted nitrous acid, which is to be diſtilled to dryneſs and affords the ſame phenomena as before. But the reſidue is of a lighter colour than before.

After the ſame operation has been repeated four or five times, the reſidue is in form of a powder as white as chalk. This is to be edulcorated with warm water til it has no more acid, and when dry will weigh about ſix drams and a half, and is the true molybdenous acid. *Mongez.*

and precipitates the ſulphur from a ſolution of its hepar.

7. It becomes bluiſh by being boiled on the filings of any of the imperfect metals.

8. A very ſmall quantity of alkali being previouſly added, it afterwards diſſolves a much greater quantity at the heat of boiling water: and by cooling affords ſmall irregular cryſtals. The ſmall portion of alkali previouſly added, is ſufficient to prevent its volatilizing in open veſſels.

9. It efferveſces with calcareous earth, magneſia, or clay: and forms neutral ſalts very little ſoluble in water.

10. It precipitates ſilver, mercury, or lead, diſſolved in the nitrous acid, and likewiſe lead diſſolved in the muriatic acid.

11. It precipitates ponderous earth from the nitrous or marine acids. And theſe precipitates are not the regenerated ponderous ſpar.

12. It diſengages the aerial acid from fixed and volatil alkalis, and gives neutral acids that precipitate all metallic ſolutions, namely gold, corroſive ſublimate, zink, and mangaueſe of a white colour: iron and the muriatic ſolution of tin, of a brown colour: cobalt of a roſe colour: copper of a blue, &c.

13. On the charcoal, if urged by the blowpipe, this acid is abſorbed. In the ſpoon it takes a white earthy appearance in the exterior flame: which becomes a fine blue white, when acted on by the interior apex of the flame. It gives a beautiful green colour to the microcoſmic ſalt;

a cina cinereous color to the globule of borax, viewed by reflection, but which appears as an obſcure violet if ſeen by tranſmitted light. It is the acid alone that colours the fluxes. *Mongez.*

See other properties of this acid in Note a *of the following Section.*

SECT. 163. (Additional.)

The acid of Tungſten. Acidum Tungſtenicum. *Lat.* Acide Tungſtenique. *Franc.*

Sir Tobern Bergman ſuppoſes, in his Sciagraphia, the tungſtenic acid to be nearly allied to that of molybdena: but he has ſhewn elſewhere the real differences between theſe two acids [*a*]. This acid is found in the ſubſtance of this name, which was formerly called *lapis ponderoſus.* *See Sect.* 27 *and the Notes thereon.*

Mr.

[*a*] In the Journal de Phyſique for February 1783, are inſerted two Memoirs tranſlated from the Acts of the Academy of Stockholm for 1781, compoſed by MM. Scheele and Bergman, in which the chemical analyſis of the Tungſten is given in detail. The latter did not find the ponderous earth as the external appearances in it ſeemed to indicate, but the mere calcareous earth combined with an acid eſſentially different from other acids, though in ſome particulars reſembling the acid of molybdena.

The moſt remarkable differences are,

The acid of molybdena is fuſible in the fire, but the acid of tungſten is not.

2. The

The ſame profeſſor ſtrongly ſuſpected that this acid is of a metallic nature (Sciagraphia. Sect. 33.). And this ſuſpicion is now verified by the labours of Meſſrs. John and Fauſtus de Luyart, two Spaniſh gentlemen, who have applied themſelves with the greateſt ſucceſs to mineralogical chemiſtry. They have demonſtrated this truth by experiments made on Wolfram, a mineral hitherto ranged with ſimple manganeſe, but which is a diſtinct ſpecies on account of its combination with this metallic acid. A detail of the analyſis made by theſe gentlemen may be ſeen in the *Journal de Phyſique* for October and November 1784. The reſult of theſe, together with thoſe of Meſſrs. Scheele and Bergman are as follow:

The tungſtenic acid is obtained in the form of a white powder [b].

This

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2. The molybdenous acid has a ſtronger affinity with phlogiſton, as may be ſeen from its union with ſulphur, and the change it undergoes when treated with oil.

3. The calcareous molybdena is not turned yellow by the nitrous acid, (ſee Note *e* to page 47), and is eaſily ſoluble in it. The contrary obtains in the tungſten.

4. The ponderous earth united with the molybdenous acid is very ſoluble in water, but the ſame baſe united with the acid of tungſten is not.

5. The molybdenous acid has leſs affinity with the calcareous earth than the tungſtenic. For in digeſting calcareous molybdena with a ſolution of ammoniacal tungſten, that is to ſay, a combination of the tungſten acid with volatile alkali, the calcareous earth unites with the tungſtenic acid, and regenerates the tungſten of Sect. 27.

[b] To ſeparate the tungſtenic acid from its baſe, the tungſten is to be reduced into powder, and mixed with four parts

3. It powerfully attracts moiſture and aſſumes an oleaginous appearance like the vitriolic acid, but it recovers its concrete form by the action of fire.

4. While

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water added till it paſſes taſteleſs, and precipitates nothing from lime water. Evaporate all the filtrated water to dryneſs, and removing the reſidue into a crucible, urge it by a violent heat. The matter will then be reduced to the form of glaſs, and is the ammoniacal phoſphoric acid in a ſolid form. Pour out this glaſs on a marble or other ſmooth ſurface. It muſt be covered with a bell glaſs, becauſe it attracts the humidity of the air if left for ſome days. This vitreous acid is nearly tranſparent. I have ſeen ſpecimens of this acid prepared by the method of the Duc de Chaulnes, as clear and beautiful as the fineſt cryſtal.

To obtain phoſphorus nothing more is neceſſary, than to reduce this acid to powder in a mortar, before it has attracted the moiſture of the atmoſphere, otherwiſe it muſt be previouſly dried by heat: mix it well with an equal weight of pulverized charcoal well dried. Put the whole in an earthen retort, and adapt a balloon receiver half filled with water. The receiver muſt have a ſmall perforation to ſuffer the expanſive vapours to eſcape; but if it be tubulated after the manner of Mr. Woulfe, the vapours will be abſorbed by the water in which the tube is immerſed.

As ſoon as the retort is red hot, the phoſphorus will enter the balloon by drops; which ceaſing, the whole apparatus muſt be ſuffered to cool. The phoſphorus, which is in maſſes reſembling wax or reddiſh tallow, muſt be cautiouſly preſſed together, becauſe a ſmall grain adhering to the ſkin, or beneath the nails, may do conſiderable damage by catching fire in the air. Small glaſs tubes are then to be taken a little conical, and the lower ends being cloſed with cork, they are to be filled with the phoſphorus, the operation being performed under water. The tubes being ranged perpendicularly on the bottom of the veſſel, the water muſt be heated, though not to boiling, and the phoſphorus will melt, the purer part falling

to

4. While in a fluid ſtate it has an acid taſte.

5. It reddens the blue vegetable colours.

6. It decompoſes nitre and ſea-ſalt by combining with their alkaline baſes and expelling the acids.

7. With alkalis it forms peculiar neutral ſalts.

8. It diſſolves aerated earths with effervefence.

9. It acts on ſiliceous earth and on glaſs.

10. It diſſolves neither lead nor zink, unleſs it be very concentrated.

11. The ſolution of zink in this acid exhales a fœtid odor.

12. Its fixity is very ſingular. For it may be melted and even ignited without ſubliming.

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to the bottom, and the impurities riſing to the top. When all is cold, the ſticks of phoſphorus are to be taken out of the tubes, and the impure parts cut off, ſtill remembering to keep the phoſphorus under water. Phoſphorus may be rendered very pure by a ſecond diſtillation with a very gentle heat.

As to the fluid phoſphoric acid, it may be procured from phoſphorus by placing pieces of this ſubſtance on the ſides of a glaſs funnel whoſe ſpout is received in a glaſs bottle The funnel muſt be covered, and a piece of glaſs tube placed in the aperture, to prevent the ſolid phoſphorus from falling through. At the end of a certain time more or leſs long, according to circumſtances, an ounce of phoſphorus will have afforded three ounces of acid mixed with the water that ſhould be previouſly put in the bottle.

This acid is obtained from all the ſolid part of animals, as well as from urine, fleſh, &c. Margraff has alſo obtained it from cheeſe; and laſtly, Mr. Gahn has obtained it from the mineral kingdom, as already mentioned. *The Editor*, from *Fabroni*, *Mongez*, *Macquer*, &c.

After this operation it is ſolid and tranſparent like glaſs.

13. By diſtillation with zink in a high degree of heat, it produces phoſphorus in a conſiderable quantity.

14. It attacks and diſſolves iron and the calx of copper very readily. But it acts feebly on copper in its metallic ſtate, only rendering its filings green.

15. By fuſing it with tin, lead, iron, or zink, it produces phoſphorus.

16. If by any means united to phlogiſton, it forms the phoſphorus called after Kunkel, its inventor.

17. And in this ſtate it precipitates almoſt all the metals in the metallic form from their ſolvents [*b*].

[*b*] The Marquis de Bouillon was the firſt who reduced ſilver by phoſphorus in the dry way. Mr. Sage, of the Academy of Sciences, gave him the idea of attempting it in the humid way, which ſucceeded perfectly well. A ſtick of phoſphorus is placed in the diluted ſolution of any metal: and at the end of a certain time it becomes coated with the reduced metal: ſo that when the phoſphorus is melted out by hot water, the metalic tube may be rendered ſolid and ſmooth by a gentle fire. Copper is the beſt adapted for the experiment, and next afterwards gold, ſilver, platina and mercury. I have ſeen theſe tubes of gold, ſilver, and copper in the labratory of Mr. Sage, at the *Hotel de la Monnoie*, and alſo in the laboratory which the Preſident de Saron has fitted up in his own houſe for his chemical amuſements. *Editor.*

SECT. 165. (Additional.)

The Boracic acid. Acidum Boracis. Sal Sedativum. *Lat.* Sel Boracique, Sel Sedatif. *Fr.*

The mineral alkali contained in borax is ſaturated with the acid here mentioned. Its origin had long been a ſubject of contention; but it has been naturally found, within theſe few years, in certain ſtagnant waters near Sienne in Tuſcany, and alſo cryſtallized with other ſaline matters on the mud of thoſe lakes, after the water had been evaporated in a dry ſeaſon [a].

This

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[a] It was in the waters of the Lagoon named Cerchiaio, near Monte Rotondo, that Mr. Hoeffer diſcovered the Sedative Salt here ſpoken of, and concerning which ſeveral diſputes had been made among chemiſts. It naturally exiſts ready formed, and it is probable that the borax we receive from the Eaſt Indies, is formed by art, by the addition of an alkaline matter to waters of this kind. *Fabroni.*

It was on making the analyſis of the waters of the above Lagoon called *Cherchiaio*, that Mr. Hoefer of *Cologne ſur le Rhin*, Director of the mineral waters to the Grand Duke of Tuſcany, found the boracic acid, of which diſcovery he publiſhed an account in 1778. But Mr. Paul Maſcagni, Profeſſor of Anatomy found the ſame acid in a concrete form in ſeveral ſtreams of the Lagoons, in the neighbourhood of Sienna and Volterra. Mr. Maſcagni enumerates ſix places, viz. the lake of *Travale*, 20 miles to the weſt of Sienna: that of *Rotondo*, which lies 30 miles to the weſt of the ſame town: that of *del Saſſo*, three miles further: at another called *Sarazzano*, ſix miles from *Monte Rotondo:* another called *Caſtel Nuovo*, ſeven miles from *Monte Rotondo*, and twenty-four from Sienna: and that of *Monte Cerboli*, at the diſtance of four miles

from

This ſalt is produced in a concrete form, like thin laminæ or ſcales, ſhining and very light, from borax, either by ſublimation or cryſtallization, or by precipitation [*b*]: in the laſt caſe this acid is heavier.

1. Its ſpecific gravity is 1480.

2. It acts like an acid, though very feebly.

3. It melts in the fire and volatilizes with water; that is to ſay, it evaporates partially with water on the fire, but after deſſication this ſalt is fixt: and if urged by fire it runs into a kind

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from *Caſtelnuovo*. In the neighbourhood of all theſe lakes are conſiderable ſprings of hot water ruſhing out of the earth, ſome clear and ſome muddy, either of a dark or a whitiſh colour: and in ſome a kind of a metalic cruſt or pellicle is ſeen over the ſurface of the water. Many cavities from which theſe waters ruſh out, ſeem to be true ſmall volcanic craters: and continually emit from the earth vapours of a ſulphurous and ammoniacal nature.

Not only the boracic acid, both in the fluid and in the concrete ſtate, is found in theſe waters, but various other concretions are there obſerved, ſuch as martial vitriol, ammonaical, aluminous, concrete boracic ſalts, brimſtone, &c. *See Maſcagni's account of theſe Lagoons above quoted. Editor.*

[*b*] The eaſieſt method of obtaining this acid is given by Mr. Mongez. It conſiſts in making a ſolution of borax in boiling water, and adding afterwards ſome vitriolic acid. This acid ſeizes the baſe of the borax, which is the mineral alkali, and the boracic acid is precipitated in the form of ſmall brilliant ſcales, very thin and light. It is called Sedative ſalt, from Homberg, its inventor, who imagined it poſſeſſed a calming and even a narcotic quality. But theſe properties are far from being well eſtabliſhed, and that name ſeems to be beſtowed without reaſon, whereas the name of *Boracic acid* very conveniently points out its origin. *The Editor.*

kind of glaſs, which attracts humidity if expoſed to the air.

4. It is ſoluble in water, but requires a great quantity (50 times its weight) to be diſſolved, though much leſs if the water be hot: one pint of hot water diſſolves no more than 183 grains of this ſalt.

5. It is alſo ſoluble in ſpirit of wine, and gives a green colour to its flame.

6 This acid has very little taſte, and does not change the blue colours of vegetables, according to Macquer: but according to Kirwan it turns the infuſion of litmus red.

7. It is almoſt a neutral ſalt, though it poſſeſſes ſome qualities of true acid ſalts.

8. This acid decompoſes nitre and common ſalt, by attracting their alkaline baſis, and expelling their acids.

9. It attacks mercury, lead, copper, and zink, and forms with them neutral ſalts of very difficult ſolution.

10 It likewiſe attacks the earth precipitated from the *liquor ſilicum*.

11. It unites with almoſt all the earths, as barytes, calx and magneſia, and forms particular ſalts with them.

SECT. 166. (Additional.)

The Succinous or Amber Acid. Acidum Succini. *Lat.* Acide du Succin. *French.*

The ſuccinous acid or acid of amber is the name given to a concrete ſalt obtained from the foſſil of this denomination. It poſſeſſes the properties of a true acid, though they are very feeble. It is not in fact decided whether yellow amber (diſtinguiſhed from *ambre-gris* or grey amber, by the appellation *yellow*), owes its origin to the vegetable or mineral kingdoms; but it is as uſually claſſed among foſſils [a].

1. This acid combines readily with the vegetable and volatile alkalis, and forms cryſtals which are very deliqueſcent.

2. But with the mineral alkali it forms cryſtals that do not deliqueſce by expoſure to the atmoſphere [b].

3. With

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[a] From amber by diſtillation are obtained an acid liquor, an oil, and a cryſtallized (I think better to ſay concrete) volatile acid, which may be ſomewhat purified by ſolution and cryſtallization. *Bergman de Attract. Elec.*

[b] There is no acid whoſe combinations have been leſs examined into than thoſe of amber. Its great weakneſs is doubtleſs the cauſe. Barchuſen and Boulduc, the elder, are the

3. With *calcareous* or *ponderous* earths, it forms cryſtals very difficult of ſolution.

4. With the *argillaceous* earth it likewiſe forms cryſtals. But its combination with magneſia has a gummy or gelatinous appearance.

5. This acid diſſolves metals when they are well dephlogiſticated, that is to ſay it diſſolves the metallic calces; and forms with them ſalts that do not deliqueſce.

6. It has a ſtronger affinity to the *calcareous*, *ponderous* and *muriatic* earths, than to *alkalis*: ſo that the former attract this acid from ſolutions of the ſalts into whoſe compoſition theſe laſt enter.

7. But among the three juſt mentioned earths its attraction to the *ponderous* is the greateſt; as this earth will diſengage that acid from its combination with either of the others.

8. *Lime-water* precipitates nothing from the ſolution of *ponderous* earth with this acid: but it ſhews a ſufficient indication of this kind when added to magneſian ſuccinous ſalt in ſolution.

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the two firſt who obſerved the volatile ſalt of amber which was formerly taken for an alkali, but it poſſeſſes all the properties of a true acid. *Mongez.*

SECT. 167. (Additional.)

Aerial acid, or *fixed air*. Acidum aereum. *Lat* [a].

This acid is found either in an aerial ſtate, as in ſubterraneous caverns, wells, and coal as well as other mines, where it is called *Choak damp*,

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[a] The diſcovery of the *aerial acid* dates from the year 1770, when Profeſſor Bergman publiſhed it in Sweden, whilſt Dr. Prieſtley was making in England his numerous and important diſcoveries on this and other aerial ſubſtances, which have opened a new field of the utmoſt extent leading to the moſt abſtruſe receſſes of the operations of nature, entirely unknown to, or even unſuſpected by the philoſophers of all preceding ages. Many were the objections to the exiſtence of any acid in this kind of air, which has been called *fixed air*, ſince Doctor Black of Edinburgh had diſvovered its exiſtence in a fixed ſtate in alkaline ſalts, chalk, and other calcareous ſubſtances. But my late ingenious and worthy friend, Mr. Bewly, of Great Maſſingham, fully demonſtrated that this aerial ſubſtance is a peculiar and diſtinct acid fluid *ſui generis*, although by its ſubtle and rarified form, when uncombined, it cannot be ſhewn as eaſily as other ſtrong acids, by the common ſalts generally imployed in ſimilar inquiries.

The preſent method for obtaining this aerial acid diſengaged from chalk or other ſubſtances with which it is combined, is ſo generally known after theſe few years among thoſe who practiſe philoſophical experiments that I forbear to deſcribe it. I'll notice, however, that to get pure *aerial acid*, by the uſual method, the pellucid calcareous ſpar of Section 10 is to be employed, coarſely powdered, and mixed with diſtilled *damp*, and exiſts tolerably pure in the famous *Grota del cane* near Naples; or combined with mineral water [*b*], abſorbent earths, or ores, &c. &c [*c*].

1. Its ſpecific gravity, in its aerial form, is 0,0018 [*d*].

2. *Fixed*

ſtilled water, to which pure vitriolic acid is to be dropped, little by little, to expel the aerial acid, taking care that no heat be generated in the operation. Any other ſtrong acid will alſo expel the *aerial* one, but both the *nitrous* and the *marine acids* are apt to be volatiliſed partially, and their vapour will mingle with the *aerial acid*. Even the vitriolic acid will mix with the aerial, if it is ſtrong enough to generate conſiderable heat: but in this caſe it may be ſeparated, by cauſing the aerial acid to paſs ſlowly through a proper quantity of water, that is to ſay, in ſmall bubbles through it; becauſe the water will abſorb the *vitriolic* part more readily, than the *aerial acid*, which however will alſo be a little diminiſhed in its quantity by combining with the water in this operation. *Editor, from Bergman.*

[*b*] When the aerial acid is abſorbed by common pure water ſomewhat above an equal bulk of this laſt (which is chiefly obtained by the proceſs mentioned in the laſt Note *a*) the ſpecific gravity of this aerated water is as 1,0015 to 1,0000, the thermometer being about the 35th or 36th *degree* of Fahrenheit. *Berg.*

[*c*] Fixed air may be expelled with efferveſcence by a ſtronger acid (See Note *q.* to pag. 17); or by a ſtrong heat, from bodies where it is contained: and finally it may be extricated by fermentation. *Edit.* from *Berg.*

[*d*] Aerial acid, or fixed air, being about one and a half times heavier than common air, is the heavieſt of all the aeriform ſubſtances we know. Profeſſor Bergman ſays, that when the barometer ſtands at a mean height, and the thermometer at 15 degrees of the Swediſh ſcale (anſwering to 59 of Farenheit) the ſpecific gravity of aerial acid is = 0,0018, relatively

2. *Fixed air*, or *aerial acid*, excites a diſtinct ſenſation of acidity on the tongue.

3. It reddens the tincture of turnſole.

4. It attacks fixed alkalis violently, and renders them mild, leſs ſoluble, and cryſtallizable.

5. In its union with volatile alkali, this laſt becomes more fixed, leſs odorous or penetrant, and cryſtallizes.

6. When combined with pure calcareous earth to the point of ſaturation, it takes away its ſolubility in water together with its cauſticity: and cryſtallizes it. But when it is ſuper-

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relatively to diſtilled water, whilſt that of common air is only =0,0012. The following Table is given, as the real weight of one cubic inch of each kind of the principal different airs, we are now acquainted with: but it muſt have been calculated upon experiments made in different temperatures from thoſe which gave to Profeſſor Bergman the above proportion, there being ſome variety in the relative weights; otherwiſe the weight of a cubic inch of aerial acid ſhould be 0,5775 in the table, inſtead of 0,570.

A cubic inch of	weighs grains
Inflammable air —	0,305
Phlogiſticated air by nitrous air —	0,377
Atmoſpheric air —	0,385
Nitrous air —	0,399
Dephlogiſticated air -	0,420
Aerial acid, or *fixed air*	0,570

abundant

abundant, it renders the lime again ſoluble [e].

7. The ſame effects are produced by the *aerial acid* on *ponderous earth.*

8. It produces a neutral cryſtallizable earthy ſalt, when united with *magneſian earth.*

9. With iron, zink, and mangeneſe, it forms ſalts, which, when diſſolved in water, redden the tincture of turnſole, like all other metallic ſalts.

10. When combined, almoſt every other acid diſlodges it from the ſubſtance it is combined with: provided it be at liberty to aſſume its elaſtic aerial form; which ſhews it is a ſubtle, but very weak acid.

11. It exerts elective attractions, both ſimple and double, as other acids do.

12. It precipitates ſubſtances diſſolved in pure alkalis.

13. Notwithſtanding its extreme volatility, it is very difficult to diſengage it totally from water by boiling [f].

14. It

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[e] Let a ſmall portion of lime water be dropped into water impregnated with aerial acid, ſlight clouds are immediately formed, by the ſaturation of the lime with the fixed air. Theſe clouds however diſappear upon gently ſhaking the veſſel, becauſe the lime is again diſſolved by the ſuperabundant aerial acid, with which the water is combined. *Editor*, from *Bergman* de Acido Aereo.

[f] Water ſo impregnated will eaſily part with great part of this acid, in proportion as it is heated. But it will require

14. It ſtrongly attracts phlogiſtic ſubſtances [g].

15. Its bulk is doubly expanded by ether: but if this increaſed vapour be paſſed through water, it then returns to its former magnitude and qualities.

16. The aerial acid prevents fire from being kindled, ſo as to prevent the exploſion of bombs and fire arms. It even inſtantaneouſly extinguiſhes red-hot and flaming bodies.

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to boil for half an hour before it parts with the whole. This aerated water has an acidulous taſte, but when near the freezing cold its taſte is leſs ſenſible. If proper ſalts and other ingredients are mixed with theſe waters, the beſt and moſt wholſome artificial waters are produced at home, far exceeding the natural and more celebrated mineral ſprings of Pyrmont, Aix-la-Chapelle, &c. &c. ſee Bergman's treatiſe on the ſubject, from whence I chiefly collected what I have publiſhed in a pamphlet intituled Deſcription of a glaſs apparatus for making the *beſt Mineral Waters*, &c. the ſecond edition of which was printed in London, 1783, in 8vo.

[g] A bottle of fixed air being plunged in ſpirit of wine, with its mouth downwards under the ſpirit of wine, this laſt will be found to abſorb in a temperature of about 50 *d. gr.* of Fahrenheit, the double of its own bulk of *fixed air*. Oil of olives abſorbs above its own bulk of the ſame, in the ſame circumſtances. From whence it appears, that covering the ſurface of any fluid with oil, does not prevent it from abſorbing *aerial acid.* Oil of turpentine abſorbs the double of its own bulk of the ſame *fixed air*.

N. B. This great affinity with phlogiſton ſeems to be the foundation of that quality which *fixed air* poſſeſſes of retarding putrefaction in dead fleſh. *See Sir William Lee's experiments, in the 4th Vol. of Dr. Prieſtley's Works on this ſubject, pag.* 461. The Editor.

17. It kills animals, if ſurrounded or immerſed ſo as to breathe therein. Even water impregnated with fixed air is fatal to fiſhes.

18. *Aerial acid* or *fixed air* ſeems to be produced by the union of *phlogiſton* and *dephlogiſticated air. See the Remarks of Mr. Kirwan, read to the Royal Society on the 5th of February,* 1784, *and printed in the Philoſophical Tranſactions of that year.*

THE SECOND ORDER.

SECT. 168. (135.)

Alcaline Mineral Salts, *Alcalia Mineralia* [a].

Theſe are known by their action on the above-mentioned acids, when they are joined together,

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[a] Alkalies are known by their peculiar lixivial urinous taſte, by their vehement attraction to acids, and by their changing the blue colours of vegetables to the green. In a pure ſtate, as was before obſerved of acids, their attraction to other ſubſtances is ſo ſtrong that they cannot long remain uncombined; and if other acids were wanting, the aerial acid, every where preſent in the atmoſphere, would unite with them: therefore they are always found in a ſtate of combination, unleſs prepared and preſerved by art.

New acids are daily detected, but no additions have been made to the three ſpecies of alkaly long ſince known. *Berg.*

Alkalis in general appear to be ſubſtances of much greater ſimplicity than acids, becauſe they are much more difficult to be decompoſed. When they are placed on the tongue, they develope an urinous and burning taſte. They powerfully attract the humidity of the air, and readily unite with water. At the moment of mixture, heat is produced; though on the contrary, they generate cold when added to ice. We have remarked in the acids a very great tendency to combination: the alkalis poſſeſs it alſo to nearly the ſame degree of energy. Whence the extreme difficulty of meeting them naturally pure. *Mongez.*

Alkalis

together, whereby a fermentation ariſes, and a precipitation enſues of ſuch bodies as either of them had before kept in diſſolution, uniting

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Alkalis are of two ſorts, fixed or volatile: the fixed are either of vegetable or of mineral origin, and differ in ſome properties.

It muſt be obſerved that ſome vegetables afford alſo an alkali intirely ſimilar to that of mineral origin; particularly marine plants, or thoſe which grow near the ſea.

Neither of the fixed alkalis is ever found in a cauſtic ſtate; but all are combined with the aerial acid. They then effervesce with moſt other acids.

Alkalis turn infuſions of the blue flowers of certain vegetables green (ſee the Note to page 278); cryſtalliſe with the three ancient acids, &c. *Kirwan.*

The difference between *mild* and *cauſtic* alkalis, conſiſts only in *being* or *not being* combined or at leaſt partly ſaturated with *aerial acid*, viz. *fixed air*. This ſubſtance is ſo generally found and even produced every where in phlogiſtic proceſſes continually going on in the great laboratory of Nature, that, it is no wonder that alkalies are generally found in a mild ſtate. To obtain them free from ſuch a combination, or in other words to render them *cauſtic*, artificial means muſt be employed, either by offering another baſis which has a greater attraction to the *aerial acid*, ſuch as the calcareous earth, already deprived of it by calcination, &c. or by expelling it from them by fire itſelf, the moſt powerful of all agents in chemical proceſſes.

Various have been the opinions about cauſticity among chemical philoſophers. Theſe may be ſeen in Macquer's Dictionary; but ſince Dr. Black's Theory is now ſo well eſtabliſhed, and already adopted by all rational philoſophers, it would be a very uſeleſs taſk to enter into any explanations of the abſorbed *pure fire* of Lemery, or the *acidum pingue* of Meyer.

But the eſſential difference between acids and alkalis, is hardly to be underſtood, but from their particular actions on different ſubſtances: there is no doubt but theſe reſpective actions ing at the ſame time together, by which new compoſitions are made, that are called neutral ſalts, or *ſalia neutra.*

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actions are produced by their proper powers of attraction, which in alkalis ſeems to be modified to a certain degree of activity below that of mere acids. We may complain indeed of the deficiency of our knowledge in regard to the eſſential cauſe of this phenomenon which we mean to explain by the word *attraction*; but it being the ultimate effect our knowledge can reach to, after our obſervation has been driven from cauſe to cauſe of all that we can diſcern in nature, we muſt reſt contented with the ſimple deductions from ſuch an evident and general principle, whatever may be its original cauſe.

When I am told that the effects of attraction depend from a *tendency* of the parts of matter to one another, or from that *avidity* or *eagerneſs*, with which they endeavour to unite together, expreſſions ſo often repeated among modern theoriſts, I cannot help thinking of thoſe poetical ideas given by Plato in his *Convivium*, where man and woman are ſaid to be at firſt united together in a ſingle body. But, being ſeparated afterwards by the hand of deſtiny, theſe mutilated beings find themſelves now ſituated in a diſſatisfied poſition, anxiouſly deſiring to recover their former union. Theſe emblematic fictions of a poetical imagination may produce a good effect to draw up the moral picture of human affections: but they neceſſarily miſlead our attention from the true inveſtigation of natural phenomena, by the falſe colours they beſtow upon thoſe facts which flow from phyſical cauſes, and which alone can lead us through philoſophical diſquiſitions. Let us then baniſh for ever from philoſophical inquiries thoſe childiſh expreſſions of *tendency*, *avidity* and *eagerneſs* to reciprocal union, &c. all which ſuppoſe a deliberate action of living and ſenſible beings; and let us ſimply employ the words of attraction or *attractive powers*, to ſignify thoſe *effects* or *actions* between inanimate ſubſtances, by which they follow the impulſe of their natural energy, whenever they are within the ſphere of each other's action. *The Editor.*

SECT.

SECT. 169. (Additional.)

Vegetable fixed Alkali. Alkali fixum vegetabile. *Lat.* [*a*].

A. Vegetable fixed alkaly, deprived of every acid, is not found on the face of the earth; but it is ſometimes met with, in combination with the vitriolic acid or the muriatic, generally with the nitrous, rarely with the aerial [*b*].

The

[*a*] With regard to the origin of the vegetable fixed alkali, there are ſufficient proofs that it exiſts already formed in plants, (*See note* (a) *to Sect.* 174.): and alſo that a portion is formed by combuſtion. But in each caſe the alkali is obtained in an impure ſtate through the admixture of other matters which muſt be ſeparated before it can be uſed for chemical purpoſes.

The *cendres gravelées* are made by burning the huſks of grapes and wine lees. They contain the pureſt alkali met with in common, and are uſed by the dyers.

Potaſh is made by burning wood and other vegetables. This alkali is much phlogiſticated; and contains many foreign and ſaline matters, which however may be ſeparated.

That which is obtained from the aſhes of wood burned in kitchens, is the moſt impure of all.

On the contrary that which is got from tartar of wine, properly burned, then diſſolved in boiling water and purified by filtration and cryſtalliſation, is called *ſalt of tartar*. It is the beſt and moſt uſed in all chemical operations. *Macquer.*

[*b*] The *vegetable alkali* is ſeldom found in the earth, except in wells of towns, as at Doway: or in the argillaceous alum-

The fixed vegetable alkali (or *potaſſe* of Morveau) is of a powdery appearance and of a dead white colour. When pure, it is much more cauſtic than the neutral ſalt it forms with the aerial acid: and even corrodes the ſkin [c].

1. It changes the blue colours of vegetables into a deep green.

2. It has no ſmell when dry, but when wetted it has a ſlight lixivious odor.

3. Its taſte is ſtrongly acrid, burning, cauſtic, and urinous [d]. This laſt ſenſation ariſes from the volatile alkali it diſengages from animal ſubſtances.

4. When expoſed to the air, it attracts humidity, and is reduced into a tranſparent colourleſs liquor. According to Gellert, it attracts three times its own weight of water.

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alum-ore of *la Tolfa*: it is found alſo united to the nitrous acid near the ſurface of the earth in *Spain*, and in the *Eaſt-Indies*, probably from the putrefaction of vegetables. *Kirwan.*

[c] Common vegetable alkali, ſalt of tartar, and potaſh were formerly conſidered by chemiſts as ſimple alkalis: but Dr. Black of Edinburgh has demonſtrated them to be true neutral ſalts, ariſing from the combination of the vegetable alkali with the *aerial acid*. From hence it follows that the above common alkalis, even after any other extraneous ſubſtance has been extracted, muſt be freed from this acid by putting each in a crucible, and expoſing it to a ſtrong fire, which will diſſipate this aerial acid. The alkali ſo purified, is to be put in a glaſs phial, before it is intirely cold, and kept cloſe with a proper ſtopple; otherwiſe the aerial acid which floats in large quantities on the atmoſphere, will combine again with the pure alkali. *Mongez.*

[d] The alkali muſt be largely diluted with water in order to be taſted: otherwiſe it will act on the tongue, and corrode the parts where it touches. *Macquer.*

5. It likewiſe attracts ſometimes the aerial acid from the atmoſphere, and is thereby deprived of its property of deliqueſcing.

6. When it is diſſolved in an equal weight of water, it has an oily feel, owing to its action on the fatty parts of the ſkin, whence it is, though improperly, called oil of tartar.

7. In a moderate heat it melts: but in a more violent fire, it is diſperſed or volatilized.

8. It is a moſt powerful ſolvent by the *dry way:* in a proper heat it diſſolves *calcareous*, *argillaceous*, *ſiliceous* and *metallic* earths: and when the alkali is nearly equal in quantity to the earth, it forms various kinds of hard ſolid and tranſparent glaſs.

9. But if the alkali be in quantity three or four times that of the earth, the glaſs is deliqueſcent.

10. The mild vegetable alkali unites with the vitriolic acid with a violent effervefcence, and produces vitriolated tartar.

11. With the nitrous acid, it forms the cryſtallizable ſalt, called *nitre.*

12. With the marine acid it forms a kind of ſalt leſs grateful than common ſalt, which is called the *febrifuge ſalt of Sylvius.*

13. With vinegar it forms a neutral deliqueſcent ſalt of a ſharp taſte, called *terra foliata tartari.*

14. With cream of tartar it forms *tartarized tartar.*

15. It diſſolves ſulphur, and forms the ſubſtance, called *liver of ſulphur*, which is a powerful ſolvent of metallic ſubſtances.

17. It

17. It attacks the metals, and diſſolves ſome of them with peculiar management. Silver, mercury, and lead, are more difficultly diſſolved than gold, platina, tin, copper, and eſpecially iron. The laſt gives a fine reddiſh ſaffron colour, firſt obſerved by Stahl who called it the *martial alkaline tincture.*

18. It diſſolves, in the dry way, all the dephlogiſticated metallic calces.

19. It unites with oils and other fat ſubſtances, with which it forms ſoap.

20. This alkali becomes opaque when expoſed to the flame of the blow-pipe: it decripitates a long time, and forms a glaſſy button which is permanent in the little ſpoon; but is abſorbed with ſome noiſe on the charcoal, when blown upon it.

See Note b *to the following Section, for an account of the cryſtalline figure of this vegetable alkali.*

SECT. 170. (136.)

Mineral or foſſil fixed alkalis, Alcalia mineralia fixa. *Lat.*

B. Alcali of the ſea, or of common ſalt, *Alcali ſalis communis, propriè minerale dictum* [a].

1. Pure, *Purum.*

This has nearly the ſame qualities with the lixivious ſalt, which is prepared from the

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[a] 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 glaſs: 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 contain 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. *The Author.*

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 loſt its acid [b].

The

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[b] The mineral alkali is often combined with the *vitriolic* and *marine* acid, and alſo with the *aerial acid*, with which laſt it retains not only the name, but many of the properties of a pure alkali, becauſe this laſt acid is eaſily expelled.

It is eaſily known by its cryſtalliſation and its ſolubility in *two times and a half* of its weight of water at the temperature of ſixty degrees.

One hundred parts of this alkali when pure, and recently cryſtalliſed, contain twenty of mere alkali, ſixteen of *aerial acid*, and ſixty-four of water. *Kirwan.*

The cryſtals of *mineral alkali*, when perfect, have a rhomboidal octaedral figure, compoſed of two pyramids joined by their baſes, ſomewhat ſimilar to the cryſtals of ſulphur, but more flattened, and with the angle, formed at the common baſe of the two pyramids, leſs ſharp. However the moſt common figure of theſe cryſtals is a rhombic oblique-angled decahedron, reſulting from the abſence of the two upper corners or tops of the pyramids. Some of theſe cryſtals are figured alſo in rhomboidal octahedrons, conſiſting of two wedge-form pyramids joined by their baſes; each conſiſting of two ſcalene triangles, and two trapezoides.

But the cryſtals of the *vegetable alkali*, which are only produced when ſaturated with the *aerial acid*, have the priſmatic figure of an oblong rectangular octahedron, terminated by the baſes of two triangles, which form a wedge at each end. There are however ſome other varieties in the configuration of theſe as well as almoſt all other cryſtals, which juſtify what I have ſaid elſewhere (Note *a* to page 164) about the little or no dependence at all on the configuration of mineral bodies, to conſtitute their ſpecific characters. Theſe various configurations

The properties of the mineral alkali [c] are as follows:

1. It effervefces 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 and forms ſoap.
5. Diſſolves the ſiliceous earth in the fire, and makes glaſs with it, &c. It diſtinguiſhes

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rations of the alcaline cryſtals may be ſeen in the *Criſtallographie* of Mr. Romé de l'Iſle, vol. I. page 142, and following of the ſecond edition.

The ſame Author in that very elaborate work (in which his great prejudices have very often run away with his diſcernment) ſpeaks about the tranſmutation of alkalis into one another; and quotes ſome authorities to eſtabliſh its exiſtence. But until ſuch proceſſes are better aſcertained, than thoſe hinted by various Authors about the metamorphoſis of the three principal acids already mentioned in the Note to p. 294, every one is entitled to draw the ſame concluſion I have there expreſſed. *The Editor.*

Mineral alkali is found in *Hungary* in marſhy grounds, of an argillaceous or marly nature, either mixed with water, or cryſtallized and effloreſcing. It is found alſo in *Egypt* at the bottom of lakes, and dried up by the ſummer's heat: and alſo in the province of *Suchena*, twenty-eight days journey from Tripoli, where it has the name of *Trona*; in Syria, Perſia, as well as in the Eaſt-Indies and China where it is called *Kien*.

It ſometimes germinates on walls, and is called by many *Aphronitron*. In its native ſtate, is frequently mixed with magneſian earth, common ſalt, muriatic magneſia, and marine ſelenite. *Kirwan*

[c] *See Note* a *to Sect.* 174 *concerning the* exiſtence of alkalies *in vegetables*, *before their* combuſtion and incineration.

guiſhes itſelf from the ſalt of the pot-aſhes, by the following properties [d].

6. It ſhoots eaſily into rhomboidal cryſtals, that
7. Fall to powder in the air, merely by the loſs of their humidity [e].
8. Mixed with the vitriolic acid, it makes the *ſal mirabile Glauberi.*
9. It melts more eaſily, 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.

SECT.

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[d] This mineral alkali likewiſe differs from the vegetable. 1. By its taſte, which is leſs corroſive and burning. 2. By its not deliqueſcing. 3. By the ſmall degree of heat it produces if calcined and afterwards added to water. 4. By its property of cryſtallizing by evaporating the water from its ſolution as is practiſed with neutral ſalts, whereas the vegetable alkali does not cryſtallize unleſs combined with a large portion of aerial acid.

[e] This alkali being a very uſeful commodity, and eſſentially neceſſary in a number of manufactories, many ingenious proceſſes have been contrived and attempted to procure it at a cheap rate by decompoſing the ſea ſalt: but I am informed that till now none of theſe new manufactures have ſucceeded, except that of Mr. Turner, mentioned by Mr. Kirwan in the ſecond part of the Philoſophical Tranſactions for 1782. I am informed that the proceſs conſiſts in mixing a quantity of litharge with half its weight of common ſalt, which on being triturated with water till it aſſumes a white colour, is left to ſtand ſome hours; after which a decompoſition enſues, the alkali being left alone, whilſt the acid unites to the metalic calx: and this laſt being urged by a proper degree of fire, produces a fine

S E C T. 171. (140.)

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 [a].

Its

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a fine pigment of a greeniſh yellow colour, whoſe ſale pays for the moſt part of the expences.

Mr. Kirwan ſays in the place already quoted, that if perfectly dry common ſalt be projected on lead heated to incandeſcence, the common ſalt will be decompoſed, and a *horn-lead* formed, according to Margraff. He adds alſo, that according to Scheele, if a ſolution of common ſalt be digeſted with litharge, the common ſalt will be decompoſed, and a cauſtic alkali produced. And finally that the ſame Mr. Scheele decompoſed common ſalt, by letting its ſolution ſlowly paſs through a funnel filled with litharge. *The Editor.*

[a] Volatil alkali is frequently found in clays, doubtleſs in a mild ſtate, as the help of art is required to render it cauſtic. It is alſo found united to the vitriolic, and to the muriatic acids. *Berg. Sciagr.*

It is eaſily known by its ſmell, though in a mild ſtate; by its volatility; and by its action on copper, the ſolutions of which in the mineral acids, are turned blue by an addition of this alkali. It is frequently found, though in ſmall quantities, in

mould,

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*].

b. It precipitates the ſolution of the mercurial ſublimate, in a white powder.

c. It alſo precipitates gold out of *aqua regia*, and detonates with it, becauſe

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mould, marl, clay, ſhiſtus, and in ſome mineral waters. It probably derives its origin in the mineral kingdom, from the putrefaction or combuſtion of animal or vegetable ſubſtances. *Kirwan.*

The ſame is cauſtic when uncombined with any *acid*, not excepting even the *aerial acid.* It differs from the other two alkalies in many eſſential particulars. 1. By its aeriform or gaſeous nature. For, the volatile alkali, in a ſtate of purity, is nothing more than an alkaline Gas diffuſed in water, as Dr. Prieſtley has demonſtrated. 2. By its volatility. 3. By the nature of the ſalts it forms with acids, which are very different from thoſe whoſe baſes are formed either of the vegetable or mineral alkali. *Mongez.*

[*b*] Pure volatile alkali in an aerial form reſembles atmoſpheric air, but is more heavy. Its ſmell is penetrating and ſuffocates animals. Its taſte is acrid and cauſtic. It quickly converts blue vegetable colours to green, and produces heat during its combination with water. But if the water be frozen, it melts, producing at the ſame time an extreme degree of cold. It has a remarkable action on moſt metals, particularly copper.

This ſubſtance is obtained by the putrefactive fermentation from animal and ſome vegetable matters. It is this ſalt which cauſes that ſtrong ſmell which is perceived in drains and privies on a change of weather. *Mongez.*

Its volatility ariſes from a very ſubtile and volatile (or phlogiſtic) oil which enters as a principle into its compoſition. *Macquer.*

d. It

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 [*c*].

f. It deflagrates with nitre, which proves that it contains a phlogiſton.

It is never found pure.

[*c*] The ſolution of copper by this alkali, which is of a fine blue, preſents a remarkable phenomenon. For if it be kept in a well cloſed phial, the colour decays, and at length diſappears, giving place to tranſparency. But on opening the phial, the ſurface or part in contact with the air becomes blue and the colour is communicated through the whole maſs. This experiment may be many times repeated with the ſame ſucceſs. *Editor* from *Macquer.*

Query. Is it the *phlogiſton* of the air, or its *acid*, that produces this phenomenon? if either, or both, how can it vaniſh through the glaſs, and not be able to come in, unleſs the ſtopple be removed? does this not prove, that light and phlogiſton are the very ſame ſubtle ſubſtance, but variouſly modified, viz. capable of pervading in a more or leſs quantity through glaſs, uniting to ſome ſubſtances, or flying off, according to various circumſtances: and producing a variety of effects according to its denſity? *The Editor.*

THE THIRD ORDER.

SECT. 172. (Additional.)

Neutral Salts. Sales neutrales. Sales medii.

ACIDS united to *alkalies* form neutral ſalts. Theſe diſſolved in water are no ways diſturbed by the addition of an alkaly: and generally by evaporation, concrete into cryſtals. If by proper teſts they ſhew neither acid nor alkaline properties, they are ſaid to be *perfect* neutrals; but *imperfect*, when from defect in quantity or ſtrength of one ingredient, the peculiar properties of the other more or leſs prevail. *Bergm. Sciag.*

The name of *neutral* given to theſe ſaline combinations, is relative to the reciprocal ſaturation of the acid and its baſe. Thoſe produced by the union of an acid and a fixed alkali, are in a ſtate of more abſolute ſaturation than thoſe which have a baſe of volatile alkali; and theſe laſt are ſtill more ſaturated than ſalts with an earthy baſe [a]. There are however ſome exceptions,

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[a] When a ſubſtance is ſaid to be *united* to, or *combined* with another ſubſtance, it muſt be underſtood that both are joined

ceptions, as for inſtance *ſelenite* which has a very complete ſaturation of its principles.

Laſtly the neutral metallic ſalts are moſt commonly the leaſt ſaturated of all, and conſequently it is among them that the greater number of corroſive, active, and deliqueſcent ſalts are found.

But it is obſervable, that theſe properties do not follow any ſettled proportion of their coherence and ſaturation. For it is ſeen that corroſive ſublimate is much leſs ſoluble than marine ſalt, and at the ſame time its corroſive quality or action on many bodies is vaſtly greater. *Macquer.*

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joined by the ſtronger power of *attraction*: but when it is ſaid that they are *contaminated* by, or *mixed* with one another, it is only ſignified that their mixture is of the mechanical kind. *Berg. Sciag.* § 103.

SECT. 173. (Additional.)

Vitriolated tartar. Alkali vegetabile vitriolatum. *Lat.*

The vitriolated vegetable alkali, or as Morveau calls it the *vitriol* of *potaſh*, is a perfectly neutral ſalt which reſults from the combination of the vitriolic acid with the vegetable fixed alkali. According to Bergman it ſeldom occurs ſpontaneouſly in nature, unleſs where tracks of wood have been burnt down: and Mr. Bowles quoted by Mr. Kirwan, ſays it is contained in ſome earths in Spain.

1. It requires about ſixteen times its weight of water to diſſolve it in the temperature of ſixty degrees of Fahrenheit, and only five of boiling water.

2. It forms non-deliqueſcent permanent cryſtals [*a*].

3. It decrepitates when heated, but loſes little of its weight [*b*].

[*a*] This ſalt being expoſed to extreme heat melts, and at length volatilizes, but without decompoſition. *Mongez.*

[*b*] Expoſed ſuddenly to the flame of the blow pipe it decrepitates with noiſe, melts, flows on the charcoal, and leaves a yellow reddiſh matter which emits an hepatick ſmell, eſpecially if it be melted with any acid. This maſs is a true ſulphur produced by the vitriolic acid and the phlogiſton of the coal. The vegetable alkali reacting on this ſulphur produces the hepar ſulphuris. *Mongez.*

4. It

4. It is of very difficult fuſion, and precipitates the nitrous ſolutions of *ſilver*, *lead*, *mercury*, and *chalk*.

5. It is not rendered turbid by the addition of an alkali; but the acid of tartar, dropped into its ſolution, forms a precipitate [c].

6. One hundred parts of this ſalt contain about thirty-one of real vitriolic acid, ſixty-three of the vegetable alkali, and ſix of water.

7. It is eaſily obtained by pouring the vitriolic acid on a ſolution of fixed vegetable alkali till it is ſaturated. Cryſtals of this neutral ſalt are then formed. This cryſtallization ſucceeds better by evaporation than by cooling, according to *Mongez*.

8. The taſte of this ſalt is diſagreeable, tho' ſomewhat reſembling common ſalt.

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[c] Almoſt all the acids act on vitriolated tartar, and decompoſe it, as well as combuſtible matters, eſpecially charcoal. It has no action on ſimple earths. *Mongez*.

SECT. 174. (Additional.)

Common nitre. Alkali vegetabile nitratum.

This is known in commerce by the name of *ſalt-petre*, and is alſo called *priſmatic nitre*, to diſtinguiſh it from the *cubic nitre* of Sect. 178. It is a *perfect neutral ſalt*; reſulting from the combination of the nitrous acid with the pure vegetable alkali of Sect. 169.

According to Bergman in his *Sciagraphia*, it is formed upon the ſurface of the earth where vegetables, eſpecially when mixed with animal ſubſtances, putrify. The alkaline baſis previouſly exiſts in the plants [a], but the origin of the

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[a] My late worthy friend, Mr. Rouelle, demonſtrator of chemiſtry at the *Jardin Royal* at Paris, and himſelf a chemiſt of the firſt eminence, evidently proved in two papers of his, read at the Royal Academy of Sciences of Paris in 1770, that both the vegetable and mineral alkalies naturally exiſt ready formed in vegetable ſubſtances before their combuſtion and incineration. The famous Mr. Margraaf had indeed publiſhed the ſame diſcovery, before Mr. Rouelle, without any knowledge of his labours on this ſubject: but this laſt communicated them, long before that publication appeared, to Meſſrs. Venel, Roux, and d'Arcet, having begun to work on this matter as early as the year 1748 (ſee Journal de Phyſique for January 1773, page 13, and following). The late Mr. A. Leroy in 1780 endeavoured by ſpecious arguments to overthrow the concluſions of Mr. Rouelle; but Mr. Berniard a very able chemiſt at Paris confuted his falſe reaſonings, by direct inferences,

the acid is not ſo well underſtood, viz. whether it lies concealed in the vegetable acid, and by means of the putrefactive proceſs ſufficiently dephlogiſticating it, is evolved; or whether the purer part of the atmoſpheric air contains nitrous acid *fully* ſaturated with phlogiſton, which upon the alkaly being ſeparated by the putrefaction is attracted and extricated by it, and upon loſing its inflammable principle aſſumes its accuſtomed form. Nature perhaps operates in both ways; the latter however ſeems clearly confirmed by a remarkable phenomenon to be mentioned in Sect. 190.

As nitre is annually produced in large quantities, it cannot but ſometimes be found in ſprings or wells, as has been obſerved at Berlin [b], London [c], and elſewhere [d]. Sometimes

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ferences, from a variety of judicious proceſſes, made jointly with the celebrated profeſſor of chemiſtry at the Royal College of Paris, Mr. d'Arcet, brother in law and intimate friend of the ſaid Mr. Rouelle, by which the truth of his aſſertions was compleatly eſtabliſhed. *See Mr. Berniard's Memoir in the* Journal de Phyſique *of March* 1781, *page* 179, *and following*. The Editor.

[b] *Margraf Opuſcula*, quoted by Bergman in his Sciagr. Sect. 45.

[c] Cavendiſh in the Phil. Tranſact. for 1767 quoted by the ſame.

[d] Dr. Home, in his eſſay on Bleaching, ſays that nitre is found in coal mines in this iſland: and a friend aſſures me that he has obtained it from the water iſſuing out of coal pits. *Dr. Withering*.

Nitre is ſaid to be found formed by nature on the ſurface of maſſes of chalk in the neighbourhood of *Rocheguyon* in France, times it abounds in ſuch quantities that fleſh boiled in theſe waters turns red [e].

According

France, and in certain clays in the *Eaſt-Indies*, *China*, *Spain*, and in *Siberia*, in the cavities of rocks. *Kirwan.*

"Nothing is more certain (ſay Meſſrs. Van Egmont and "Heyman at page 149 of the ſecond volume of their Travels, "printed in 1759,) than that ſalt-petre is found in all the "parts (of Egypt) which the inundation of the Nile reaches; "but it is alſo ſeen in places, to which the water of that river does not extend. In ſeveral (of them) the ſurface of "the earth is whitiſh; whereas on others, the only difference is in a ſaltiſh taſte. Salt-petre can likewiſe be extracted from it, by only ſifting and macerating it in water, "then boiling it in a copper like ſugar; the ſediment is the "ſalt-petre uſed all over Egypt.

"The places where this earth is found, are conſidered as "mines, and belong to the Grand Signior, and are worked on "his account; ſo that any perſon embezzling it, is ſeverely "puniſhed. In going to Cairo are ſeveral villages along the "Nile, the chief employment of which is to make the ſalt-petre. The province of Saide particularly abounds in ſalt-petre, and it is an ingredient in all the gun-powder made "in Egypt."

Nitre is found very frequently in old mortar; ſometimes it ſhoots on the ſurface of damp walls, and is then called by the French *ſalpetre de houſſage*: but old mortar often contains only nitrous ſelenite, which is converted into true nitre by mixture with aſhes, though thoſe aſhes contain a large proportion of *vitriolated tartar* and *Glauber's ſalt*; becauſe theſe ſalts decompoſe the calcareous ſelenite, and form nitre by the way of double decompoſition. *Kirwan.*

[e] This property of ſalpetre is well known to our Engliſh cooks, who employ it often for giving that agreeable lively red look to boiled meat ſerved at table. This is a particularity not ſeen in the tables abroad, where ſuch a ſight would be looked upon as an indication of a ravenous taſte for raw fleſh, like that of wild carnivorous animals. So oppoſite are the ideas of beauty or deformity, of the agreeable or the diſguſting

According to Mr. Kirwan, one hundred parts of nitre contain about thirty of *nitrous acid*, ſixty-three of *vegetable fixed alkali*, and ſeven of *water*.

1. This ſalt has a ſaline cooling taſte, which afterwards becomes ſomewhat diſagreeable.
2. It is ſoluble in water, and requires about ſeven times its weight of water to diſſolve it in the temperature of ſixty degrees of Fahrenheit; but half its weight of boiling water is ſufficient to diſſolve it.
3. Its ſpecific gravity is 1920.
4. Vegetable alkalies do not render its ſolution turbid: but the acid of tartar does.
5. Mixed with *marine acid* produces *aqua regia*, which diſſolves gold.
6. It melts over the fire before it be red hot: but
7. If left in this melted ſtate a long time, the acid flies off, and the alkaline baſis is left behind.
8. Expoſed to the fire with combuſtible bodies, for inſtance if an alive coal is put into it, or it is put in a red hot iron veſſel, a detonation enſues, producing a vivid white flame [*f*], on account of the dephlogiſticated

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ing which ariſe more from habits of education, than from any natural connection with their objects, among various nations, and ſets of men! *The Editor*.

[*f*] The only ſatisfactory explanation of this remarkable phenomenon, was firſt given by that indefatigable Enquirer into

phlogiſticated air contained in the nitre, which combines with the phlogiſton of the combuſtible matter.

SECT.

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into nature and moſt able philoſopher Dr. Prieſtley, in the fourth volume of his important diſcoveries on Air, page 254: he there aſcribes it to the ſudden deflagration of that new kind of air, he firſt diſcovered, known by the name of *dephlogiſticated air*, in which *combuſtible ſubſtances burn with the greateſt violence.* Mr. Chaptal, profeſſor of chemiſtry at Montpellier, ſucceſsfully purſued the ſame idea, although without mentioning Dr. Prieſtley. He affirms that the *dephlogiſticated air* contained in nitre, when urged by heat, detonates, becauſe it unites with the *phlogiſton* of the charcoal, or of the heated iron, upon which the nitre is laid: and the ſame happens when the *dephlogiſticated* air of the calx of gold or mercury, unites in a proper heat to the *phlogiſton* of the precipitating volatil alcali in the firſt, or of the ſulphur in the ſecond caſe, &c. See his account in *Journal de Phyſique*, vol. 22. page 61.

The celebrated profeſſor Bergman, in a *Diſſertation* on the fulminating calx of gold, exhibited to the Public in December 1769, and afterwards inſerted in the ſecond volume of his *Opuſcula*, explains this detonation, by the union of the calx of gold to the phlogiſton, which is let looſe by heat; and ſays, that the alkaly is thus ſuddenly expanded ſo as to make that exploſion: but he acknowledges, that the calx of platina, precipitated by the ſame volatil alkali does not detonate. This of courſe ſeems to prove that there muſt be ſome other cauſe for theſe phenomena.

Mr. Macquer, in the ſecond edition of his Dictionary publiſhed about ten years after the above diſſertation of Bergman, ſpeaks of a new *ſulphur of nitre* whoſe imaginary exiſtence has never been aſcertained, as it is ſaid to be inſtantaneouſly kindled in the very act of its formation: to this he attributes the phenomenon of detonation. He mentions afterwards the explanation of Stahl, who thought that the water, or rather the acid of nitre is violently inflamed by the ſuperabundance of

SECT. 175. (Additional.)

Digeſtive Salt. Salt of Sylvius. *Alkali vegetabile Salitum. Sal digeſtivus Sylvii.*

This neutral ſalt is ſometimes though rarely met with on the earth, generated perhaps, as profeſſor Bergman obſerves, by the deſtruction of animal and vegetable ſubſtances.

According to Macquer this ſalt has been very wrongly called *regenerated marine ſalt*: and the epithet of *Febrifuge* has alſo been given to it, without any good reaſon to evince that it has

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of the phlogiſton in the act of detonating: and finally ſays that the aeriform elaſtic ſubſtances contained in nitre, may be the cauſe of ſuch ſudden exploſions or detonations.

After all it ſeems that Doctor Prieſtley's explanation of this phenomenon purſued by Mr. Chaptal, is the better ſupported by collateral facts: but it remains ſtill to be underſtood, how the immediate action of each cauſe upon one another is performed.

Whenever we come to be better acquainted with the nature of *elementary fire*, we may in all probability account in a compleat and ſatisfactory manner for theſe and many other phenomena, in which this powerful agent of nature has undoubtedly the greateſt ſhare. And if we allow with Dr. Crawford, that phlogiſton is always expelled by the introduction of fire into thoſe bodies where it is contained, we may form ſome idea of the ſudden exploſion or detonation of theſe ſubſtances, when acted upon by it in a more intimate contact with one another. *Editor.*

has ſuch a property. But Mr. de Morveau calls it *muriate de potaſſe* with great propriety.

This ſalt is produced by a perfect combination of the *vegetable alkali* with *marine acid.* It has been wrongly confounded with common ſalt: but

1. Its flavour, though ſaline and ſharp to the taſte, is very diſagreeable.
2. Its ſpecific gravity is 1836 according to Kirwan.
3. It decrepitates in the fire, by which it alſo melts.
4. It may be volatiliſed by fire, without being decompoſed.
5. It diſſolves in three times its weight of water, either hot or cold.
6. When urged by the blow-pipe on a piece of charcoal, it exhibits nearly the ſame phenomena as common ſalt.
7. Diſſolved in nitrous acid, it makes *aqua regia.*
8. With the nitrous ſolution of ſilver, it takes a cloudy appearance.
9. The acid of tartar cauſes a precipitation from its ſolution. But
10. Neither fixed alkali, nor the mixture of marine ſelenite make any precipitation in its ſolution.
11. One hundred parts of this neutral ſalt, contain about thirty of real marine acid: ſixty-three of vegetable alkali, and ſeven of water.

It is found in ſome bogs in Picardy, and in ſome mineral waters at Normandy, according to Monet, quoted by Kirwan: Mongez adds alſo the ſea water as containing this ſalt, and that it is never found in large quantities, although its component parts are abundantly produced by nature.

SECT. 176. (Additional.)

Mild vegetable Alkali. *Alkali vegetabile aeratum.* Lat. Alkali végétal aéré. *French.*

This ſalt was formerly conſidered as a pure alkaly, known by the name of *potaſh*, and *ſalt of tartar:* but ſince the diſcovery of the *aerial acid* (Sect. 167), it is very properly claſſed among the neutral ſalts: and ought to be called *aerated potaſſe*, the epithet *aerated* indicating much better the nature of its neutraliſing acid, than the uncouth and improper expreſſion of *Mephitic* adopted by the French which always conveys a diſguſting idea of putreſcence by no means applicable to the aerial acid. But of all the languages of Europe none is ſo full of indelicate terms as that of our (ſo called) *polite* neighbours, the Italians only excepted.

This neutral ſalt reſults from a combination of the *vegetable alkali* with the *aerial acid:* and is hardly ever found native, unleſs in the neighbourhood of woods deſtroyed by fire. *See Note* a *to Sect.* 174 *concerning the exiſtence of* alkalies *in* vegetables, *previouſly to their combuſtion and incineration.*

In the year 1774, at Douai in Flanders, a ſpring was diſcovered ſurrounded by a wall, whoſe waters, beſides other impregnations, contained eleven grains of this mild vegetable alkaly in a pint.

Although this ſalt is a neutral one, it always poſſeſſes a ſuperabundance of alkaly, of which it diſplays the properties, though with leſs efficacy than pure alkalies, viz.

1. It effervesces with acids, which are ſtronger than the *aerial*, and of courſe expel it from its union with the alkali.
2. Turns green the vegetable blue colours.
3. And produces an urinous alkaline taſte in the mouth.
4. It is diſſolved in four times its weight of cold water, and in a leſs quantity if it be hot.
5. It fuſes on the fire, looſes its aerial acid, leaving behind the pure vegetable alkali.
6. It ſerves as a flux to earthy ſubſtances: and
7. Is decompoſed by the *ponderous* and the *calcareous* earths, which have a greater affinity to the *aerial acid*, than to the vegetable alkali.

8. On

8. On being expoſed, on a piece of charcoal, to the flame urged by the blow-pipe, it melts, and is abſorbed by the coal; but,
9. In the metallic ſpoon, it forms a glaſſy bead, which becomes opake when cold.

SECT. 177. (126.)

Vitriolic acid ſaturated with mineral alkali. Glauber's ſalt. *Alkali minerale vitriolatum. Sal mirabile Glauberi.* Alkali minéral vitriolé, *(or* vitriol de ſoude, *according to Mr. Morveau)* French [a].

This is a neutral ſalt, prepared by nature, (as well as by art) containing more or leſs of

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[a] This ſalt reſults from the combination of vitriolic acid with mineral alkali. Its properties come near to thoſe of *vitriolated tartar* in Sect. 173, from which it only differs on account of its baſe.

1. Its flavour is cooling, but it
2. Is of a very bitter taſte.
3. Its cryſtals, which are of various forms (all derived from a rectangular octahedral priſm, ending in a kind of a wedge at each end) effloreſce when expoſed to the air; and by heat, they loſe half their weight.
4. Melts in the fire: and when it is urged conſiderably,
5. It is volatilized.
6. It diſſolves in four times its weight of cold water; and only in three times, if in the temperature of ſixty degrees of Fahrenheit. But,

of iron, or of a calcareous earth, from which ariſes alſo ſome difference in its effects, when internally uſed. It ſhoots eaſily into priſmatical criſtals, which become larger in proportion to the quantity of water evaporated before the criſtalliſation. When laid on a piece of burning charcoal, or elſe burnt with a phlogiſton, the vitriolic acid diſcovers itſelf by the ſmell reſembling the *hepar ſulphuris.*

It is found in a diſſolved ſtate in ſprings and wells [b], and in a dry form on walls, in ſuch places where aphronitrum has effloreſced through them, and the vitriolic acid has happened to be preſent; for inſtance, where marcaſites are

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7. In warm water, it diſſolves in an equal weight.
8. The nitrous and marine acids, and even the cauſtic fixed vegetable alkali, decompoſe this ſalt, according to Bergman, on account of their double affinities.
9. On the charcoal, it is fuſed by the flame urged by the blow pipe, and leaves behind an yellow, or reddiſh maſs, (as the vitriolated tartar of Sect. 173 does) which gives out an hepatic ſmell, particularly if a little vitriolic acid be added to it. This maſs is a true *ſulphur*, produced by the vitriolic acid united to the phlogiſton of the charcoal, and by the reaction of the alkali on the ſulphur, an *hepar ſulphuris* is then produced, as its ſmell indicates.
10. According to Kirwan, 100 parts of this ſalt contain about fourteen of the real vitriolic acid; twenty-two of the mineral alkali; and ſixty-four of water.

[b] Some of the lakes in Siberia and Aſtracan, and many ſprings in other places, contain this ſalt, *Berg. Sciag.* Sect. 47. It is found in the ſea water, and alſo in the earth at ſeveral parts of *Dauphine* in France, and in *Lorraine*; and ſometimes it germinates on the ſurface of the earth, according to *Monet*, quoted by *Kirwan.*

roaſted

roaſted in the open air. This ſalt is often confounded with the aphronitrum, or mild mineral alkali; and a learned diſpute once aroſe, which of theſe ſalts ought with the greateſt propriety to be called natron, *Baurach veterum*, *ſal mirabile*, or Epſom ſalt, whereas it might eaſily have been decided by chemical experiments, if their qualities had been regarded, in preference to their figures or their native places.

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S E C T. 178. (Additional)

Cubic, or rather quadrangular Nitre. *Alkali minerale nitratum*, Lat. *nitre cubique*, French. (*Nitre de Soude* of Morveau).

This is the neutral ſalt which reſults from the combination of *mineral alkali* with *nitrous acid*. It has almoſt all the characters of *priſmatic* or *common nitre* (Sect. 174), from which it only differs on account of its baſe; and takes its denomination from the figure of its cryſtals, which appear *cubic*. But it ſhould be called *quadragular nitre*; becauſe its cryſtals are truly Rhomboidal, their obtuſe angles being of about 100 degrees, and the acute ones of 80. For want of preciſion in obſerving this ſmall difference, this nitre has been called *cubic*.

This ſalt rarely occurs, but where marine plants putrify. According to Bowles, quoted by Kirwan, it is found native in Spain.

1. Its ſpecific gravity is = 1870.
2. Expoſed to the air, it is more alterable, and attracts moiſture more powerfully than priſmatic nitre.
3. According to Mongez, it requires only twice its weight of cold water to be diſſolved: but Kirwan ſays, that in the temperature of ſixty degrees of Fahrenheit, three times its weight of water are ſufficient for its ſolution.
4. Expoſed to the flame of the blow-pipe, it melts like common priſmatic nitre, and remains fixed on the metallic ſpoon; but if put on a piece of charcoal, takes flame by the addition of its phlogiſton, making a kind of decrepitation. But, according to *Mongez*,
5. Its flame is *yellow*, inſtead of the *blue* that is given by the priſmatic nitre in ſimilar circumſtances.
6. According to Kirwan, the vegetable fixed alkali decompoſes, it, without forming a viſible precipitate in its ſolution.
7. Neither does the tartarous acid precipitate any thing from it.
8. The *vitriolic* acid expels from it the *nitrous*, and forms *Glauber's* ſalt.
9. With the marine acid, it forms *aqua regia*.

10. According to Kirwan, one hundred parts of quadrangular nitre, contain about 29 of *nitrous acid*, 50 of mineral alkali, and 21 of water.

SECT. 179. (129.)

Common Salt, or Sea-Salt. *Alkali minerale ſalitum. Sal commune*, Lat. *Sel commun, Sel de cuiſine*, French.

This ſalt ſhoots into cubical cryſtals during the very evaporation; crackles in the fire, and attracts the humidity of the air [a].

A.

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[a] This is a perfect neutral ſalt, compoſed of marine or muriatic acid, ſaturated with mineral alkali. It has a ſaline but agreeable flavour.

It requires about four times its weight of cold water to be diſſolved, and nearly the ſame quantity of boiling water. *Macq.* But according to Kirwan, it only requires 2,5 its weight of water to be diſſolved in the temperature of ſixty degrees of Fahrenheit. This ſalt always contains ſome part formed with a calcareous baſe; and, in order to have it pure, it muſt be diſſolved in diſtilled water; then a ſolution of mineral alkali is to be poured in it, until no white precipitation appears; then by filtrating and evaporating the ſolution, a pure common ſalt is produced. *Macq.*

Its figure is perfectly cubic, and thoſe hollow pyramids, or *tremies* as the French call them, as well as the parallelipipedes formed ſome times in its criſtalliſation, conſiſt all of a quantity of ſmall cubes diſpoſed in thoſe forms. *Macq.*

Its decrepitation on the fire, which has been reckoned by ſome as a characteriſtic of this ſalt, although the *vitriolated tartar*, *A.* Rock ſalt, foſſil ſalt. *Sal montanum.* Occurs in the form of ſolid ſtrata in the earth [*b*].

1. With

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nitrous lead, and other ſalts, have the ſame property, is owing chiefly to the water, and perhaps alſo to the air of its cryſtalliſation. *Macquer.*

Its ſpecific gravity is 2120. Kirwan.

The acid of tartar precipitates nothing from it.

One hundred parts of common ſalt contain thirty-three of real acid, fifty of mineral alkali, and ſeventeen of water.

It is commonly found in ſalt water and ſalt ſprings, in the proportion of even thirty-ſix *per cent.*

It is found alſo in coals, and in beds of gypſum. *Kirwan.*

This ſalt is inalterable by fire, though it fuſes, and becomes more opake: nevertheleſs a violent fire with the free acceſs of air, cauſes it to evaporate in white flowers, which ſtick to the neighbouring bodies. *Macquer.*

It is only decompoſed, as Macquer affirms, by the *vitriolic* and *nitrous* acid; and alſo by the *boracic* (or ſedative) ſalt of Sect. 165. But although nitre is decompoſed very eaſily by arſenic, this neutral marine ſalt is noways decompoſed by the ſame. *See* note *e* to Sect. 170, concerning *its decompoſition by the calx of lead.* According to Mongez, the fixed vegetable alkali, when cauſtic, decompoſes alſo this marine ſalt.

It preſerves from corruption, almoſt all ſorts of animal food much better for uſe than any other ſalt, as it preſerves them without deſtroying their taſte and qualities: but when applied in too ſmall a quantity, it then forwards their corruption. *Macquer.*

[*b*] Of all natural ſalts, this is the moſt abundantly furniſhed by Nature in various parts of the world; being found in large maſſes, occupying great tracts of land. It is generally formed in ſtrata under the ſurface of the earth, as in Hungary, Moſcovy, Siberia, Poland, Calabria, Egypt, Ethiopia, and the Eaſt Indies. In England, the ſalt mines at Northwich are in a high ground, and contain it in layers or ſtrata of various colours, of which the yellow and brown are the moſt plentiful, as I have obſerved on the ſpot, which I viſited in June

1782.

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

a. Grey, and

b. White [*c*], 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. Cryſtallized rock ſalt. *Sal montanum cryſtallizatum. Sal gemmæ.*

a. Tranſparent, from Cracow in Poland [*d*].

1782, in company with my worthy and learned friend Mr Volta, profeſſor of Natural Philoſophy in the Univerſity of Pavia, and well known by his great abilities, and many diſcoveries in that branch of knowledge. The mine into which we deſcended, was excavated in the form of a vaſt dome, or vault under ground, ſupported by various columns of the ſalt, that were purpoſely left to ſupport the incumbent weight. And, the work-men having lighted a number of candles all round its circumference, it furniſhed us with the moſt agreeable and ſurpriſing ſight, whilſt we were deſcending in the large tub, which ſerves to bring up the lumps that are broken from the mine, &c. See the *deſcription of the famous ſalt-mines of Wieliczka* in Poland, by Mr. Berniard in the *Journal de Phyſique*, vol. 16. for 1780, pag. 459, in which the miraculous tales concerning thoſe ſubterraneous habitations, villages, and towns, are reduced to their proper magnitude and eſtimate. *The Editor.*

[*c*] From the Tranſilvanian and Hungarian ſalt-mines. *Brunnich.*

[*d*] And alſo from Tranſilvania. Sometimes there are drops of water included in them. The various kinds of ſalt from the Poliſh mines are deſcribed by Dr. Schober in the Hamburg Magazine. Thoſe of Tranſilvania, will appear in the next volume of the Daniſh Royal Society of Sciences, among my hiſtorical account of the mines of that country. *Brunnich.*

SECT. 180. (130.)

B. Sea-Salt. *Sal marinum.*

This ſalt is produced alſo from ſea-water, or from the water of ſalt-lakes, by evaporation in the ſun, or by boiling.

The ſeas contain this ſalt, though more or leſs in different parts [e]. In Siberia and Tartary,

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[e] The method of extracting the ſalt from ſea water, conſiſts in evaporating the water either by fire after it is put on large flat pans of lead, or by letting it evaporate by the heat of the ſun in hot climates. Several parcels of flat ground under the mark of the high tides, and properly ſurrounded by dikes, are diſpoſed, near the ſea, into many compartments, the laſt of which are well lined with clay, and properly beaten in an even horizontal ſurface. So that when the ſea-water is allowed to run into theſe, after it has partly evaporated in the former ones, the heat of the ſun in a few hours evaporates it enough to cryſtalize the ſalt, which falls to the bottom, and is drawn out with a flat piece of board at the end of a pole, &c.

But in the cold climates, much labour and fuel may be ſpared, by letting the ſea water ſtand to freeze; and after ſeparating the ice, which is only formed of the watery particles, the remaining brine contains a much larger quantity of ſalt, which may be very ſoon evaporated by fire. This method, as I have been informed by General Baur, has been already practiſed with great ſucceſs in Ruſſia, and perhaps it is alſo now uſed in various other parts of the North.

It is ſaid (vol. I. of Romé de l'iſle's *Cryſtalograph*, pag. 375) that the ſalt water in the Baltic-ſea, contains one ſixty-fourth part of its weight of ſalt; that of the ſea between England and Flanders, contains the 32th part; that of the coaſts of Spain, tary, there are lakes that contain great quantities of it [*f*].

SECT. 181. (131.)

C. Spring Sea-Salt. *Sal fontanum* [*g*].

Is produced by boiling the water of the fountains near Halle in Germany, and other places [*h*].

Near the city of Lidkoping, in the province of Weſtergotland, and in the province of Dal,

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Spain, one ounce in the pound; and that between the Tropics, one ounce and a half, or even two ounces, viz. one eighth of the whole. From this may be ſeen the great advantage of ſeparating the brine of the ſea-water in cold climates, by the above freezing method, before it be ſet over the fire for evaporation. *Editor.*

[*f*] The lake Yelton, beyond the River Volga, ſupplies all Ruſſia with ſalt. See Philoſ. Tranſ. vol. 77. and Forter's Introduction to Mineralogy, page 32.

[*g*] Salt fountains are very common in various parts of Europe, and elſewhere, ſo that hardly any kingdom is abſolutely diveſted of one or other of the kind. At leaſt, we know that ſuch ſalt ſprings are found in Lorraine, Alſatia, Franche-Comté, and Gaſcony, Provinces of France; in the Palatinat of the Rhine, Spira, Heſſe, and Lunebourg in Germany; Halle in Saxony; in Oſtrogothland, Weſtmanland, &c. &c. *Mongez.*

[*h*] Theſe ſalt waters are evaporated, firſt by raiſing the water into reſervoirs, from whence they are diſperſed through troughs with holes, and fall down on heaps of thin branches of wood, in order to expoſe a multiplicity of ſurfaces to evaporation by the action of the air in long galeries. The remaining brine is evaporated in large flat pans of lead, till the ſalt is formed, as was above ſaid of the ſea ſalt. *The Editor.*

ſalt-ſprings are found, but they contain very little ſalt: and ſuch weak water is called *Jolen* by the Swedes [i].

SECT. 182. (139.)

Borax [a].

This is a peculiar alcaline ſalt, which is ſuppoſed to belong to the mineral kingdom, and cannot be otherwiſe deſcribed, than that it is . . . . . . diſſoluble in water, and vitreſcible; . . . . . . that it is fixed in the fire; and melts to

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[i] 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. How common ſalt is produced in the earth, and from whence the great ſtore of it in the ocean is ſupplied? naturaliſts have laboured in conjecturing, but have not proceeded farther. *The Author.*

[a] This is an imperfect neutral ſalt, compoſed of mineral alkali, nearly ſaturated with the *boracic acid* already deſcribed in Sect. 165. Its diſcovery in Europe has been mentioned in Note *a* to that Section. It is ſaid alſo, that borax has been found in ſome coal-pits of Saxony. This fact is mentioned by Mr. Kirwan; and Mr. Mongez ſays that it is found naturally formed and cryſtallized on the bottom of the lake *Necbal*, in the *Sembal*, a province of the kingdom of Thibet; in ſome caverns in Perſia, in the Mogul's empire; in the iſland of Ceylon

to a glaſs, which glaſs is afterwards diſſoluble in water [b].

Many

Ceylon as well as in the neighbourhood of Halberſtadt in the Lower Saxony.

When the Author publiſhed this mineralogy, the ſame ancient doubts continued to ſubſiſt, viz. whether borax was a factitious or natural ſubſtance: but ſince the year 1772, when Mr. d'Engeſtrom recieved from Mr. Grill Abrahamſon, ſome tinçal ſent to Sweden in cryſtalline form, as dug out of the earth in the kingdom of Thibet, where it is called *pounxa*, *my poun* and *houi poun*, and the diſcovery of Mr. Hoeffer in the lagoons of Tuſcany, mentioned in the note to Sect. 165; it is now beyond all doubt, that this neutral ſalt is a natural production, as Mr. Kirwan aſſerts.

It is remarkable, that near 40 years ago, doctor Hill, in his notes to *Theophraſtus's Treatiſe* on *Stones*, aſſerted that borax was a ſalt made by evaporation of an ill-taſted and foul water, of which there were ſprings in Perſia, Muſcovy, and Tartary. But he was hardly believed, on account of the many bold and groundleſs aſſertions, of which he had been found guilty in almoſt all his numerous works. Mr. Beaumé at Paris pretended to have diſcovered the method of making the ſedative ſalt (and of courſe the borax, which is a combination of this ſalt with mineral alkali) by a long maceration of greaſy and earthy ſubſtances; but nobody has yet been able to verify this fanciful diſcovery. *The Editor*.

[b] Borax, in the ſtate in which it is naturally found,

1. Requires about eighteen times its weight of water to diſſolve it, in the temperature of ſixty degrees of Fahrenheit.
2. Its ſpecific gravity is = 1740.
3. Its taſte is aſtringent and ſtyptic: and
4. It effloreſces when expoſed to the air.
5. It does not efferveſce with the mineral acids, except they be heated: and then but ſlightly.
6. When heated, it loſes four-tenths of its weight.
7. If vitriolic acid be added to a ſolution of borax, the ſedative ſalt will be ſeparated, and ſwim on the ſurface

in

Many experiments have been made with it, in order to diſcover its origin and conſtituent parts, of which an account is given in chemical books [c]; 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

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in the form of white ſcales (ſee note *b* to page 316). The filtrated liquor will, by evaporation, yield *Glauber's ſalt* Sect. 177. *Kirwan.*

[c] . . . . The unrefined borax 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 nature; however, there remains to known 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

2. It changes the ſyrup of violets into green; and precipitates the ſolution of allum, and that of metals, made with acids [d].
3. It unites with mineral acids . . . . . . from which ſhoot very fine and ſubtile hair-like cryſtals, called *ſal ſedativum* (Sect. 165.) . . . . This mixed with *litmus*, or *ſuccus heliotropii*,

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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 alcaline 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 propogated 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. *The Author.*

[d] One hundred parts of purified borax contain thirty-two of real boracic acid, ſeventeen of mineral alkali, and forty-ſeven of water; but of the mineral alkali, only about five parts are ſaturated; and hence, in many caſes, borax acts as an alkali. *Kirwan.*

Borax takes nearly an equal weight of acid (the boracic acid) before the alkaline properties intirely diſappear. *Berg. Sciagr.*

From ſome experiments lately made, I found that both tincal and purified borax, required twice their weight of ſedative ſalt, (the *boracic acid*) to neutralize them perfectly, ſo that they would no longer change vegetable blues to a green colour. *Withering.*

and the ſyrup of violets, diſcovers marks of acidity [e].

4. When it has been united with the vitriolic acid and a phlogiſton, no *hepar 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 *borax*, conſiſt of flat octagonal priſms, flat at the extremities, and with their angles cut off or truncated [f].

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[e] See Sect. 165.

[f] Borax is imported from the *Eaſt Indies* to Europe, in a very impure ſtate, in the form of large flat hexangular, or irregular cryſtals, of a dull white greeniſh colour, greaſy to the touch, or in ſmall cryſtals, cemented together, as it were by a rancid, yellowiſh, oily ſubſtance, intermixed with marls, gravel, and other impurities. In this ſtate, it is called *chryſocolla* or *tincal.* Kirwan.

In all probability, theſe oily ſubſtances are purpoſely mixed with tincal by the Indians, to hinder its efflorescence or decaying, on being expoſed to the air, and this ſeems to have furniſhed the miſtaken idea to Mr. Beaumé for the pretended diſcovery of making borax out of fat ſubſtances, as above mentioned, at the end of *note* a. *The Editor.*

SECT. 183. (Additional.)

Mild mineral alkaly. Natron, the Nitre of the ancients. *Alkali minerale aeratum*, ſeu *acido aereo ſaturatum.*

This neutral ſalt is a combination of the *mineral alkaly* with the *aerial acid* or *fixed air.* It is found plentifully in many places, particularly in Africa and Aſia, either concreted into cryſtallized ſtrata, or fallen to a powder; or effloreſcing on old brick walls; or laſtly, diſſolved in ſprings. It frequently originates from decompoſed common ſalt. I am not ignorant that the acid of common ſalt adheres ſtrongly to its baſis, ſo as not to be expelled by fire; but perhaps the viciſſitudes of the atmoſphere acting for ages, may be more powerful. In immenſe plains covered over with this alkaly, ſcarcely any common ſalt is found upon the ſurface, but the deeper you dig, the more it is contaminated by it, the common ſalt being yet undecompoſed for want of acceſs of air. *Bergman Sciagr.*

This is an imperfect neutral ſalt, and was formerly conſidered as a pure alkali, but the diſcovery of the *aerial acid* (§ 167.) has ſhewn the miſtake.

1. It has nearly all the properties of mineral alkali (§ 170.) but with leſs energy.

2. The

2. The vegetable blue colours are turned green by this ſalt; it effloreſces with acids; and has an urinous taſte.
3. It is ſoluble in twice its weight of cold water, but if the water is hot, an equal weight is ſufficient for its ſolution.
4. It effloreſces when expoſed to the action of the atmoſphere.
5. It fuſes eaſily on the fire, but without being decompoſed.
6. Facilitates the fuſion of vitrifiable earths, and produces glaſs more or leſs fine, according to their qualities.
7. It is decompoſable by lime and ponderous earth, which attract the aerial acid.
8. And alſo by the mineral acids; but theſe expel the aerial acid of this ſalt, by ſeizing its alkaline baſis. *Mongez.*

Wallerius confounds this ſalt with the *Aphrontirum* of Sect. 215. and calls it *Halinitrum*, when it contains ſome phlogiſton. It is often confounded alſo with the *ſal-petre d' houſſage* of Sect. 174. and that of Sect. 178. Mr. Kulbel, quoted by the ſame Wallerius, ſhowed that it exiſts in ſome vegetable earths, and takes it to be the cauſe of their fertility; but this only can be on account of its combination with the oily parts of them, and forming a kind of ſoap, which is miſcible with the watery juices, the whole upon the principle already ſtated in Sect. 34, and more fully treated of in Rozier's *Dictionaire d' Agriculture* in French. *The Editor.*

SECT. 184. (Additional)

Vitriolic ammoniac. *Alkali volatile vitriolatum.*

This neutral ſalt was called *ſecret ſalt of Glauber*, and is a combination of the volatil alkali, with vitriolic acid. It is ſcarcely found any where, but in places where the phlogiſticated fumes of vitriolic acid ariſe from burning ſulphur, and are abſorbed in putrid places by the volatile alkaly [a]. Thus at Fahlun the acid vapour from the roaſted minerals, produces this ſalt in the neceſſary-houſes. It is ſometimes alſo formed in the craters of Volcanos. *Bergman Sciagr.* [b].

1. This

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[a] As volatile alkaly may be obtained in large quantities from pit-coal, and produced by proceſſes not dependant upon putrefaction, there is reaſon to believe that the vitriolic ammoniac may be formed in ſeveral ways not noticed by this author. *Withering.*

[b] It is ſaid to have been found in the neighbourhood of Volcanos, particularly of *Mount-Veſuvius*, where, indeed, it might well be expected: yet its exiſtence ſeems dubious, ſince Mr. Bergman could ſcarce find any trace of it among the various ſpecimens of ſalts from *Veſuvius*, which he examined. The reaſon probably is, that the vitriolic acid diſengaged by the combuſtion of ſulphur, is in a phlogiſticated ſtate: and all its combinations in this ſtate, are eaſily decompoſed by the marine acid, which plentifully occurs in Volcanos.

1. This ſalt is of a friable texture, and has an acrid and urinous taſte.
2. Attracts the moiſture of the atmoſphere.
3. Is very ſoluble in water, it requiring only twice its weight of cold water, or an equal weight of boiling water, to be diſſolved.
4. It becomes liquid on a moderate fire: but if urged,
5. It becomes red hot, and volatilizes.
6. The nitrous and muriatic acid decompoſe this ſalt by ſeizing the volatil alkali. But
7. Lime, ponderous earth, and pure fixed alkali, ſet the volatil alkali free, and combine with the vitriolic acid.
8. According to Kirwan, *one hundred* parts of this ſalt contain about 42 of real vitriolic acid: 40 of volatil alkali; and 18 of water.

This vitriolic ammoniac is eaſily known; for if quick-lime, or fixed alkali be thrown into its ſolution, the ſmell of the volatil alkali is perceived; and if this ſolution be poured into that of chalk or ponderous earth by the nitrous acid, a precipitate will appear. *Kirwan.*

It is alſo ſaid to be found in the mineral lakes of *Tuſcany*, which is much more probable: as the vitriolic acid when united to water, eaſily parts with phlogiſton, and recovers its ſuperiority over other acids.

It is ſaid alſo, that this neutral ſalt is found on the ſurface of the earth in the neighbourhood of Turin. *Kirwan.*

SECT.

SECT. 185. (Additional.)

Nitrous Ammoniac. *Alkali volatile nitratum.*

This is a neutral ſalt, which reſults from the combination of the *nitrous acid* with the *volatile alkali.* It is frequently found in the *mother-liquor* of *nitre.* When mixed with a fixed alkali, the volatile betrays itſelf by its ſmell.

1. It is of a friable texture, of a ſharp bitter; and of a nitrous, or cooling taſte.
2. According to Mongez, it attracts the moiſture of the atmoſphere; but Romé de l'Iſle aſſerts, that its cryſtals are not deliquescent; the experiment may be eaſily tried, and the truth aſcertained.
3. It is ſoluble in cold water; but half the quantity of water, if boiling, is ſufficient for diſſolving it.
4. It liquefies on the fire, and afterwards it becomes dry.
5. It detonates with a yellow flame, before it is red-hot: and what is peculiar to this ſalt, it needs not, like common nitre, the contact of any combuſtible matter for its detonation, from whence it appears that the volatile alkaly itſelf poſſeſs a great ſhare of phlogiſton.

6. Its

6. Its component parts, viz. the nitrous acid and the volatile alkali, are not very intimately united: and of courſe,
7. It is eaſily decompoſed by all the ſubſtances that have any affinity to either of them. *Mongez.*
8. Mixed with the muriatic acid it makes *aqua regia.*
9. One hundred parts of this neutral ſalt, contain 46 of nitrous acid, 40 of volatile alkali; and 14 of water, as Mr. Kirwan thinks.

SECT. 186. (132 and 141,)

Native ſalt ammoniac. *Sal ammoniacum naturale.*

The muriatic (or marine) acid ſaturated with a volatile alkali. *Acidum ſalis communis alcali volatili ſaturatum* [a].

It

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[a] This is a perfect neutral ſalt, reſulting from the combination of marine acid with volatile alkali.

1. Its taſte is ſharp, acrid and urinous; and it
2. Has a peculiar property not found in any other ſalt, viz.
3. It is tough in a certain degree, being capable of a very ſenſible flexibility, without breaking.
4. It is ſoluble in water: and produces a great cold with ice.
5. According to Mr. Mongez, it requires ſix times its weight of cold water to be diſſolved; but boiling water diſſolves

It is of a yellowiſh colour, and is ſublimed from the flaming crevices, or fire-ſprings, (*eld brunnarne*) at Solfatara near Naples [*b*].

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diſſolves an equal weight of this ſalt. According to Kirwan 3,5 times its weight of water at the temperature of ſixty degrees, are ſufficient for its ſolution.

6. Is very volatile in the fire.
7. Lime, calcareous earth, and fixed alkali, decompoſe this ſalt, by ſetting free the volatile alkali: on the contrary,
8. The vitriolic and nitrous acid ſeize the alkaline baſe, and diſengage the marine acid.
9. Its ſpecific gravity, according to Kirwan, is =1420.
10. It makes *aqua regia* when mixed with nitrous acid.
11. This ſalt diſſolves copper: and
12. Wholly evaporates, when laid on a hot iron.

[*b*] 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 (See the Author's note to Sect. 203.), the origin of the ſal ammoniac at Solfatara would eaſily be diſcovered: ſince we know that petrifactions diſcover a principle within them, which contains the *ſal urinoſum*. *The Author*.

Ammoniacal ſalt is alſo found effloreſcent on the ſurface of the earth, or adherent to rocks in a powdry form; and ſometimes as hard as ſtones, in Perſia, and in the country of the Kalmuks. *Mongez*.

It is found native of different colours, grey, black, green, and red, in the neighbourhood of Volcanos, in the caverns or grottos of *Puzzuoli*, and in the mineral lakes of *Tuſcany*, in ſome mountains of *Tartary* and *Thibet*, and alſo in various clays. *Kirwan*.

SECT. 187. (Additional.)

Aerated (or mild) volatil alkali. *Alkali volatile aeratum.*

This neutral ſalt reſults from the combination of volatile alkali united to the aerial acid. It was formerly conſidered as a pure alkali, but the diſcovery of the *aerial acid* (or *fixed air*) has ſhewn it to be a true neutral ſalt, though imperfect; as it retains ſtill all the properties of an alkaly, though in a weaker degree, on account of its combination with the aerial acid, which is itſelf the moſt weak of all acids, and of courſe other ſtronger acids eaſily diſlodge it from its baſe, and from various ammoniacal ſalts.

1. This imperfect neutral ſalt has an urinous taſte, and a particular ſmell, which is very penetrating, though leſs pungent than the pure volatile alkali of Sect. 171: and in the ſame manner, it turns the blue vegetable juices green. But it
2. Effervesces with other acids ſtronger than the aerial one, which the pure or cauſtic volatil alcali does not.
3. It ſublimes very eaſily with a ſmall degree of heat:
4. And diſſolves in twice its weight of cold water; but in a leſſer quantity, when this laſt is boiling hot.

5. It

5. It acts on metallic ſubſtances, chiefly on copper, with which a blue colour is produced.

According to Bergman, this ſalt was found in a well in London (Phil. Tranſ. for 1767), at Frankfort on the Mein, and at Lauchſtadt. Meſſ. Hierne, Henkel, and Brandt, have found alſo this ſalt in the vegetable earth, in various kinds of Argill, and in ſome ſtony ſubſtances. Mr. Vozel found it alſo in ſome of the incruſtations at Gottingen; and Mr. Malouin in ſome acidulous waters of France. *Mongez.*

SECT. 188. (Additional.)

Obſervations on the preceding foſſil neutral ſalts.

The four neutral ſalts already deſcribed in Sect. 176, 182, 183, and 187, viz. the Borax and the three aerated alkalis are called *imperfect*, whilſt the other neutral ſalts have acquired the name of *perfect*, becauſe theſe laſt do not exhibit any of the diſtinguiſhing properties of their component parts. The three aerated alkalis have a very diſtinct alkaline character, as they turn blue-vegetable juices green, though not of ſo vivid a colour as the cauſtic alkali does: and the borax is capable of receiving almoſt an equal quantity of its ſedative acid, without loſing all its alkaline properties.

In general, thoſe neutral ſalts conſiſting of fixed alkalies combined with acids, are more ſaturated than thoſe compoſed of volatile alkali, called *ammoniacal ſalts*; or thoſe called *aerated*, which laſt are only compoſed by the combination of the *aerial acid*, united to any alkaline or earthy baſe.

The *aerated* alkalis are called alſo by the name of *mild* alkalis, becauſe they poſſeſs no longer that ſharp corroding quality, which they exhibit when deprived of the *aerial acid* or *fixed air*, in which caſe they are termed *cauſtic alkalis*, as has been explained in the note to page 327.

Theſe *aerated* alkalis differ alſo from the *cauſtic* ones, not only on account of the mildneſs of their taſte, from which comes their epithet of *mild alkalies*, but alſo by their property of cryſtallizing, (See N° 4 and 5 of Sect. 167), and by their efferveſcing with other acids, which expel the *aerial one*, the weakeſt of all acids we know.

There are many other obſervations which might be properly made in this place, concerning the various properties and peculiar phenomena of neutral ſalts; but as they would conſiderably augment the bulk of this Section, the curious reader is referred to the ample deſcriptions of them to be found in Macquer's Dictionary, under the reſpective titles of *Sels neutres*, *chaux terreſtre*, and *cauſticité*, &c. *The Editor.*

THE

THE FOURTH ORDER.

Earthy Neutral Salts, *Sales medii Terreſtre* [a].

SECT. 189. (124.)

Calcareous earth combined with vitriolic acid. Vitriolated calx. Selenite. *Gypſum.* See Sect. 13. and following [b].

SECT.

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[a] The compounds of earths and acids, which poſſeſs ſolubility as mentioned, Nº 2 and *Note* g to *page* 10, are decompoſed and precipitated by mild, but not by phlogiſticated alkalis. *Berg. Sciag.* § 57.

[b] The gypſum, or plaſter, is not only found diſſolved in various waters; but alſo, in many places, it forms immenſe ſtrata. It is placed by all mineralogiſts among the earths, which it greatly reſembles; but it rather belongs to the ſaline ſubſtances of the neutral kind, as appears by its conſtituent parts. When burnt, generates heat with water, but in a leſs degree than lime does: (as was obſerved in *note* n to *page* 32). *Berg. Sciag.* § 59.

This ſalt has a particular taſte, neither bitter nor aſtringent, but earthy, when applied to the tongue: and it is owing to it that ſome waters, chiefly from pumps and wells, are called *hard waters*, becauſe they lay heavy on the ſtomach.

It is inalterable whilſt kept in a dry place: but on being expoſed to a moiſt air, it is much alter'd, and ſuffers a kind of decompoſition.

When expoſed to fire, ſo as to loſe the water off its cryſtallization, it aſſumes a dead white colour. It is what we call *plaſter*

SECT. 190. (Additional.)

Nitre of Lime. Terrene nitre. *Calx nitrata*, lat. *Nitre Calcaire* of Mr. Morveau.

This earthy ſalt is ſometimes found in water, but very ſparingly. It is ſaid that the chalk

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plaſter of Paris (ſee note *n* to Sect. 13.) : but if the fire is too ſtrong, it melts and vitrifies, after loſing the vitriolic acid with which it is ſaturated.

If put over a very hot iron, it becomes phoſphoric.

It is decompoſed by fixed alkalis, which have a ſtronger attraction to its calcareous baſe. *Mongez.*

According to Kirwan, its ſolution mixes uniformly with the nitrous and marine ſelenite (Sect. 190 and 191) ; but is precipitable by fixed alkalis, mild or cauſtic : and alſo by the ſaccharine acid, but not by the volatile cauſtic alkali, which diſtinguiſhes it from the Epſom ſalt of Sect. 196 ; and from *Alum* of Sect. 200, and following.

The moſt famous quarries of Gypſum in Europe, are thoſe of Montmartre near Paris. See *Journal de Phyſique* for 1780, tom. 16. p. 289, and for 1782, vol. 19. p. 173.

It is found alſo in the vegetable kingdom. Mr. Model found that the white ſpots in the root of Rhubarb, are a ſelenitical or gypſeous earth (*Journal de Phyſ.* vol. VI. p. 14.)

What is called *foſſil flour* (*farine foſſile* in French) generally found in the fiſſures of rock and gypſeous mountains, is very different from the *agaricus mineralis* of Sect. 5. and from the *lac lunæ* of Sect. 130 : as it is a true gypſeous earth already deſcribed in Sect. 14. which, according to Mongez, is of a white and ſhining colour : though ſometimes it aſſumes a reddiſh or bluiſh colour, on account of ſome martial mixture.

See in Sect. 13. and following, other varieties and properties of the gypſeous earth.

hills

hills in ſome parts of France, become ſpontaneouſly impregnated with nitrous acid, which may be waſhed out, and after a certain time they will become impregnated with it again. *Berg. Sciagr.*

It is a combination of the nitrous acid with calcareous earth.

1. Is deliqueſcent, and is ſoluble in twice its weight of cold water, or in an equal weight of boiling water.
2. Its taſte is bitter.
3. Is decompoſed by fixed alkalies, which form the cubic, or the priſmatic nitres of Sect. 178 and 174.
4. But cauſtic volatile alkali cannot decompoſe it.
5. It does not deflagrate in the fire; yet paper moiſtned with a ſaturated ſolution of it, crackles in burning.
6. In a ſtrong red heat, it loſes its acid.
7. Its ſolution does not trouble that of ſilver in nitrous acid.
8. The vitriolic acid precipitates its baſis.
9. As does likewiſe the acid of ſugar.
10. One hundred parts of it contain, when well dried, about 33 of nitrous acid, 32 of calcareous earth, and 35 of water.

It exiſts in old mortar, and in the *mother liquor* of nitre; and alſo in the chalk rocks near *Roche Guyon*, in France. *Kirwan.*

This ſalt is found for the moſt part of a reddiſh colour; and Wallerius ſays, that it has been found on the walls of a fortreſs at Upſal. *Editor.*

SECT.

SECT. 191. (128.)

Muriatic chalk, or fixed ſalt ammoniac. *Acidum ſalis communis terrâ calcarea ſaturatum*, lat. *Muriate calcaire de* Morveau. *French.*

This ſomewhat deliqueſces, or attracts the humidity of the air: It is found in the ſea-water. *See Sect.* 21. [a].

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[a] It is with great impropriety that this ſalt has obtained the name of *ammoniac*, on account only of its being formed in the chemical laboratories, during the decompoſition of the ammoniacal ſalt with lime, in the proceſs for making the cauſtic volatile alkali. In this caſe, the Muriatic acid unites to the calcareous baſis, while this laſt gives its water to the volatile alkali, which therefore comes over in a fluid cauſtic ſtate; but if chalk is employed inſtead of lime, the volatile alkali receives the aerial acid inſtead of water, and comes over in a concrete form; in neither caſe, the new combination of calcareous earth with muriatic ſalt has any volatil alkali, to deſerve the name of *ammoniacal ſalt*. *Macquer.*

1. This earthy ſalt has a ſaline and very diſagreeable bitter taſte. It is ſuppoſed to be the cauſe of that bitterneſs and nauſeous taſte of ſea-water.
2. It fuſes in the fire, and becomes phoſphoreſcent, after undergoing a ſtrong heat.
3. It becomes hard, ſo as to ſtrike fire with ſteel:
4. It is then the phoſphorus of Homberg:
5. It is decompoſable by ponderous earth, and fixed alkalis.
6. And alſo by the vitriolic or nitrous acid, which expel the muriatic acid, to unite with the calcareous baſis. *Mongez.*
7. Its ſolution renders that of ſilver in the *nitrous acid* turbid, at the ſame time that

SECT. 192. (Additional.)

Aerated chalk, *Calx aerata.*

Whenever calcareous earth is over ſaturated with the *aerial acid*, it becomes a true earthy neutral ſalt: becomes ſoluble in water: and has a ſlight pungent bitter taſte. It is commonly found diſſolved in waters in conſequence of an exceſs of the aerial acid. When this greatly abounds, the water is ſaid to be hard *(cruda)*. By boiling or by evaporation, it depoſits ſtreaks or cruſts of calcareous matter.

But when the calcareous earth is only ſaturated with the aerial acid, without exceſs, it is not eaſily ſoluble; it is then the calcareous ſpar of *Sect.* 10. and is properly referred to the claſs of earths. See the 4th and following Sections.

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8. It makes no change in that of nitrous ſelenite.
9. It obſtinately retains its acid in a red heat.
10. One hundred parts of this earthy ſalt contain, when well dried, about 42 of marine acid, 38 of calcareous earth, and 20 of water.
11. It is found in mineral waters, and in the ſalt works at Saltzburg. *Kirwan.*

SECT. 193. (Additional.)

Vitriolated ponderous earth. *Terra ponderoſa vitriolata. Barytes vitriolata.*

This earthy ſalt, known by the name of *ponderous ſpar*, is a combination of the ponderous earth deſcribed in Sect. 48. with the vitriolic acid; and has been already treated of in Sect. 50.

N. B. The nitrous ponderous earth, according to Bergman, has not yet been found, although it may perhaps exiſt ſomewhere, and of courſe be diſcovered in Nature.

SECT. 194. (Additional).

Muriatic Barytes. Marine Baro-ſelenite. *Barytes Salita.*

This earthy ſalt conſiſts of marine acid united to the ponderous earth. It is ſaid to have been found in ſome mineral waters in Sweden: and may be known by its eaſy precipitability with vitriolic acid; and by the great inſolubility and weight of this reſulting compound, which is the true ponderous ſpar of the preceding Section.

SECT.

SECT. 194. (Additional)

Aerated ponderous earth. *Barytes aerata.*

This earthy neutral ſalt was found lately by Doctor Withering, in a mine at Alſtonmore in the county of Cumberland in England, as has been noticed in Sect. 49. where may be ſeen a ſhort account of its properties. The Doctor ſays that it is very pure, and in a large maſs. This ſubſtance is a new acquiſition to mineralogy, and may be turned to uſeful purpoſes in chemiſtry. He gave an account of it to the Royal Society of London, which was inſerted in the Philoſophical Tranſactions for 1784, part 2. page 293.

1. It effervesces with acids, and melts with the blow pipe, though not very readily.
2. In a melting furnace, it gave ſome ſigns of fuſion; but did not feel cauſtic when applied to the tongue, nor had it loſt its property of effereſcing with acids.
3. But the precipitated earth from a ſaturated ſolution of it in the marine acid, by the mild vegetable or mineral alkali being burned, and thrown into water, gave it the properties of lime water, having an acrid taſte in a high degree: and a ſingle drop of it added to the ſolutions of vitriolated

lated ſalts, as the *Glauber ſalt*, *vitriolated tartar*, *vitriolic ammoniac*, *alum*, *Epſom ſalt*, *ſelenite*, occaſioned immediately a precipitation; from whence it appears to be the *niceſt teſt to diſcover the vitriolic acid.* By it the marine acid may alſo be eaſily freed from any mixture of vitriolic acid, by means of this calx of ponderous earth.

Conſult the ſaid paper of Dr. Withering, *inſerted in that volume of the* Philoſophical Tranſactions, for a variety of *ingenious obſervations on* ponderous earth, *and its different combinations*, &c.

SECT. 195.

Vitriolated magneſia. *Magneſia Vitriolata.*

This earthy neutral ſalt is called by the Engliſh *Epſom ſalt*. *Sel d' Angleterre* by the French; and alſo *ſel de Sedlitz*, *de Seydſchutz*, *ſel amer*, *ſel cathartique amer*, &c.

Theſe various names are given to it, either on account of its properties, it being a very mild purgative; or from the places where it is found, beſides many others as in the waters of *Egra*, of *Creutzbourg*, *Obernental*, *Umea*, &c. It has alſo been found native, mixed with common ſalt, and coally matter, germinating on ſome free ſtones in coal mines. See *Kirwan's Mineralogy*, p. 183.

1. It has a very bitter taſte.
2. It is ſoluble in one part and a half of its weight of cold water: but in hot water, a given weight of it diſſolves the double of this ſalt.
3. It effloreſces when expoſed to a dry atmoſphere, and is reduced to a white powder.
4. Expoſed to the fire it loſes the water of its cryſtallization, and is reduced into a friable maſs.
5. This earthy ſalt is decompoſed by fixed and volatil alkalies.
6. Lime-water precipitates the magneſia from its ſolution, the calcareous earth of lime-water combining itſelf with the vitriolic acid, and forming a ſelenite. N. B. By this teſt the vitriolated magneſia is eaſily diſtinguiſhed from the vitriolated mineral alkali, or *Glauber's ſalt* which it reſembles.
7. But crude chalk, or aerated calcareous earth, has not ſuch an effect in the ſame caſe: which ſhews how much the efficacy of this ſubſtance, viz. the calcareous earth, is diminiſhed merely by its union with the *aerial acid.*
8. When urged by the flame with the blowpipe, it froths; and may be melted by being repeatedly urged with that inſtrument.
10. With borax it effervesces, and alſo when burned with the microcoſmic ſalt.

11. According to Bergman, one hundred weight of this ſalt contains only nineteen parts of pure magneſia, thirty-three of vitriolic acid: and forty-eight of water. But
12. According to Kirwan, one hundred parts of it contain about twenty-four of real vitriolic acid, nineteen of magneſian earth, and fifty-ſeven of water.

SECT. 197. (Additional.)

Nitrated Magneſia. Nitrous Epſom Salt. *Magneſia nitrata.*

This earthy ſalt is uſually found together with nitre. It is a combination of the nitrous acid with the magneſian earth.

1. It has an acrid taſte, very bitter.
2. Attracts the moiſture from the atmoſphere, and deliqueſces.
3. Is very ſoluble in water.
4. Is eaſily decompoſable by fire.
5. The ponderous and calcareous earths decompoſe it, and alſo the alkalies.
6. On being urged by the blow-pipe, it ſwells up with ſome noiſe, but does not detonate.
7. If ſaturated ſolutions of nitrous ſelenite and of this ſalt be mixed, a precipitate will appear, but

8. Neither vitriolic acid, nor mild magneſia will occaſion any turbidneſs in its ſolution.
9. One hundred parts of this ſalt contain about thirty-ſix of real nitrous acid, twenty-ſeven of magneſian earth, and thirty-ſeven of water.

It exiſts in old mortar, and is found alſo in the mother liquor of nitre. As lime-water decompoſes it, Mr. de Morveau has indicated the uſe of this proceſs, not only to compleat its analyſis; but alſo to ſeparate, in large quantities, and at a very cheap rate, the magneſian from the calcareous earth, as Mr. Mongez relates upon this ſubject.

SECT. 198. (Additional.)

Muriatic Magneſia. *Magneſia Salita.*

This earthy ſalt is a combination of magneſian earth with the muriatic acid. According to Bergman, it is found in the ſea in greater plenty than any other ſalt, except the ſea ſalt.

1. It has a very bitter taſte: and being always mixed in the ſea-water, it is the principal cauſe of its bitterneſs.
2. It is very deliqueſcent, and ſoluble in a ſmall quantity of water.
3. All the alkalies, even the cauſtic volatil alkali, and lime, decompoſe it by precipitating its baſis.

4. The vitriolic, nitrous, and boracic acids expel the muriatic acid from the baſe of this neutral ſalt.
5. Its ſolution does not trouble that of *nitrous* or *marine ſelenite:* but
6. It cauſes a cloud in the nitrous ſolution of ſilver.
7. The vitriolic acid throws down no viſible precipitate from the ſolution of this neutral Salt.
8. It loſes its acid in a red heat.

SECT. 199. (Additional.)

Aerated Magneſia. *Magneſia aerata.*

Common magneſia with an exceſs of aerial acid is a true neutral ſalt, like the aerated ſelenite of Sect. 192: and becomes ſoluble in cold water. Otherwiſe it is ſcarce ſoluble at all; and is then claſſed among the earths. *See Sect.* 53 *and following.*

This neutral ſalt is decompoſable by fire, by which its water and its acid are expelled: and it may become phoſphoric.

When urged by fire, it agglutinates a little: and ſome pretended, that it melts. But by what appears in Note *i* to page 94, it muſt be in an impure ſtate to vitrify at all.

The three mineral acids, and the alkalis diſſolve this ſalt with effervеſcence, by expelling the aerial acid.

SECT. 200. (124.)

Argillaceous earth combined with vitriolic acid. The Alum Kind. *Alumina* [a].

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

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[a] This ſalt is ſometimes ſpontaneouſly generated, by the decompoſition of pyrites lodged in argillaceous ſchiſtus, and clay.

It is found in a ſpring at Steckenitz in Bohemia, and elſewhere. *Bergman.*

Mr Kirwan affirms on very good authorities that this ſalt is found native in a few mineral ſprings, though rarely; in the mineral lakes of *Tuſcany*; alſo germinating on the ſurface of free ſtone or ſhiſtus in coal mines, or in Lavas near Volcanos; on ſeveral rocks in the *Archipelago*; on various parts of *Hungary*, in the *Eaſt*, *Bohemia*, and *Swiſſerland*, though ſeldom pure. Native alum mixed with vitriolic ammoniac, is found cryſtallized on the borders of the mineral lakes of Tuſcany; and alſo in a capillary form near the lake of St. *Agnano*, and in the grotto of St. *Germano*.

1. According to Kirwan, alum requires about 15 times its weight of water, to be diſſolved in the temperature of 60 degrees of Fahrenheit. But Beaumé, quoted by Mongez, ſays that it requires 18 times its weight of cold water, viz. that two *pints*, or *livres* of cold water are required to melt 14 *gros*: from whence it appears, the neceſſity of expreſſing the degree of the thermometer in which ſuch experiments are made, to form a proper idea of them, a circumſtance which Mr. Kirwan is in general very careful of pointing out. The ſame Mr. Beaumé adds, that boiling water diſſolves more than half its

weight

Is found on decayed alum ores in very ſmall quantities; and therefore, through ignorance, the *alabaſtrites* and *ſelenites*, both

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weight of alum: but Profeſſor Bergman ſays, that 100 parts of cryſtallized alum require, in a mean heat, 1412 of diſtilled water to be diſſolved: and that of boiling water, only 75 are ſufficient.

2. Its ſpecific weight, according to Bergman, is=2071; but if the aerial acid contained in it is included in the computation, it is but=1757.
3. Its flavour is ſweetiſh, and remarkably aſtringent.
4. It ſwells and bliſters when heated on the fire, and leaves a light-ſpongeous ſubſtance of a dead white colour. In this ſtate is called *calcined alum*; loſes half its weight; and having loſt the water of cryſtallization, the vitriolic acid remains more contentrated, the taſte becomes more acrid, and exerts its corroſive properties in a higher degree.
5. It is precipitable by all *alkalis*, and even by *magneſia*, which diſtinguiſhes its baſis from that of Epſom-ſalt (of Sect. 196) the argillaceous earth being abandoned by the vitriolic acid, and this laſt uniting to the magneſian earth, from whence it evidently appears, how groundleſs opinion of thoſe is, who aſſerted theſe two earths to be identic. The precipitated argil retains ſtill nearly half its weight of the vitriolic acid to which it was united; and is in reality an *embryon alum*. But by digeſting it in volatil alkali (becauſe its baſis would unite to fixed alkalies) it may be properly purified.
6. Its ſolution, like that of Epſom-ſalt (of Sect. 196), renders the nitrous ſolutions either of ſilver, or chalk, turbid; but mixes uniformly with thoſe of *nitrous* or *marine alum* (of the following Sect. 202); or of the vitriols of any metal. Theſe properties diſtinguiſh it ſufficiently, as Mr. Kirwan expreſſes himſelf.
7. According to the ſame author, one hundred parts of alum contain about 24 of vitriolic acid; 18 of argillaceous earth, and 58 of water.

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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].

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

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 *Roch Alum* [c]. 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 [d].

c. With

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[b] The gypſa 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, D. C.

[c] This neutral ſalt is called ſometimes *Roch alum*, from an ancient city in Syria, called *Roccho*, and now *Edeſſa*, where the moſt early alum-manufactury was carried on; but this name has been changed, through ignorance, into *rock-alum*, as if it were naturely found in large maſſes like *ſtony rocks*. Bergman *de confect. aluminis*.

[d] What is called *Roman alum*, has been conſidered as the beſt ſort; it has a roſy-coloured caſt. It is manufactured at *Tolfa* near *Civita Vecchia*, and contains about *five per centum* of

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.

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of a roſe-coloured earth, whoſe nature Profeſſor Bergman did not aſcertain, *but*, ſays he, *we know for certain, that the goodneſs of the alum does not depend upon it.* Mr. de Morveau ſuſpects this colour to proceed from ſome ſlight mixture of iron. That from the manufacture of Brunſwick has the ſame colour, which ſeems to proceed from the mixture of Cobalt, which it has been diſcovered to contain, both by Profeſſor Bergman and Mr. Erxleben; but it ſeems to have ſome different properties from the Roman alum; and on my inquiring from Mr. Waugh, a capital Salter-druggiſt in London, whether the roſy-coloured alum called Roman, was preferred by our manufacturers to the white alum, he anſwered in the negative. Mr. Guſtav Von Engeſtrom, counſellor at the Board of Mines in Stockholm, to whom I am indebted for my attachment to mineralogical ſubjects, ſince I had the happineſs of his acquaintance when he viſited this country about twenty years ago, wrote to me in 1783, that he has diſcovered an eaſy and infallible method for purifying alum from the ſmalleſt mixture of iron, which is a deſideratum in the dying buſineſs, and very worthy of the attention of our manufacturers. The ſame gentleman has alſo diſcovered a method of purifying ſalt-petre from any mixture of marine ſalt, which is a great acquiſition for the manufacture of gun-powder; he has beſides ſent me a ſpecimen of canvaſs ſo prepared, that it cannot take fire, a circumſtance which might be of great advantage to prevent the decorations, in the play-houſes and other public places, from taking fire. He was then about to publiſh a chemical work, the firſt part of which treats of the refining of gold and ſilver; but it being in the Swediſh language, I muſt wait, with moſt Engliſh readers, for its tranſlation into a more common idiom, to profit by the great knowledge and ſkill of this moſt able chemiſt. *The Editor.*

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

It is found,

1. With parallel plates, having a dull ſurface, *Schiſtus lamelloſus tegularis*, 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. [*e*].
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.

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

SECT. 201. From the Author's Note to the preceding Section.

Obſervations on Alums.

The purity abovementioned in the laſt Section *b.* 1. of the earth of the Roman or Roch alum, is meant with the ſame reſtriction as in general is underſtood by that expreſſion: viz. that the heterogeneous particles are not very obvious, nor of any great conſequence [a].

The

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[a] Beſides the numerous uſes of this neutral ſalt in the *materia medica*, it is very advantageouſly employed in various œconomical uſes. When added to tallow, the candles made therewith are harder (ſee this proceſs at large in *Bibliotheque Phyſico-œconomique* for 1782 at the word *Bougies œconomiques*). Wood ſufficiently ſoaked in alum, does not eaſily take fire; the ſame is true of paper impregnated with it, which is fitter to keep gun-powder, as it alſo excludes moiſture. Paper impregnated with alum, is uſeful in whitening Silver, and ſilvering braſs without heat. Alum mixed in milk, helps the ſeparation of its butter. If added in a very ſmall quantity to turbid water, in a few minutes it renders it perfectly limpid, without any bad taſte or quality: whilſt the vitriolic acid does not precipitate ſo ſoon, nor ſo well, the opake earthy mixtures that renders it turbid, and gives to it a very ſenſible acidity as I have often tried. It is uſed in making the pyrophorus, in tanning, and many other manufactories, particularly in the art of dying, in which it is of the greateſt and moſt important uſe, by cleanſing and opening the pores on the ſurface of the ſubſtance to be dyed, rendering it fit for receiving

The phlogiſton which is contained in the black alum ſlates, may perhaps during the calcination diſpoſe the iron to be more eaſily diſſolved; and it may alſo occaſion the black colour in ſome of them, that even contain but very little

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receiving the colouring particles (by which the alum is generally decompoſed), and at the ſame time making the colour fixed. Alum conſtitutes the baſis of crayons, which generally conſiſt of the earth of alum, finely powdered and tinged for the purpoſe. It is alſo employed in the preparation of Pruſſian blue, &c. *The Editor chiefly from Bergman.*

The greater part of this ſalt is factitious, being extracted from various ores, ſuch as

1. The *ſulphurated* clay. This conſtitutes the pureſt of all aluminous ores, namely that of *la Tolfa* near *Civita Vecchia* in Italy. It is white, compact, and as hard as indurated clay; from whence it is called *petra aluminaris.* It is taſteleſs and mealy: one hundred parts of this ore contains above forty of *ſulphur*, and fifty of clay, a ſmall quantity of fixed vegetable alkali, and a little iron. Bergman ſays it contains forty-three of *ſulphur* in one hundred, thirty-five of *argill*, and twenty-two of *ſiliceous earth.* This ore is firſt torrefied to decompoſe the *ſulphur*, whoſe vitriolic acid reacts on the argil, and forms the alum.
2. *The pyritaceous clay*, which is found at *Schwemſal* in *Saxony*, at the depth of ten or twelve feet. It is a black, and hard, but brittle ſubſtance, conſiſting of clay, pyrites and bitumen. It is expoſed to the air for two years; by which means the pyrites are decompoſed, and the alum is formed. The alum ores of *Heſſe* and *Liege* are of this kind: but they are firſt torrefied, which, according to my late worthy friend Mr. Jars, is a diſadvantageous method.
3. The *ſhiſtus aluminaris.* This differs from that of Sect. 146, as it contains a variable proportion of *petrol* and *pyrites* intimately mixed with it. When theſe laſt are in a very large quantity, this ore is rejected as containing

little of iron, as moſt likely in part of thoſe from Nas mentioned Sect. 200. *c.* 2.

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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

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ing too much iron. Profeſſor Bergman very properly ſuggeſted, that by adding a proportion of clay, this ore may turn advantageouſly for producing alum. But if the *petrol* is conſiderable, it muſt be torrefied. The mine of *Becket* in *Normandy*, and thoſe of *Whitby* in *Yorkſhire*, are of this ſpecies.

4. *Volcanic aluminous ore.* Such is that of *Solfaterra* near *Naples.* It is in the form of a white ſaline earth, after it has effloreſced in the air; or elſe it is in a ſtony form.
5. *Bituminous alum ore.* Is called *ſhale*, and is in the form of a ſhiſtus, impregnated with ſo much oily matter or bitumen, as to be inflammable. Is found in Sweden, and alſo in the coal mines at *Whitehaven*, and elſewhere.
6. Alum might alſo be extracted from many ſpecies of pyrites, but ſo contaminated with iron, as ſcarce to pay the expences of the operation. It may be alſo extracted from calamine, and pyritaceous foſſil woods: which laſt are employed in ſome aluminous works at Bohemia and Heſſe, as the noble author aſſerts. *Editor chiefly from Kirwan.*

ſlates to the pit-coal, in proportion as the quantity of the phlogiſton encreaſes, and the quantity of the earth decreaſes (ſuch as will be mentioned in Sect. 159 of the Author). It is the 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 flame ſpontaneouſly upon certain occaſions, according to what the celebrated experiments of Lemery, and others, demonſtrate, and from which cauſe many volcanos and earthquakes may perhaps be deduced. The *pulvis pyrophorus* is alſo made of alum [b], intimately united with a phlogiſtic ſubſtance; in the preparing of which, they ought carefully to avoid that any

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[b] Bergman ſeems to affirm that alum, unleſs it has ſome mixture of vegetable alkali, as the Roman alum has, is not fit for making the pyrophorus: but Morveau thinks that no alkali is required for its production, and quotes various reſiduums which are true pyrophori without containing any alum at all, as may be ſeen in the memoir of Prouſt inſerted in the ſupplement of the *Journal de Phyſique* for 1778, p. 432. Almoſt every ſubſtance which leaves, after its decompoſition, a coaly matter, ſimply divided by an earth, or a metallic calx, poſſeſſes the ſame pyrophoric property. See the laſt paper of my late worthy friend Mr. Bewly, inſerted in the fourth volume of Dr. Prieſtley's work *on different kinds of air*, page 485, where he ſpeaks of Mr. Prouſt's firſt obſervations on this ſubject of pyrophori. *The Editor*.

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.

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8. Fixed alkalies precipitate the copper from a ſolution of this ſalt, in the form of a blue powder, which on drying becomes greeniſh; but
9. The precipitation by the volatil alkali, is at firſt of a whitiſh blue, and afterwards takes a fine deep blue colour. This together with the quality of N°. 7. diſcovers its baſis: as its uniform mixture with other vitriolic ſalts does its acid. In general the blue colour produced by the volatil alkali is a characteriſtic of the preſence of copper in any ſolution.
10. It melts eaſily on the fire: loſes its water of cryſtallization; is reduced to a whitiſh blue powder: and is at length almoſt intirely decompoſed in a violent fire, the acid being ſeparated from its baſis.
11. Urged by the flame of the blow-pipe on a piece of charcoal, it froths at firſt with noiſe, giving a green flame, and the metallic particles are often reduced to a ſhing globule of copper, leaving an irregularly figured ſcoria. But with borax, the ſcoria is diſſolved, and forms a green glaſs.

This ſalt rarely occurs cryſtallized: but is often found naturally diſſolved in water, in *Hungary*, *Sweden*, and *Ireland*: from this water a blue vitriol is generally prepared. Theſe natural waters are called *cementatory* or *cementing* ones. According to Monet, this concrete ſalt when found naturally formed, only proceeds from the evaporation of ſuch waters.

It is alſo occaſionally extracted from ſulphurated copper ores, after torrefaction. *The Editor chiefly from* Kirwan *and* Mongez.

SECT.

Cornea, or *Argentum Salitum*) mentioned by the noble Author in his Sect. 134; the ſaline quickſilver or muriatic mercury &c. *Bergman's* Sciagraphia.

SECT. 205. (122. 2.)

Vitriol of Copper. Blue Vitriol. *Vitriolum Veneris, ſeu Cyprium. Cupprum Vitriolatum* [a].

This is of a deep blue colour: and is found in all *Ziment waters*, as they are called; for inſtance, at Neuſohl in Hungary, in St. Johan's mine

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[a] This neutral metallic ſalt is a combination of the vitriolic acid with copper.

1. Its colour is blue: and, being long expoſed to the air, it degenerates into a ruſty yellow blue.
2. Requires *four times* its weight of water, to be diſſolved in the temperature of *ſixty* degrees of Fahrenheit.
3. Its ſpecific gravity is about 2236.
4. One *hundred* parts of this ſalt contain thirty of vitriolic acid: twenty-ſeven of copper: and forty-three of water.
5. *Eighty* parts of iron precipitate one *hundred* of copper from a ſolution of this ſalt, if it does not contain a notable exceſs of acid. *Kirwan.*
6. This ſalt has a harſh, ſtiptic, metallic taſte.
7. If rubbed on a wet knife, or poliſhed plate of iron, or if ſuch a body be dipped into a ſolution of this ſalt, it will almoſt immediately be covered with a copperous reddiſh coat; becauſe the acid, by its ſtronger attraction to the iron, corrodes it, and leaves the copper behind.

S E C T. 207. (122. 1.)

Martial Vitriol. Vitriol of Iron. Common green Vitriol, or Coperas. *Vitriolum martis ſimplex. Ferrum Vitriolatum* [a].

This is the common green vitriol, which is naturally found diſſolved in water, and is produced

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[a] This metallic neutral ſalt reſults from the combination of the vitriolic acid (§ 127.) with iron.

1. It is of a greeniſh colour when perfectly and recently cryſtallized; but
2. Effloreſces by being expoſed to the air, becomes yellowiſh, and is covered with a kind of ruſt. Sometimes it becomes *white* by long ſtanding (ſee the end of this note.)
3. It requires ſix times its weight of water, in the temperature of ſixty degrees, to be diſſolved.
4. Has an aſtringent harſh and acidulous taſte.
5. Expoſed to a moderate heat, even to that of the ſunſhine, it falls into an yellowiſh powder; but
6. On being expoſed to a ſudden heat, it melts: and on cooling, aſſumes a whitiſh brown colour.
7. When ſtrongly urged by fire, it loſes its acid, becomes of a dark red colour, and is then called *colcothar*, a powder which is employed in poliſhing metals; and to which our artiſts have applied the improper name of *crocus martis*, though this name only belongs to the *yellow* preparations of the iron-calces, uſed in pharmacy, and in enameling, &c.
8. Pure fixed alkali precipitates the iron from its ſolution, in deep green flakes: the mild alkali, in a greeniſh white colour:

duced in abundance by decayed or calcined marcaſites.

SECT.

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colour: pure volatil alkali, in ſo deep a green that it appears black: but the mild volatil alkali precipitates it in a greyiſh-green colour.

9. All vegetable aſtringents, as the tincture o *ftea*, *quinquina*, *gales*, &c. precipitate the iron in a black colour, from whence they are uſed as teſts to diſcover its preſence in chemical analyſes: and it is from this black precipitate that the common writing-ink is made, being diluted in water, and there ſuſpended by the Arabic or Senegal gums. Macquer adviſes to add eight ounces of *galls* coarſely powdered with three of green vitriol, and as much of *gum arabic*, in two pints of cold water, which is to be paſſed through a ſieve, after twenty-four hours ſtanding, for uſe. The proportions I have long employed, conſiſt of eight ounces of gales broken into ſmall pieces, with four ounces of green vitriol, equally divided into two pint bottles, or into a large one of leather, half filled with water, which I leave hanging behind the door of my ſtudy, to be ſhaken by its motion. From theſe I occaſionally fill the ink-ſtand, adding to it two or three pinches of fine powdered gum-arabic; and putting in the bottle as much water as taken off, until the ink becomes ſo pale as to require a ſupply of freſh materials.

10. One hundred parts of this ſalt, recently cryſtallized, contain twenty of real vitriolic acid: twenty-five of iron: and fifty-five of water.

11. Its acid is known by this: viz. that its ſolution mixes without turbidity with the ſolutions of other ſalts, that contain vitriolic acid, as *Epſom*, *Selenite*, *vitriolated tartar*, &c.

12. And the baſis of this metallic ſalt is known by the black colour, produced by the ſolution of vegetable aſtringents, as mentioned N 9.

13. On being urged by the flame thrown by the blow-pipe, it offers the ſame phenomena as the vitriol of copper, except that it does not colour the flame.

Green

SECT. 208. (Additional.)

Aerated iron. *Ferrum aeratum.*

This metallic ſalt is a combination of the aerial acid (of Sect. 167.) with iron: and is found in

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Green vitriol is frequently found native, either in coal mines, or in the cavities of pyritaceous mines, or adhering to their ſcaffolds in a ſtalactitical form. It is found alſo in ſmall round ſtones, called *ink-ſtones*, of a white, red, grey, yellow, or black colour, which are almoſt ſoluble in water, and contain a portion of copper and zinc. Alſo ſometimes in form of ſhiſtus or ſlaty pyritaceous ſtones. But the greateſt part of that in uſe, is prepared by art, from the martial pyrites or mundic.

Martial pyrites is an iron ore, containing from one-ſixth to one-third of *ſulphur*, from one-eighth to five-eighth of *iron:* and the remainder conſiſts of *argill* and *ſillex:* the three firſt are intimately combined with each other, and the iron is in a ſemiphlogiſticated ſtate.

1. It ſtrikes fire with ſteel, from whence it has its name.
2. It is generally of a *yellow* or *grey* colour.
3. Is of a globular or cubic ſhape, internally radiated: and ſometimes is lamellar.
4. Commonly is partly ſoluble in *nitrous acid* with effervefcence.
5. With *vitriolic acid* it diſſolves ſlowly, and forms *allum.*
6. Detonates with nitre: and
7. Is very infuſible.
8. Its ſpecific gravity is from 3700 to 4912.

Some *pyrites* inſtead of *argillaceous*, contain *calcareous earth.* Theſe are common in France, and their iron is in a dephlogiſticated ſtate.

Pyrites

in the light-Chalibeate waters, where it is diſſolved by an exceſs of this acid.

Pyrites are frequently found in a ſtalatactical ſhape: and often form the matter of petrifications. They are alſo found mixed and interſperſed through almoſt every ſort of ſtones, except granits.

Thoſe of a *filamentous* or ſtriated texture contain leaſt *ſulphur:* thoſe of a lamellar, moſt. Theſe laſt effloreſce difficultly, if at all: and are ſaid to contain from twenty-five to thirty-five per cent of *ſulphur*.

Vitriol is formed out of theſe ſtones, by *expoſing* them a long time to the action of the air and moiſture: or by *torrefaction* in open air, and ſubſequent expoſition to its action, which operation in ſome caſes muſt be often repeated, according to the proportion of their ſulphur and the nature of their earth. The calcareous pyrites are thoſe of which it is moſt eaſily formed, as they effloreſce the ſooneſt.

Good pyrites properly treated, yield about two-thirds of their weight of vitriol.

Vitriol is alſo prepared from mineral waters that hold copper in ſolution, which is precipitated by iron, this ſolution of the iron is afterwards cryſtallized, and always retains ſome copper.

In Hungary it is prepared from pyritaceous ſhiſtus: and in many places from a ſpecies of calamine. The vitriol of *Goſlaar* commonly contains a portion of *zinc*; as that of *Hungary* and *Saxony* does of *copper*. The *Engliſh* and *French vitriols* are purer; yet ſometimes contain a ſmall portion of *alum*.

Turf and *peat* are ſometimes impregnated with vitriol: other earths alſo often contain vitriol and alum. This vitriol is ſometimes found of a *white colour*, on the borders of the mineral Lakes of *Tuſcany*. Even the artificial Engliſh vitriol becomes ſometimes *white* after a great length of time, as I found this very day in a paper bag of it in ſmall pieces, among the materials for making ink, which I had forgotten above theſe ſix or eight years paſt on a ſhelf in my ſtudy. *The Editor chiefly from* Kirwan.

Mr. Lane, F. R. S. of London was the firſt that diſcovered in England the action of the aerial acid on iron, when the water is impregnated with that menſtrum. The late Mr. Rouelle demonſtrated the ſame phenomenon in France, upon this and other metals.

But the celebrated Profeſſor Bergman ſeems to have preceded them both, nearly about the ſame time, though neither had any knowledge of each other's diſcoveries.

" As far as I know (ſays Pr. Bergman in " his Treatiſe on *Aerial acid)* fixed air alone, in " its elaſtic ſtate, does not diſſolve, nor even " corrodes any metal . . . but, when united with " water, it attacks ſome of them."

The great volatility of this acid is the cauſe, why this neutral ſalt is not often found. For the mere evaporation of the ferrugineous mineral waters, in order to analyze them, is ſufficient to let looſe the *aerial acid:* ſo that the iron which was there diſſolved by its power, falls down to the bottom in the form of a light ore, which amounts to nearly $\frac{1}{10440}$ of the weight of the water: and, when freſh, retains ſo much phlogiſton as to obey the magnet, as Bergman ſays.

" Iron ſays the ſame Profeſſor (*de Analyſi* " *aquarum*), when barely ſaturated with aerial " acid, refuſes to unite with water; but may " be taken up when this ſubtile menſtruum is " ſuperabundant in water. This ſuperabundance " adheres but ſlightly, and therefore flies " off during evaporation . . . a pellicle is found

" entire

" entire (on the evaporating water), when
" formed by iron; and in this caſe is tinged
" with the different priſmatic colours . . . (ac-
" cording) to the various degrees of tenuity, or
" various ſtates of dephlogiſtication in the (me-
" tallic) particles."

SECT. 209. (Additional.)

Vitriol of Cobalt, vitriolated Cobalt. *Cobaltum vitriolatum.*

This metallic ſalt reſults from the combination of the vitriolic acid with cobalt.

3. It is of a roſy colour, when artificially made;
4. Effloreſces when expoſed to the action of the atmoſphere: and
5. Takes then a greeniſh colour mixed with a pale purple, or a *Lilas colour* as the French call it.
1. When found native, it is always in an effloreſcent ſtate, from whence it ariſes that, in this caſe,
2. Its colour is greeniſh, mixed with a grey tint: but
6. It is difficultly ſoluble in water, and
7. Its ſolution is of a red colour.

8. The

8. The phlogiſticated alkali precipitates the cobalt from the ſolution of this ſalt, which with borax gives an azure glaſs.

By the above qualities, chiefly the roſy-colour of the ſolution of this neutral ſalt, its baſis is ſufficiently diſtinguiſhed. As to its acid, it is eaſily known by the ſame teſts, as thoſe of the preceding vitriols.

It is ſaid to be found native in ſmall pieces, mixed with a greeniſh efflloveſcence in cobalt mines. *Editor from* Kirvan *and* Mongez.

N. B. *Halotrichium*, *Trichites* or native alum, mixed with vitriol of cobalt will be treated of in Sect. 221.

SECT. 210. (122. 3.)

Vitriol of Zink. Vitriolated Zink. White Vitriol. *Zincum Vitriolatum. Vitriolum Zinci* [a].

Is white and clear as alum: and is found at Rammelſberg in the Hartz, as alſo in the rubbiſh

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[a] This middle metallic ſalt reſults from the combination of vitriolic acid with zink.

1. Its colour is white.
2. Requires little more than twice its weight of water to diſſolve it in the temperature of ſixty degrees of Fahrenheit's thermometer: and depoſits a greyiſh yellow powder.
3. Its ſpecific gravity is 2000.
4. Its taſte is very ſtyptic.
5. It mixes uniformly with vitriolic neutral ſalts.
6. Precipitates nitrous or marine ſelenites from their ſolutions, by which its acid is aſcertained.
7. It is precipitable in a whitiſh powder by alkalies, and earths: but
8. Neither iron, copper, nor zink precipitate it: by this circumſtance its baſis is ſufficiently indicated.
9. If it contains any other metallic principle, this may be precipitated by adding more zink to the ſolution; excepting iron, which will of itſelf precipitate by expoſure to the air, or boiling in an open veſſel.
10. One hundred parts of this metallic ſalt contain twenty-two of vitriolic acid: twenty of zink, and fifty-eight of water.

11. Urged

rubbiſh at Stollgrufvan in Weſtmanland, where the mock lead has decayed either ſpontaneouſly, or after having been burnt.

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11. Urged by fire, it loſes a good part of its acid.
12. Treated with the blow-pipe, it exhibits nearly the ſame phenomena, as other metallic vitriols: except only that the flame is brilliant when the zinc is reduced, and gives out white flocs, called *flowers of zinc.*

This neutral metallic ſalt is ſometimes found native, mixed with vitriol of iron and in the form of white hairy cryſtals, or in a ſtalactitical form in the mines of *Hungary*, *Goſlaar:* or as an efflorefcence on ores of zinc.

It is alſo found diſſolved in mineral waters, and generally with ſome proportion of vitriols of iron and copper.

Bergman ſays, that this ſalt is ſometimes produced by the decompoſition of *pſeudogalæna*, or *black jack*; but this rarely happens, becauſe this ſubſtance does not readily decompoſe ſpontaneouſly. Sciag. § 73.

But that in common uſe is moſtly prepared at Goſlaar, from an ore, which contains *zinc*, *copper*, and *lead*, mineralized by *ſulphur*, and a little iron. The copper is firſt ſeparated as much as poſſible: the remainder after torrefaction and diſtillation, is thrown red-hot into water, and lixiviated. It is never free from iron. *Editor from* Kirwan *and* Mongez.

SECT.

SECT. 211. (Additional.)

Vitriolated Nickel, or Vitriol of Nickel. *Niccolum Vitriolatum.*

This is a middle or neutral metallic ſalt, which reſults from the combination of the vitriolic acid with Nickel. It exiſts ſometimes, in conſequence of the decompoſition of the ſulphureous ores of this ſemimetal. It is found native efflorcſcing on *Kupfer-nickel:* and generally mixed with vitriol of iron.

It is of a green colour, as well as its ſolution.

It is precipitated by zinc; but when joined with iron, this laſt is not precipitated by the ſame.

Its origin is perhaps owing to the decompoſition of the pyritaceous and ſulphurous ore of Kupfer-nickel mentioned by Wallerius, p. 190 of the ſecond volume of his Mineralogy publiſhed in 1778. This ore contains a great quantity of arſenic and ſulphur, as well as cobalt, nickel and iron. And if it comes to be decompoſed in the bowels of the earth, it is natural to expect that the vitriolic acid of the *ſulphur* will attack the nickel and the iron, with which it will form neutral metallic ſalts. *Editor from* Mongez *and* Kirwan.

SECT. 212. (Additional.)

Muriatic Manganeſe. *Manganeſium Salitum.*

Mr. Hielm is the only perſon who has as yet found this middle ſalt, in ſome mineral waters of *Sweden*. It is compoſed by the combination of the regulus of Manganeſe with muriatic acid.

1. It is precipitated of a whitiſh yellow colour, by the Pruſſian [phlogiſticated] alkali: and of a browniſh yellow, by the mineral alkali.
2. It does not cryſtallize, in any diſtinct form.
3. It abſtracts the moiſture of the air.
4. To obtain its baſis free from iron, it muſt be precipitated by the mineral alkali: rediſſolved in nitrous acid; then calcined until this acid is expelled: and the reſiduum is to be treated with diſtilled vinegar, which will then take up only the manganeſe. *The Editor from* Kirwan.

SECT. 213. (Additional.)

Obſervations on the metallic Salts of the preceding Sections.

It has been already obſerved Sect. 172. after Macquer, that this kind of ſalts are the leaſt ſaturated of all neutral ſalts: and of courſe do not poſſeſs a perfect degree of neutralization.

Thoſe already mentioned ſubſequent to Sect. 204. are the only ones that have been found formed by nature, and on this account they are entitled to enter into a ſyſtem of Mineralogy.

But many other metallic combinations with ſome of the mineral ſalts, may be ſtill diſcovered, which muſt be then added to thoſe already known. Our very ingenious and profound chemiſt Mr. Kirwan has already pointed out various methods of diſtinguiſhing ſome of theſe ſalts which in all probability will be found, when mineralogical reſearches ſhall be purſued, with a due attention to the indiſpenſable aſſiſtance of chemiſtry. The preparatory inſtructions as laid down by that eminent philoſopher, may be ſeen in various parts of his truly valuable Elements of Mineralogy, to which the reader is referred, as a book which the editor of this work ardently recommends to all ſuch as are deſirous of acquiring a real knowledge of theſe uſeful proceſſes.

The ſame philoſopher affirms (page 194) that the vitriols of *copper*, *iron*, and *zinc*, are according to our noble Author, frequently found mixed in waters pumped out of mines: that ſome times all three are found cryſtallized in lumps of a yellow colour: and that Bergman affirms the vitriol of *Fahlun* in *Sweden* to contain all three. But theſe and other triple ſalts are to make the ſubject of the following Order. *The Editor.*

ORDER THE SIXTH.

SECT. 214. (Additional.)

Triple Salts. *Sales triplices.*

THE Neutral ſalts hitherto enumerated are ſuch as are compoſed of two ingredients only; but ſometimes three or more are ſo united as not to be ſeparated by cryſtallization. The vitriols that we are acquainted with, are hardly ever pure, and two or three of them ſometimes are joined together.

Sometimes likewiſe it happens that neutral ſalts join earthy ſalts, and earthy ſalts metallic ones. I generally diſtinguiſh compound ſalts according to the number of their principles, whether the ſame acid be joined to ſeveral baſes, or the ſame baſe to different acids; or laſtly, whether ſeveral menſtrua and ſeveral baſes are joined together. Hence ariſe ſalts triple, quadruple, &c. which the diligence of after-times muſt illuſtrate. I ſubjoin the moſt remarkable examples of triple and quadruple native-ſalts which have occurred to me. *Berg. Sciag.* § 75.

SECT. 215. (137.) Aphronitrum.

Mineral Alkali with a ſmall quantity of calcareous earth. *Alkali ſalis communis, terræ calcareæ parva portione combinatum.* Aphro nitrum [*a*].

Whatever the noble Author ſays of the Aphronitrum *in his Sect.* 137, *ſeems to belong with greater propriety to the* calcareous nitre, *combined with* mineral alkali, *which is in fact a* triple ſalt, *and of courſe belongs to this order, notwithſtanding that the ſame has been claſſed among the* alkalies in Sect. 170. [*b*]. *His words are the following.*

“ This

[*a*] The celebrated Wallerius in the ſecond volume, page 46, of his Mineralogy, printed at Vienna in 1778, calls this ſalt by the name of *Aphronitrum:* and recites the experiments of Cartheuſer, who aſſerts, that, on throwing into its ſolution in water, a fixed mineral alkali, the calcareous earth was precipitated: and on the contrary, that by the addition of oil of vitriol, a nitrous acid was expelled, and a *Glauber's ſalt* was produced; from which it is evident that the aphronitrum is a *triple ſalt* ariſing from the combination of the *nitrous acid* with *calcareous earth* and *mineral fixed alkali*. *The Editor.*

[*b*] The ſame Profeſſor Wallerius in page 65 of that edition already quoted in the preceding Note *a*, ſpeaks of three ſpecies of Aphronitrum, viz. one that contains only a mixture of *calcareous earth* with *fixed mineral alkali:* this he affirms to be the *aphronitrum* of the *antients:* and adds in page 44, that it ought rather to be called *aphronatron*, which ſeems to be a very proper remark; ſince the ſame Antients gave the name

" 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 [c].

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 criſtals: but when it is purer, the cryſtals ſhoot into a priſmatick figure.

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name of *natron* to the mineral alkali, as was ſaid in Note *a* to page 333.

The ſecond Aphronitrum mentioned by Wallerius, is the *calcareous nitre* of Sect. 190.

And the third is that neutral ſalt deſcribed by Fr. Hoffman by the name of *Aphronitrum jenenſe*, into whoſe compoſition the vitriolic acid enters; it is a kind of *Sal mirabile glauberi*: and is with great reaſon confounded with it, as is ſaid in the text. *The Editor.*

[c] From theſe words of the Author it appears, that this is not only a *triple*, but a *multiple* ſalt; as theſe pieces of old mortar covered with this white froſt, on antient walls, are the very ſame from which the ſaltpetre-makers extract the *mother-water* of nitre, after mixing therewith the vegetable aſhes, to furniſh the alkaline baſe to it. Mr. Fourcroy ſays in his ſeventeenth Lecture that this mother-water contains not only *nitre*, but five other kinds of ſalt, viz. the *marine ſalt*, *nitrous-magneſia*, *calcareous-nitre*, *magneſia-nitrata*, and *calx-ſalita*: to which the Chymiſts of Dijon add the *digeſtive ſalt of Sylvius*, and in ſome caſes various *vitriols* with *alkaline*, or *earthy baſes*. See *Elemens de Chymie de l'Acad. de Dijon*, vol. II. p. 133. *The Editor.*

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 very often confounded with the *ſal mirabile Glauberi.*

S E C T. 216. (Additional.)

Common ſalt with magneſia: or muriatic mineral alkali contaminated by muriatic magneſia. *Alkali minerale ſalitum, magneſia ſalita inquinatum.*

This is a compound of the common ſalt with muriatic magneſia: and by the expreſſion *contaminated* (*inquinatum*) of profeſſor Bergman, already explained in the Note to page 340, we may ſuppoſe that the magneſian ſalt is not intimately united to the alkaline baſe.

This triple ſalt is very deliqueſcent, a quality it owns to its integrant part the *muriatic magneſia* of Sect. 198. For the pure muriatic alkali does not deliqueſce: but this degree of purity is ſeldom found; even in the native foſſil or *ſal gem* of Sect. 179. In general all the earthy marine ſalts are very deliqueſcent, as the *muriatic chalk* of Sect. 191; the *muriatic barytes* of Sect. 194; and the *muriatic magneſia* of Sect. 198. *Editor from* Bergman, Macquer, *and* Mongez.

SECT.

SECT. 217. (133.)

Mineral alkali with Succinous acid, and phlogiſton. *Amber, Succinum.*

See this ſubſtance among the *Inflammables*, in Sect. 146 of the Author, viz. Sect. 234 of this edition.

SECT. 218. (Additional.)

Vitriolated magneſia with vitriol of iron. Epſom ſalt contaminated with Copperas. *Magneſia Vitriolata, Vitriolo Martis inquinata.*

This triple ſalt is found in ſome mineral waters, according to Mr. Monet, in his Treatiſe on theſe waters. *Berg. Sciag.* § 77.

SECT. 219. (Additional.)

Native-alum contaminated by Copperas. Vitriolated argil with vitriol of Iron. *Alumen nativum vitriolo martis coinquinatum.*

This triple ſalt is found in the aluminous ſhiſtus. It ſometimes effloreſces in a feathery form. Perhaps this is the *plumoſe alum* of the antients.

antients. Cartheuſer, in his *Elemens of Mineralogy* quoted by Wallerius, reckons the *plumoſe alum* among the martial vitriolic ſubſtances, and calls it *white martial native vitriol*, affirming that it is compoſed of longitudinal fibres or filaments, which are flexible and very cloſe to one another. He obſerves,

1. That it has an acid ſtyptic taſte.
2. That its ſolution is turned into a black-purple, by that of galls.
3. And that, with the alkaline ſalts, the colour is of an obſcure or deep green, which in both caſes becomes afterwards yellow: and its tranſparency diſappears, depoſiting a martial precipitate.

But as in Egypt, Macedonia, and Milo, is found a kind of native alum already mentioned (Sect. 200, p. 389), which conſiſts of ſtrait ſmall filaments of a whitiſh colour, poſſeſſing the taſte and other properties of the ſimple alum; there is no reaſon to confound this earthy ſalt, which Wallerius calls *Trichites of Dioſcorides*, with the triple ſalt of this Section. *See* Wallerius's Mineralogy, *vol.* II. *page* 32 *of the edition of* 1778, and the following Sect. 221 concerning the *Trichites of Dioſcorides*. The Editor from Berg. and Mongez.

SECT.

SECT. 220. (Additional.)

Native alum, contaminated by Sulphur. *Argilla vitriolata Sulphure inquinata.*

At the places about Wedneſbury and Bilſton, in Staffordſhire, where the coal pits are on fire, this ſubſtance ſublimes to the ſurface; and may be collected, in conſiderable quantity, during dry or froſty weather. I cannot be certain that this is a true chemical union, but the eye cannot diſtinguiſh the parts. Perhaps the ſulphur volatilizes the alum: and ſo becomes intimately mixed with it. The exceſs of vitriolic acid keeps it in a deliqueſcent ſtate.

I believe a ſimilar compound ſubſtance ſublimes at the Solfaterra near Naples. Dr. *Withering.*

SECT. 221. (Additional.)

Native Alum contaminated by vitriolated Cobalt. *Alumen nativum vitriolo Cobalti inquinatum.*

In the mines of Herregrund and Idria this ſalt may be ſeen ſhooting out into long ſlender filaments. Perhaps this is the *trichites* of the Greeks.

1. Diſſolved in water, it immediately betrays the preſence of vitriolic acid, upon the ad-

dition of *terra ponderoſa ſalita* (muriatic acid ſaturated with heavy earth.)

2. By the addition of phlogiſticated alkali, a precipitate of cobalt is thrown down, which makes a blue glaſs with borax, or microcoſmic ſalt. *Berg. Sciag.*

Mr. Mongez ſays that, according to Ferber, Scopoli, and the Baron de Dietrick, no traces of cobalt are found with the minerals of Idria: and that by the deſcription of the *trichites* given by Dioſcorides, it appears to be the ſame triple ſalt already deſcribed in Sect. 219. So that, according to Mongez, both the ſuſpicion of Bergman in the preſent Section, and the opinion of Wallerius above-mentioned (in the ſame Sect. 219.) who calls the *plumoſe alum* of Sect. 200. by this name of *trichites*, moſt neceſſarily fall to the ground. *Editor.*

SECT. 222. (123.)

Vitriol of copper with iron. *Vitriolum ferrum et cuprum continens. Vitriolum cupri martiali contaminatum* [a].

This triple ſalt is of a blueiſh green colour. Sometimes the *blue* predominates over the *green:* and ſometimes this laſt over the *blue.* Berg. Sciag. § 80.

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[a] This is the *vitriolum ferreo cupreum cyaneum* of Linnæus. Its colour varies, being ſometimes more or leſs green; and ſometimes more or leſs blue. It is found at Saltzberg and at Falhun. This vitriol is called *vitriol of Hungary*, becauſe it is found in the Hungarian mines, is of this kind. *Mongez.*

SECT. 223. (123. 2.)

Vitriol of copper, iron, and zinc. *Vitriolum cuprum ferrum et zincum continens. Vitriolum cupri, et martiali et zincino inquinatum* [a].

This ſalt 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 criſtals 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.

SECT. 224. (123. 4.)

Vitriol of copper and zinc. *Vitriolum cupreo-zinceum.*

This is the blue vitriol from Goſlar [b].

SECT.

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[a] This quadruple ſalt is the *vitriolum ferreo-zinceo-Cupreum cyaneum* of Linnæus. Its colour is of a blue inclining to green. If rubbed on a poliſhed ſurface of iron, the copper is not precipitated thereby, as it happens to the blue vitriol of Sect. 205; which ſhows that the vitriolic acid is perfectly ſaturated, in this ſalt, by the three metallic baſes. *Mongez.*

[b] According to Mongez, this is the *vitriolum zinceo-Cupreum cæruleum* of Linnæus 105. 7. The ſame author (Mr. Mongez) makes a ſeparate article of that compound ſalt, mentioned

SECT. 225. (123. 3.)

Vitriol of iron and zinc. *Vitriolum zinco-ferreum.*

This is the green vitriol from Goſlar in the Hartz [a].

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tioned by Wallerius (Spec. 231. e.) which conſiſts alſo of a vitriolated copper with *zinc*, but whoſe cryſtals are of a fine *red colour*, found lately, as Wallerius ſays, in the Fahlun mines: and adds, that the pale-blue colour of the firſt ſalt ſhows the predominancy of the copper, by which it is neceſſarily diſtinguiſhed from the ſecond, where the vitriol is over ſaturated (*ſur composè*). I do not know whether a greater quantity of copper or of zinc, or of both, may furniſh this ſalt with a *red colour*: but I ſhould rather apprehend that it is owing to a proper quantity of iron in a *dephlogiſticated ſtate*, which has been overlooked in that compound. *See what has been ſaid of the* colours of iron *at page* 81 *of this volume.*

Wallerius refers alſo to this ſame kind, another *yellowiſh* ſalt found in Hungary, which ſeems to be in the ſame circumſtances as the preceding ſalt. *Editor.*

[a] According to Mongez, this is the *vitriolum zinceo ferreum viride* of Linnæus 105. 6. Its colour is of a pale-green caſt.

SECT.

SECT. 226. (123. 5.)

Vitriol of Iron and Nickel. *Vitriolum ferrum et niccolum continens.*

This ſalt is of a deep green colour, and is contained in the ochre, or decayed parts, of the Nickell, at the Cobalt-mines of Los, in the province of Helſingland [a].

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[a] Moſt part of the vitriols owe their formation to art: becauſe when ſuch ores as contain ſulphur, are worked 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 watery vapours, diſſolving at the ſame time the metals; and it is thus that the vitriols are formed. Every ſort of ore does not commonly decay or wither in a natural manner, without being promoted by art; and this decaying or withering 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 withers 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 theſe vitriols, however, is not ſo perfectly neutraliſed by the metals, as it is by the alkali in the true neutral ſalts. *The Author.*

S E C T. 227. (143.)

Obſervations on Salts.

The perfect knowledge of theſe bodies muſt be had from chemical books and practical chemiſtry, as it conſtitutes the chief ſubject of that ſcience [a]. From thence we likewiſe learn why the

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[a] Chemiſts have given the character of *Saline* to thoſe ſubſtances, which are more or leſs, (1) *ſapid*; (2) *ſoluble* in water; and (3) *cryſtallizable*; (4) that poſſeſs the energy or power of *attraction* to combine with other bodies; and (5) that are *incombuſtible*.

The *three* firſt qualities flow naturally from the *fourth*; ſince the moſt *ſapid* ſubſtances are thoſe which have the greateſt *energy* or *power* of *attraction* to combine with other bodies. When this power is of a higher degree, they are called *cauſtic* and alſo *corroſive*; becauſe they act violently on our organs and other bodies, and deſtroy their texture, in a ſimilar manner as fire does, when in contact with them.

But when ſalts become *ſaturated*, that is to ſay when they meet with a ſufficient quantity of a proper matter to prevent the exertion of their great energy, they become *mild*. In general, theſe two epithets, *cauſtic* or *mild*, are applied to *alkaline* ſalts, when *deprived* of, or *ſaturated* with, *aerial acid*: and when their *corroſiveneſs* is lowered by being mixed with water, they are then ſaid to be *diluted*.

In the ſame manner, when ſalts poſſeſs a leſs power of attraction, ſo as not to corrode the texture of other bodies, particularly of our own organs, they have accordingly a degree of *taſte*, more or leſs remarkable to our ſenſes; and of courſe are called *ſapid*; whoſe varieties we diſtinguiſh by the words *ſweet*, *ſour*, *bitter*, *aſtringent*, and other terms expreſſive of the ſenſation they cauſe on our palate.

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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

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But when this quality is ſo feeble as not to be perceived at all, we call them *inſipid* or taſteleſs; although by the phenomena of their combinations with other bodies, we are certain of their attractive power, or of their being really *ſaline*.

It is likewiſe owing to the power of attraction, that ſalts become *ſoluble* in water. Thoſe, between which and water, a greater energy of this power ſubſiſts, are called *deliqueſcent*; becauſe the watery particles, which are diſperſed in the atmoſphere, become attracted by them in preference to the aerial maſs, in which the laſt were contained. But thoſe ſalts which require the help of another force, ſuch as that of gravity or heat, to bring them, to a nearer vicinity or contact between one another, ſo as to facilitate the exertion of their ſmall attraction to the watery particles, are in fact *ſoluble*, but *not deliqueſcent*.

It is owing alſo to the power of attraction between the conſtituent parts of ſalts, that they *cryſtallize* under various and variable forms. This happens when the watery particles in which they are kept in ſolution, are ſucceſſively reduced into vapour by virtue of their ſuperior attraction to air, and to the ſurrounding bodies in contact with them. It is however required for this purpoſe that a certain ſlow proceſs of time be allowed, in order that the ſaline particles may exert their *mutual attraction* according to their *polarity*, by which expreſſive word is to be underſtood that each ſaline particle is endued in one of its ſides or ends, with a different degree of energy (or perhaps of repulſion) ſo that it rather unites, when at liberty, with one of the ſides of another ſimilar particle; ſo as to form, by this particular agregation, a ſymetrical figure of a regular ſhape, as will be mentioned in the following Note. Theſe are indeed meer conjectures upon a ſubject, of which our own ſenſes cannot bear the leaſt teſtimony for our conviction. But it is eaſily conceived, that theſe regular ſhapes may be diſturbed by various circumſtances, and we find be eſſential to ſalts, and by its varieties to mark out their different ſpecies, depends on an alcali, earth, and metals, united with more or leſs water: for otherwiſe, the cryſtals of alum and vitriol

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find this to be the caſe with various ſalts, which are ſuſceptible of different forms, although their conſtituent parts be really the ſame.

But when the watery fluid, in which ſalts are diſſolved, happens to be drived off by a conſiderable violence of heat, they for the moſt part aſſume no cryſtalline form, but become a ſolid maſs of a more or leſs granular texture, or of a glaſſy appearance, according to the nature of their conſtituent parts.

Metals are in the ſame caſe in regard to fire, as ſalts are to water: for when their particles are ſet into motion by the introduction of a large quantity of elementary fire, as ſoon as this ſubſtance diſperſes itſelf through the ſurrounding bodies, they become either a ſolid maſs without any particular cryſtalline ſhape, if ſuddenly abandoned; or elſe they diſpoſe themſelves into ſymmetrical forms, and aſſume a regular ſhape, provided they be allowed to cool ſlowly enough, ſo that the partial attraction between the ſides or ends of their conſtituent parts may be exerted. This evidently appears by the curious experiments of Mr. Mongez, who produced this new kind of cryſtals from almoſt all known metals, only by letting them cool after fuſion, with a very ſlow gradation.

As to the *fifth* character of ſalts, viz. that of being *incombuſtible bodies*, as Dr. Cullen and Mr. Fourcroy aſſert, it ſeems by far a more difficult matter to ſettle: ſince Dr. Prieſtley found *volatil alkali* to be partly *inflammable*, and the ſame has been further confirmed, as Mr. Fourcroy mentions in a Note, by Mr. Cornette, who affirms it to be *very combuſtible*. Nor is it at all as yet demonſtrated what Mr. Fourcroy pretends, viz. that ſalts are compound ſubſtances, formed by the union of ſome combuſtible bodies with *pure* or *dephlogiſticated air*; from whence he concludes, that thoſe formerly called *ſimple* ſalts, only deſerve the name of *primitive*, as every one of them is in fact a true *compound*. But, although from the combuſtion of *ſulphur*, *phoſphorus*, and *arſenic*, acids of theſe denominations be produced, no ſimilar reſults are found, as far triol ought to be of the ſame figure; no *nitrum cubicum* would exiſt; nor could any cryſtalliſation happen in ſuch ſubſtances, as contain no acid. *See Sect.* 11. *Note f.* [b].

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

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far as we know, after other combuſtions: and, until conſtant productions be the conſequence of ſimilar proceſſes, it is quite unwarrantable to draw general concluſions. In fact it is well known that *acids* are found already formed, independently from any previous combuſtion; and that even *alkalies* exiſt already formed in plants before their incineration, as was mentioned Note *a* to Sect. 169, and Sect. 174. The Reader may ſee a good abſtract of theſe and other new Theories, in a paper of Mr. de la Metherie inſerted in the *Journal du Phyſique* for January 1786, and more fully in the *Elementary Lectures of Chemiſtry by Mr. Fourcroy*, already tranſlated into Engliſh, with Notes, in 2 vols. 8vo. *The Editor.*

[b] Very little can be ſaid, to good purpoſe, on the ſubject of cryſtallization; becauſe no experiments have penetrated ſo far into the myſteries of nature, as to afford any demonſtration of its cauſe. Whether the parts of bodies have a polarity with reſpect to each other, or whether their ſhapes may reſpectively be the cauſe of thoſe admirably regular figures we often ſee in unorganized bodies, is uncertain: but it appears to be eſtabliſhed beyond controverſy, that all bodies whatſoever which become ſolid from a ſtate of fluidity, have a diſpoſition to aſſume certain peculiar ſymmetrical forms, or arrangements of their parts; though the variety of almoſt imperceptible impediments, ariſing from temperature and the due doſes of parts, that, either deſignedly or accidentally, enter into the compound, makes it nearly impoſſible to bring the conſideration of theſe figures to any practical uſe. *See Note* a *to page* 164. The Editor.

than thoſe which are found truly changed in the earth [c].

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 that Miners ought to 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.

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[c] I think it neceſſary to add a few words concerning the diſpoſition I have followed in the Sections of this Second Claſs of mineral bodies. Various additions of new foſſil ſalts having been diſcovered ſince the firſt publication of this work: I have arranged them in the ſame order, the late celebrated Profeſſor Bergman made uſe of in his Sciagraphia, as far as the end of the Second Order, or Sect. 171.

But with regard to the compound ſalts of the following Sections, I thought it more regular to range each of them according to its baſe, by the ſame order as it ſtands in the preceding Sections of the *alkalis*, following at the ſame time the order of the acids already adopted in the firſt part of this claſs; or of the *earths* treated of in the firſt claſs of this Mineralogy; or laſtly of the *metals*, as they are ſet forth by the Noble Author in the fourth or laſt claſs of this work. *The Editor.*

END OF THE FIRST VOLUME.