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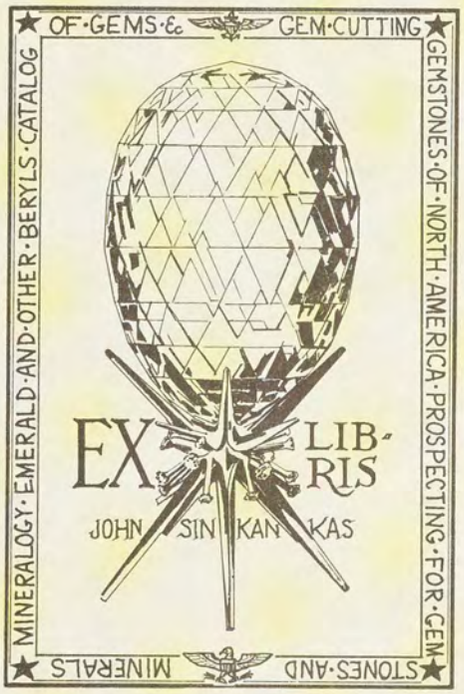

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THE THIRD EDITION, IN EIGHTEEN VOLUMES, GREATLY IMPROVED.

ILLUSTRATED WITH FIVE HUNDRED AND FORTY-TWO COPPERPLATES.

VOL. XII.

INDOCTI DISCANT, ET AMENT MEMINISSE PERITI.

EDINBURGH,
PRINTED FOR A. BELL AND C. MACFARQUHAR.
MDCCXCVII.

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Suppl. after p. 146

Minehead.	*Names of Springs.*	*Countries in which they are found.*	*Contents and Quality of the Water.*	*Medical Virtues.*	Minehead.
	Tarleton,	Lancaſhire in England.	Similar to Scarborough water.		
	Tewkſbury,	Glouceſterſhire in England.	Similar to Acton.		
	Thetford,	Norfolk in England.	Foſſile alkali, fixed air, and iron.	Purgative and diuretic.	
	Thoroton,	Nottinghamſhire in England.	Similar to Orſton.		
	Thurſk,	Yorkſhire in England.	Similar to Scarborough.		
	Tibſhelf,	Derbyſhire in England.	Iron diſſolved in fixed air.	Similar to Spaw water.	
	Tilbury,	Eſſex in England.	Foſſile alkali.	Diuretic and diaphoretic.	
	Tober Bony,	Near Dublin in Ireland.	Foſſile alkali, earth, and bituminous oil.	Similar to Tilbury.	
	Tonſtein,	Cologne in Germany.	Foſſile alkali.	Similar to Seltzer, but more purgative.	
	Tralee,	Kerry in Ireland.	Similar to Caſtle Connel.		
	Tunbridge,	Kent in England.	Iron, ſome ſea-ſalt, with a little ſelenites and calcareous earth.	An excellent chalybeate, uſeful in all diſeaſes for which the Spaw is recommended.	
	Upminſter,	Eſſex in England.	Sulphur, foſſile alkali, and purging ſalt.	Purgative and diuretic.	
	Vahls,	Dauphiny in France.	Foſſil alkali.	Diuretic and laxative.	
	Wardrew,	Northumberland.	Sulphur, earth, and ſea-ſalt.	Similar to Harrowgate water.	
	Weatherſtack,	Weſtmoreland in England.	Iron, ſea-ſalt, and a ſmall quantity of hepatic gas.	Purgative.	
	Wallenfrow,	Northamptonſhire in England.	Similar to Iſlington water.		
	Weſt Aſhton,	Wiltſhire in England.	Similar to Iſlington.		
	Weſtwood,	Derbyſhire in England.	Green vitriol.	Similar to Shadwell. Uſed for waſhing ulcers of the legs.	
	Wexford,	Ireland.	Similar to Iſlington.		
	Whiteacre,	Lancaſhire in England.	Aerated iron and probably calcareous earth.	Somewhat aſtringent.	
	Wiggleſworth,	Yorkſhire in England.	Sulphur, earth, and common ſalt.	Emetic in the quantity of two quarts, and ſaid to be cathartic in the quantity of three; a ſingular circumſtance if true.	
	Wildungan,	Waldech in Germany.	Similar to the waters of Bath.	Uſeful in ſcorbutic and gouty diſeaſes.	
	Witham,	Eſſex in England.	Aerated iron, and common ſalt.	Diuretic, alterative, and corroborant.	
	Wirkſworth,	Derbyſhire in England.	Sulphur, purging ſalt, and aerated iron.	Uſeful in ſcrofulous and cutaneous diſeaſes.	
	Zahorovice,	Germany.	Similar to Nezdenice water.	Much eſteemed in ſcrofulous caſes.	

MINEHEAD, a town of Somerſetſhire, 166 miles from London. It is an ancient borough, with a harbour in the Briſtol channel, near Dunſter caſtle, much frequented by paſſengers to and from Ireland. It was incorporated by Queen Eliſabeth, with great privileges, on condition the corporation ſhould keep the quay in repair; but its trade falling off, the quay was neglected, and they loſt their privileges. A ſtatute was obtained in the reign of King William, for recovering the port, and keeping it in repair, by which they were to have the profits of the quay and pier for 36 years, which have been computed at about 200 l. a year; and they were at the expence of new-building the quay. In purſuance of another act, confirming the former, a new head has been built to the quay, the beach cleared, &c. ſo that the biggeſt ſhip may enter, and ride ſafe in the harbour. The town contains about 500 houſes, and 2000 ſouls. It was formerly governed by a portreve, and now by two conſtables choſen yearly at a court-leet held by the lord of the manor. Its chief trade is with Ireland, from whence about 40 veſſels uſed to come hither in a year with wool; and about 4000 chaldrons of coals are yearly imported at this place. Watchet and Poriock, from South Wales, which lies directly oppoſite to it, about ſeven leagues over, the common breadth of this channel all the way from Holmes to the Land's End. Here are ſeveral rich merchants, who have ſome trade alſo to Virginia and the Weſt Indies; and they correſpond much with the merchants of Barneſtaple and Briſtol in their foreign commerce. Three or four thouſand barrels of herrings, which come up the Severn in great ſhoals about Michaelmas, are caught, cured, and ſhipped off here every year, for the Mediterranean, &c. The market here is on Wedneſday, and fair on Whitſun-Wedneſday.

MINERALOGY,

IS that ſcience which teaches us the properties of mineral bodies, and by which we learn how to characteriſe, diſtinguiſh, and claſs them into a proper order.

INTRODUCTION.

MINERALOGY ſeems to have been in a manner coeval with the world. Precious ſtones of various kinds appear to have been well known among the Jews and Egyptians in the time of Moſes; and even the moſt rude and barbarous nations appear to have had ſome knowledge of the ores of different metals. As the ſcience is nearly allied to chemiſtry, it is probable that the improvements both in chemiſtry and mineralogy have nearly kept pace with each other; and indeed it is but of late, ſince the principles of chemiſtry were well underſtood, that mineralogy has been advanced to any degree of perfection. The beſt way of ſtudying mineralogy, therefore, is by applying chemiſtry to it; and not contenting ourſelves merely with inſpecting the outſides of bodies, but decompounding them according to the rules of chemiſtry. This method has been brought to the greateſt perfection by Mr Pott of Berlin, and after him by Mr Cronſtedt of Sweden. To obtain this end, chemical experiments in the large way are without doubt neceſſary: but as a great deal of the mineral kingdom has already been examined in this manner, we do not need to repeat all thoſe experiments in their whole extent, unleſs ſome new and particular phenomena ſhould diſcover themſelves in thoſe things we are examining; elſe the tedioufneſſes of thoſe proceſſes might diſcourage ſome from going farther, and take up much of the time of others that might be better employed. An eaſier way may therefore be adopted, which even for the moſt part is ſufficient, and which, though made in miniature, is as ſcientifical as the common manner of proceeding in the laboratories, ſince it imitates that, and is founded upon the ſame principles. This conſiſts in making the experiments upon a piece of charcoal with the concentrated flame of a candle directed through a blow-pipe. The heat occaſioned by this is very intenſe; and the mineral bodies may here be burnt, calcined, melted, and ſcorified, &c. as well as in any great works.

For a deſcription of the blow-pipe, the method of uſing it, the proper fluxes to be employed, and the different ſubjects of examination to which that inſtrument is adapted, ſee the article *Blow-Pipe*, where all thoſe particulars are conciſely detailed. It may not be improper here, however, to reſume thoſe details at greater length; avoiding, at the ſame time, all unneceſſary repetitions. After which we ſhall exhibit a ſcientific arrangement of the mineral kingdom, according to the moſt approved ſyſtem.

PART. I. EXPERIMENTAL MINERALOGY; with a DESCRIPTION of the NECESSARY APPARATUS (A).

SECT. I. *Of Experiments upon Earths and Stones.*

WHEN any of theſe ſubſtances are to be tried, we muſt not begin immediately with the blow-pipe; but ſome preliminary experiments ought to go before, by which thoſe in the fire may afterwards be directed. For inſtance, a ſtone is not always homogeneous, or of the ſame kind throughout, although it may appear to the eye to be ſo. A magnifying glaſs is therefore neceſſary to diſcover the heterogeneous particles, if there be any; and theſe ought to be ſeparated, and every part tried by itſelf, that the effects of two different things, examined together, may not be attributed to one alone. This might happen with ſome of the finer micæ, which are now and then found mixed with ſmall particles of quartz, ſcarcely to be perceived by the eye. The trapp (in German *ſchwartzſtein*) is alſo ſometimes mixed with very fine particles of feltſpar *(ſpatum ſcintillans)* or of calcareous ſpar, &c. After this experiment, the hardneſs of the ſtone in queſtion muſt be tried with ſteel. The flint and garnets are commonly known to ſtrike fire with ſteel; but there are alſo other ſtones, which, though very ſeldom, are found ſo hard as likewiſe to ſtrike fire. There is a kind of trapp of that hardneſs, in which no particles of feltſpar are to be ſeen. Coloured glaſſes reſemble true gems; but as they are very ſoft in proportion to theſe, they are eaſily diſcovered by means of the file. The common quartz-cryſtals are harder than coloured glaſſes, but ſofter than the gems. The loadſtone diſcovers the preſence of iron, when it is not mixed in too ſmall a quantity in the ſtone, and often before the ſtone is roaſted. Some kinds of hæmatites, and particularly the cœruleſcens, greatly reſemble ſome other iron ores; but this diſtinguiſhes itſelf from them by a red colour when pounded, the others giving a blackiſh powder, and ſo forth.

The management of the *Blow-pipe* has been deſcribed under that article; but a few particulars may be here recapitulated, or added.

The candle ought to be ſnuffed often, but ſo that the top of the wick may retain ſome fat in it, becauſe the flame is not hot enough when the wick is almoſt burnt to aſhes; but only the top muſt be ſnuffed off, becauſe a low wick gives too ſmall a flame. The blue flame is the hotteſt; this ought, therefore, to be forced

(A) From Engeſtrom's *Treatiſe on the Blow-Pipe*, and Magellan's *Deſcription of Pocket-Laboratories*, &c. ſubjoined to the Engliſh Tranſlation of *Cronſtedt's Mineralogy*, 2d edit. in 2 vols. Dilly.

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forced out when a great heat is required, and only the point of the flame muſt be directed upon the ſubject which is to be eſſayed. M. Magellan recommends, as being moſt cleanly and convenient, that the candle be made of wax, and the wick ſhould be thicker than ordinary. Its upper end muſt be bended towards the matter intended to be heated, and the ſtream of air muſt be directed along the ſurface of the bended part, ſo as not abſolutely to touch it.

The piece of charcoal made uſe of in theſe experiments muſt not be of a diſpoſition to crack. If this ſhould happen, it muſt gradually be heated until it does not crack any more, before any aſſay is made upon it. If this be not attended to, but the aſſay made immediately with a ſtrong flame, ſmall pieces of it will ſplit off in the face and eyes of the aſſayer, and often throw along with them the matter that was to be aſſayed. Charcoal which is too much burnt conſumes too quick during the experiment, leaving ſmall holes in it, wherein the matter to be tried may be loſt; and charcoal that is burnt too little, catches flame from the candle, burning by itſelf like a piece of wood, which likewiſe hinders the proceſs.

Of thoſe things that are to be aſſayed, only a ſmall piece muſt be broken off for that purpoſe, not bigger than that the flame of the candle may be able to act upon it at once, if required; which is ſometimes neceſſary, as, when the matter requires to be made red hot throughout, the piece ought to be broken as thin as poſſible, at leaſt the edges; the advantage of which is obvious, the fire having then more influence upon the ſubject, and the experiment being more quickly made.

Some of the mineral bodies are very difficult to be kept ſteady upon the charcoal during the experiment, before they are made red hot; becauſe, as ſoon as the flame begins to act upon them, they ſplit aſunder with violence, and are diſperſed. Such often are thoſe which are of a ſoft conſiſtence or a particular figure, and which preſerve the ſame figure in however minute particles they are broken; for inſtance, the calcareous ſpar, the ſparry gypſum, ſparry fluor, white ſparry lead-ore, the potters ore, the teſſellated mock-lead or blende, &c. even all the common fluors which have no determinate figure. Theſe not being ſo compact as common hard ſtones, when the flame is immediately urged upon them, the heat forces itſelf through and into their clefts or pores, and cauſes this violent expanſion and diſperſion. Many of the clays are likewiſe apt to crack in the fire, which may be for the moſt part aſcribed to the humidity, of which they always retain a portion.

The only way of preventing this inconvenience is to heat the body as ſlowly as poſſible. It is beſt, firſt of all, to heat that place of the charcoal where the piece is intended to be put on; and afterwards lay it thereon: a little crackling will then enſue, but commonly of no great conſequence. After that, the flame is to be blown very ſlowly towards it, in the beginning not directly upon, but ſomewhat above it, and ſo approaching nearer and nearer with the flame until it become red hot. This will do for the moſt part; but there are nevertheleſs ſome, which, notwithſtanding all theſe precautions, it is almoſt impoſſible to keep on the charcoal. Thus the fluors are generally the moſt difficult; and as one of their principal characters is diſcovered by their effects in the fire *per ſe*, they ought neceſſarily to be tried that way. To this purpoſe, it is beſt to make a little hole in the charcoal to put the fluor in, and then to put another piece of charcoal as a covering upon this, leaving only a ſmall opening for the flame to enter. As this ſtone will nevertheleſs ſplit and fly about, a larger piece thereof than is before-mentioned muſt be taken, in order to have at leaſt ſomething of it left.

But if the experiment is to be made upon a ſtone whoſe effects one does not want to ſee in the fire *per ſe*, but rather with fluxes, then a piece of it ought to be forced down into melted borax, when always ſome part of it will remain in the borax, notwithſtanding the greateſt part may ſometimes fly away by cracking.

1. *Of ſubſtances to be tried in the fire* per ſe. As the ſtones undergo great alterations when expoſed to the fire by themſelves, whereby ſome of their characteriſticks, and often the moſt principal, are diſcovered, they ought firſt to be tried that way, obſerving what has been ſaid before concerning the quantity of matter, direction of the fire, &c. The following are generally the reſults of this experiment.

Calcareous earth or *ſtone*, when it is pure, does not melt by itſelf, but becomes white and friable, ſo as to break freely between the fingers; and, if ſuffered to cool, and then mixed with water, it becomes hot, juſt like common quick-lime. As in theſe experiments only very ſmall pieces are uſed, this laſt effect is beſt diſcovered by putting the proof on the outſide of the hand, with a drop of water to it, when inſtantly a very quick heat is felt on the ſkin. When the calcareous ſubſtance is mixed with the vitriolic acid, as in gypſum, or with a clay, as in marle, it commonly melts by itſelf, yet more or leſs difficultly in proportion to the differences of the mixtures. Gypſum produces generally a white, and marle a grey, glaſs or ſlag. When there is any iron in it, as a white iron ore, it becomes dark, and ſometimes quite black, &c.

The *ſiliceæ* never melt alone, but become generally more brittle after being burnt. Such of them as are coloured become colourleſs, and the ſooner when it does not ariſe from any contained metal; for inſtance, the topazes, amethiſts, &c. ſome of the precious ſtones, however, excepted: And ſuch as are mixed with a quantity of iron grow dark in the fire, as ſome of the jaſpers, &c.

Garnets melt always into a black ſlag, and ſometimes ſo eaſily that they may be brought into a round globule upon the charcoal.

The *argillaceæ*, when pure, never melt, but become white and hard. The ſame effects follow when they are mixed with phlogiſton Thus the ſoap-rock is eaſily cut with the knife; but being burnt it cuts glaſs, and would ſtrike fire with the ſteel, if as large a piece as is neceſſary for that purpoſe could be tried in this way. The ſoap-rocks are ſometimes found of a dark brown and nearly black colour, but nevertheleſs become quite white in the fire like a piece of China ware. However, care muſt be taken not to urge the flame from the top of the wick, there being for the moſt part a ſooty ſmoke, which commonly will darken all that it touches; and, if this is not obſerved, a miſtake in the experiment might eaſily happen. But if

On Earths and Stones.

it is mixed with iron, as it is ſometimes found, it does not ſo eaſily part with its dark colour. The argillaceæ when mixed with lime melt by themſelves, as above-mentioned. When mixed with iron, as in the boles, they grow dark or black; and if the iron is not in too great a quantity, they melt alone into a dark ſlag; the ſame happens when they are mixed with iron and a little of the vitriolic acid, as in the common clay, &c.

Mica and *aſbeſtos* become ſomewhat hard and brittle in the fire, and are more or leſs refractory, though they give ſome marks of fuſibility.

The *fluors* diſcover one of their chief characteriſtics by giving a light like phoſphorus in the dark, when they are ſlowly heated; but loſe this property, as well as their colour, as ſoon as they are made red hot.—They commonly melt in the fire into a white opaque ſlag, though ſome of them not very eaſily.

Some ſorts of the *zeolites* melt eaſily, and foam in the fire, ſometimes nearly as much as borax, and become a frothy ſlag, &c.

A great many of thoſe mineral bodies which are impregnated with iron, as the *boles*, and ſome of the white iron ores, &c. as well as ſome of the other iron ores, viz. the bloodſtone, are not attracted by the loadſtone before they have been thoroughly roaſted, &c.

2. *Of ſubſtances heated with fluxes.* After the mineral bodies have been tried in the fire by themſelves, they ought to be heated with fluxes to diſcover if they can be melted or not, and ſome other phenomena attending this operation. For this purpoſe, three different kinds of ſalts are uſed as fluxes, viz. ſal ſodæ, borax, and ſal fuſible microſmicum; (ſee the article *Blow-Pipe*).

The *ſal ſodæ* is, however, not much uſed in theſe ſmall experiments, its effects upon the charcoal rendering it for the moſt part unfit for it; becauſe, as ſoon as the flame begins to act upon it, it melts inſtantly, and is almoſt wholly abſorbed by the charcoal. When this ſalt is employed to make any experiment, a very little quantity is wanted at once, viz. about the cubical contents of an eighth part of an inch, more or leſs. This is laid upon the charcoal, and the flame blown on it with the blow-pipe; but as this ſalt commonly is in form of a powder, it is neceſſary to go on very gently, that the force of the flame may not diſperſe the minute particles of the ſalt. As ſoon as it begins to melt, it runs along on the charcoal, almoſt like melted tallow; and when cold, it is a glaſſy matter of an opaque dull colour ſpread on the coal. The moment it is melted, the matter which is to be tried ought to be put into it, becauſe otherwiſe the greateſt part of the ſalt will be ſoaked into the charcoal, and too little of it left for the intended purpoſe. The flame ought then to be directed on the matter itſelf; and if the ſalt ſpreads too much about, leaving the proof almoſt alone, it may be brought to it again by blowing the flame on its extremities, and directing it towards the ſubject of the experiment. In the aſſays made with this ſalt, it is true, we may find whether the mineral bodies which are melted with it have been diſſolved by it or not: but we cannot tell with any certitude whether this is done haſtily and with force, or gently and ſlow; nor whether a leſs or a greater part of the matter has been diſſolved: neither can it be well diſtinguiſhed if the matter has imparted any weak tincture to the flag; becauſe this ſalt always bubbles upon the charcoal during the experiment, nor is it clear when cool; ſo that ſcarcely any colour, except it be a very deep one, can be diſcovered, although it may ſometimes be coloured by the matter that has been tried.

The following earths are entirely *ſoluble* in this flux with efferveſcence: Agate; chalcedony; carnelian; Turkey ſtone †, *(cos Turcica)*; fluor mineralis †; onyx; opal; quartz; common flint; ponderous ſpar. The following are *diviſible* in it with or without efferveſcence, but not entirely ſoluble: Amianthus; aſbeſtus; baſaltes; chryſolite ‡; granate ‡; hornblende; jaſper; marlſtone; mica; the mineral of alum from Tolfa; petroſilex; aluminous ſlate and roof ſlate from Helſingia; emeralds; ſteatites; common flint; ſchoerl; talc; trapp; tripoli; tourmalin. And the following are neither fuſible nor diviſible in it: Diamond; hyacinth; ruby; ſapphire; topaz.

The other two ſalts, viz. *borax* and the *ſal microcoſmicum*, are very well adapted to theſe experiments, becauſe they may by the flame be brought to a clear uncoloured and tranſparent glaſs; and as they have no attraction to the charcoal, they keep themſelves always upon it in a round globular form. The ſal fuſible microſmicum§ is very ſcarce, and perhaps not to be met with in the ſhops; it is made of urine.

§ See *Chemiſtry*, n° 905, 906.

The following earths are ſoluble in borax, with more or leſs *efferveſcence*: Fluor mineralis †; marle; mica †; the mineral of alum from Tolfa; aluminous ſlate, and roof-ſlate from Helſingia †; ponderous ſpar; ſchoerl; talc †; tourmalin. And the following *without* efferveſcence; Agate; diamond; amianthus; aſbeſtus; baſaltes; chalcedony; cornelian; chryſolite; cos turcica; granate; hyacinth *; jaſper; lapis ponderoſus; onyx; opal; petro-ſilex; quartz *; ruby; ſapphire; common flint *; ſteatite; trapp; trippel, or tripoli; topaz; zeolite; hydrophanes.

In the microcoſmic ſalt, the following are ſoluble with more or leſs efferveſcence: Baſaltes †; turkey ſtone ‡; fluor mineralis †; marle; mica; the mineral of alum from Tolfa; ſchiſtus aluminaris, ſchiſtus tegularis from Helſingia †; ſchoerl; ſpathum ponderoſum; tourmalin †; lapis ponderoſus. And the following without viſible efferveſcence: Agate; diamond; amianthus; aſbeſtus; chalcedony; carnelian; chryſolite; granate; hyacinth; jaſper; onyx ‖; opal; petroſilex; quartz ‖; ruby; ſapphire; common flint ‖; emerald; talc; topaz; trapp; trippel; zeolite; hornblend; hydrophanes; lithomarga; ſteatites.

Calcareous earth, ponderous ſpar, gypſum, and other additaments, often aſſiſt the ſolution, as well in the microcoſmic ſalt as in borax. To which it is neceſſary to add, that in order to obſerve the efferveſcence properly, the matter added to the flux ſhould be in the form of a ſmall particle rather than in fine powder; becauſe in this laſt there is always air between the particles, which being afterwards driven off by the heat afford the appearance of a kind of efferveſcence (A).

The

(A) In the above liſts, the articles marked † efferveſce very little; thoſe marked ‡ not at all; thoſe marked * require a larger quantity of the flux and a longer continuance of heat than the reſt; thoſe marked ‖ are more difficultly diſſolved than the others.

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The quantity of thoſe two ſalts required for an experiment is almoſt the ſame as the *ſal ſodæ*; but as the former are cryſtalliſed, and conſequently include a great deal of water, particularly the borax, their bulk is conſiderably reduced when melted, and therefore a little more of them may be taken than the before-mentioned quantity.

Both thoſe ſalts, eſpecially the borax, when expoſed to the flame of the blow-pipe, bubble very much and foam before they melt to a clear glaſs, which for the moſt part depends on the water they contain. And as this would hinder the aſſayer from making due obſervations on the phenomena of the experiment, the ſalt which is to be uſed muſt firſt be brought to a clear glaſs before it can ſerve as a flux; it muſt therefore be kept in the fire until it become ſo tranſparent that the cracks in the charcoal may be ſeen through it. This done, whatſoever is to be tried is put to it, and the fire continued.

Here it is to be obſerved, that for the aſſays made with any of theſe two fluxes on mineral bodies, no larger pieces muſt be taken than that altogether they may keep a globular form upon the charcoal; becauſe it may then be better diſtinguiſhed in what manner the flux acts upon the matter during the experiment. If this be not obſerved, the flux, communicating itſelf with every point of the ſurface of the mineral body, ſpreads all over it, and keeps the form of this laſt, which commonly is flat, and by that means hinders the operator obſerving all the phenomena which may happen. Beſides, the flux being in too ſmall a quantity in proportion to the body to be tried, will be too weak to act with all its force upon it. The beſt proportion therefore is about a third part of the mineral body to the flux; and as the quantity of the flux above mentioned makes a globe of a due ſize in regard to the greateſt heat that is poſſible to procure in theſe experiments, ſo the ſize of the mineral body muſt be a third part leſs here than when it is to be tried in the fire by itſelf.

The *ſal ſodæ*, as has been already obſerved, is not of much uſe in theſe experiments; nor has it any particular qualities in preference to the two laſt mentioned ſalts, except that it diſſolves the zeolites eaſier than they do.

The microcoſmic ſalt ſhows almoſt the ſame effects in the fire as the borax, only differing from it in a very few circumſtances; of which one of the principal is, that, when melted with manganeſe, it becomes of a crimſon hue inſtead of a jacinth colour, which borax takes. This ſalt is, however, for its ſcarcity ſtill very little in uſe, borax alone being that which is commonly employed. Whenever a mineral body is melted with any of theſe two laſt mentioned ſalts, in the manner already deſcribed, it is eaſily ſeen, Whether it quickly diſſolves; in which caſe an effervеſcence ariſes, that laſts till the whole be diſſolved: Whether the ſolution be ſlowly performed; in which caſe few and ſmall bubbles only riſe from the matter: or, Whether it can be diſſolved at all; becauſe, if not, it is obſerved only to turn round in the flux, without the leaſt bubble, and the edges look as ſharp as they were before.

In order farther to illuſtrate what has been ſaid about theſe experiments, we ſhall give a few examples of the effects of borax upon the mineral bodies.—The *calcareous* ſubſtances, and all thoſe ſtones which contain any thing of lime in their compoſition, diſſolve readily and with effervеſcence in the borax. The effervеſcence is the more violent the greater the portion of lime contained in the ſtone. This cauſe, however, is not the only one in the gypſum, becauſe both the conſtituents of this do readily mix with the borax, and therefore a greater effervеſcence ariſes in melting gypſum with the borax than lime alone.—The *ſiliceæ* do not diſſolve; ſome few excepted which contain a quantity of iron.—The *argillaceæ*, when pure, are not acted upon by the borax: but when they are mixed with ſome heterogeneous bodies, they are diſſolved, though very ſlowly; ſuch are, for inſtance, the ſtone-marrow, the common clay, &c.

The *granates*, *zeolites*, and *trapp*, diſſolve but ſlowly. The *fluors*, *aſbeſtinæ*, and *micaceæ*, diſſolve for the moſt part very eaſily; and ſo forth.—Some of theſe bodies melt to a colourleſs tranſparent glaſs with the borax; for inſtance, the calcareous ſubſtances when pure, the fluors, ſome of the zeolites, &c. Others tinge the borax with a green tranſparent colour, *viz.* the granates, trapp, ſome of the argillaceæ, and ſome of the micaceæ and aſbeſtinæ. This green has its origin partly from a ſmall portion of iron which the granates particularly contain, and partly from phlogiſton.

Borax can only diſſolve a certain quantity of the mineral body proportional to its own. Of the calcareous kind it diſſolves a vaſt quantity; but turns at laſt, when too much has been added, from a clear tranſparent to a white opaque flag. When the quantity of the calcareous matter exceeds but little in proportion, the glaſs looks very clear as long as it remains hot: but as ſoon as it begins to cool, a white half opaque cloud is ſeen to ariſe from the bottom, which ſpreads over the third, half, or more of the glaſs globe, in proportion to the quantity of calcareous matter; but the glaſs or flag is nevertheleſs ſhining, and of a glaſſy texture when broken. If more of this matter be added, the cloud riſes quicker and is more opaque, and ſo by degrees till the flag becomes quite milk white. It is then no more of a ſhining, but rather dry appearance, on the ſurface; is very brittle, and of a grained texture when broken.

Sect. II. *Of Experiments upon Metals and Ores.*

What has been hitherto ſaid relates only to the *ſtones* and *earths*: We ſhall now proceed to deſcribe the manner of examining *metals* and *ores*. An exact knowledge and nicety of procedure are ſo much the more neceſſary here, as the metals are often ſo diſguiſed in their ores, as to be very difficultly known by their external appearance, and liable ſometimes to be miſtaken one for the other: Some of the cobalt ores, for inſtance, reſemble much the *pyrites arſenicalis*; there are alſo ſome iron and lead ores, which are nearly like one another, &c.

As the ores generally conſiſt of metals mineraliſed with ſulphur or arſenic, or ſometimes both together, they ought firſt to be expoſed to the fire by themſelves, in order not only to determine with which of theſe they are mineraliſed, but alſo to ſet them free from thoſe volatile mineraliſing bodies: This ſerves inſtead of calcination, by which they are prepared for further aſſays.

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Here it muſt be repeated, that whenever any metal or fuſible ore is to be tried, a little concavity muſt be made in that place of the charcoal where the matter is to be put; becauſe, as ſoon as it is melted, it forms itſelf into a globular figure, and might then roll from the charcoal, if its ſurface was plain; but when borax is put to it, this inconvenience is not ſo much to be feared.

Whenever an ore is to be tried, a ſmall bit being broke off for the purpoſe, it is laid upon the charcoal, and the flame blown on it ſlowly. Then the ſulphur or arſenic begins to part from it in form of ſmoke: theſe are eaſily diſtinguiſhed from one another by their ſmell; that of ſulphur being ſufficiently known, and the arſenic ſmelling like garlick. The flame ought to be blown very gently as long as any ſmoke is ſeen to part from the ore; but after that, the heat muſt be augmented by degrees, in order to make the calcination as perfect as poſſible. If the heat be applied very ſtrongly from the beginning upon an ore that contains much ſulphur or arſenic, the ore will preſently melt, and yet loſe very little of its mineraliſing bodies, by that means rendering the calcination very imperfect. It is, however, impoſſible to calcine the ores in this manner to the utmoſt perfection, which is eaſily ſeen in the following inſtance, *viz.* in melting down a calcined potter's ore with borax, it will be found to bubble upon the coal, which depends on the ſulphur which is ſtill left, the vitriolic acid of this uniting with the borax, and cauſing this motion. However, lead in its metallic form, melted in this manner, bubbles upon the charcoal, if any ſulphur remains in it. But as the lead, as well as ſome of the other metals, may raiſe bubbles upon the charcoal, although they are quite free from the ſulphur, only by the flames being forced too violently on it, theſe phenomena ought not to be confounded with each other.

The ores being thus calcined, the metals contained in them may be diſcovered, either by being melted alone or with fluxes; when they ſhow themſelves either in their pure metallic ſtate, or by tinging the ſlag with a colour peculiar to each of them. In theſe experiments it is not to be expected that the quantity of metal contained in the ore ſhould be exactly determined; this muſt be done in larger laboratories. This cannot, however, be looked upon as any defect, ſince it is ſufficient for a mineralogiſt only to find out what ſort of metal is contained in the ore. There is another circumſtance, which is a more real defect in the miniature laboratories, which is, that ſome ores are not at all capable of being tried by ſo ſmall an apparatus; for inſtance, the gold ore called *pyrites aureus*, which conſiſts of gold, iron, and ſulphur. The greateſt quantity of gold which this ore contains is about one ounce, or one ounce and an half, out of 100 pounds of the ore, the reſt being iron and ſulphur: and as only a very ſmall bit is allowed for theſe experiments, the gold contained therein can hardly be diſcerned by the eye, even if it could be extracted; but it goes along with the iron in the ſlag, this laſt metal being in ſo large a quantity in proportion to the other, and both of them having an attraction for each other.

The blendes and black-jacks, which are mineral zinc ores, containing zinc, ſulphur, and iron, cannot be tried this way, becauſe they cannot be perfectly calcined, and beſides the zinc flies off when the iron ſcorifies. Neither can thoſe blendes, which contain ſilver or gold mineraliſed with them, be tried in this manner, which is particularly owing to the imperfect calcination. Nor are the quickſilver ores fit for theſe experiments; the volatility of that ſemimetal making it impoſſible to bring it out of the poorer ſort of ores: and the rich ores, which ſweat out the quickſilver when kept cloſe in the hand, not wanting any of theſe aſſays, &c. Thoſe ores ought to be aſſayed in larger quantities, and even with ſuch other methods as cannot be applied upon a piece of charcoal.

Some of the rich ſilver ores are eaſily tried: for inſtance, *minera argenti vitrea*, commonly called *ſilver-glaſs*, which conſiſts only of ſilver and ſulphur. When this ore is expoſed to the flame, it melts inſtantly, and the ſulphur goes away in fume, leaving the ſilver pure upon the charcoal in a globular form. If this ſilver ſhould happen to be of a dirty appearance, which often is the caſe, then it muſt be melted anew with a very little borax; and after it has been kept in fuſion for a minute or two, ſo as to be perfectly melted and red-hot, the proof is ſuffered to cool: it may then be taken off the coal; and being laid upon the ſteel-plate†, the ſilver is ſeparated from the ſlag by one or two ſtrokes of the hammer†. Here the uſe of the braſs ring† is manifeſt; for this ought firſt to be placed upon the plate, to hinder the proof from flying off by the violence of the ſtroke, which otherwiſe would happen. The ſilver is then found incloſed in the ſlag of a globular form, and quite ſhining, as if it was poliſhed. When a large quantity of ſilver is contained in a lead ore, *viz.* in a potter's ore, it can likewiſe be diſcovered through the uſe of the blow-pipe, of which more will be mentioned hereafter.

† See the article Blow-*Pipe*, and Plate XCIX.

Tin may be melted out of the pure tin ores in its metallic ſtate. Some of theſe ores melt very eaſily, and yield their metal in quantity, if only expoſed to the fire by themſelves: but others are more refractory; and as theſe melt very ſlowly, the tin, which ſweats out in form of very ſmall globules, is inſtantly burnt to aſhes before theſe globules have time to unite in order to compoſe a larger globe, which, might be ſeen by the eye, and not ſo ſoon deſtroyed by the fire; it is therefore neceſſary to add a little borax to theſe from the beginning, and then to blow the flame violently at the proof. The borax does here preſerve the metal from being too ſoon calcined, and even contributes to the readier collecting of the ſmall metallic particles, which ſoon are ſeen to form themſelves into a globule of metallic tin at the bottom of the whole maſs, neareſt to the charcoal. As ſoon as ſo much of the metallic tin is produced as is ſufficient to convince the operator of its preſence, the fire ought to be diſcontinued, though the whole of the ore be not yet melted; becauſe the whole of this kind of ore can be ſeldom or never reduced into metal by means of theſe experiments, a great proportion being always calcined: and if the fire is continued too long, perhaps even the metal already reduced may likewiſe be burnt to aſhes; for the tin is very ſoon deprived of its metallic ſtate by the fire.

Moſt part of the lead ores may be reduced to a metallic ſtate upon the charcoal. The *mineræ plumbi calciformes*, which are pure, are eaſily melted into lead;

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but ſuch of them as are mixed with an *ochra ferri*, or any kind of earth, as clay, lime, &c. yield very little of lead, and even nothing at all, if the heterogenea are combined in any large quantity: this happens even with the *minera plumbi calciformis arſenico mixta*. Theſe therefore are not to be tried but in larger laboratories. However, every mineral body ſuſpected to contain any metallic ſubſtance may be tried by the blow-pipe, ſo as to give ſufficient proofs whether it contain any or not, by its effects being different from thoſe of the ſtones or earths, &c.

The *mineræ plumbi mineraliſatæ* leave the lead in a metallic form, if not too large a quantity of iron is mixed with it. For example, when a teſſellated or ſteel-grained lead ore is expoſed to the flame, its ſulphur, and even the arſenic if there be any, begins to fume, and the ore itſelf immediately to melt into a globular form; the reſt of the ſulphur continues then to fly off, if the flame be blown ſlowly upon the maſs; but, on the contrary, very little of the ſulphur will go off, if the flame be forced violently on it: in this caſe, it rather happens that the lead itſelf crackles and diſſipates, throwing about very minute metallic particles. The ſulphur being driven out as much as poſſible, which is known by finding no ſulphureous vapour in ſmelling at the proof, the whole is ſuffered to cool, and then a globule of metallic lead will be left upon the coal. If any iron is contained in the lead-ore, the lead, which is melted out of it, is not of a metallic ſhining, but rather of a black and uneven, ſurface: a little borax muſt in this caſe be melted with it, and as ſoon as no bubble is ſeen to riſe any longer from the metal into the borax, the fire muſt be diſcontinued: when the maſs is grown cold, the iron will be found ſcorified with the borax, and the lead left pure and of a ſhining colour.

Borax does not ſcorify the lead in theſe ſmall experiments when it is pure: if the flame is forced with a violence on it, a bubbling will enſue, reſembling that which is obſerved when borax diſſolves a body melted with it; but when the fire ceaſes, the ſlag will be perfectly clear and tranſparent, and a quantity of very minute particles of lead will be ſeen ſpread about the borax, which have been torn off from the maſs during the bubbling.

If ſuch a lead ore is rich in ſilver, this laſt metal may likewiſe be diſcovered by this experiment; becauſe as the lead is volatile, it may be forced off, and the ſilver remain. To effect this, the lead, which is melted out of the ore, muſt be kept in conſtant fuſion with a ſlow heat, that it may be conſumed. This end will be ſooner obtained, and the lead part quicker, if during the fuſion the wind through the blow-pipe be directed immediately, though not forcibly, upon the melted maſs itſelf, until it begin to cool; at which time the fire muſt be directed on it again. The lead, which is already in a volatiliſing ſtate, will by this artifice be driven out in form of a ſubtil ſmoke; and by thus continuing by turns to melt the maſs, and then to blow off the lead, as has been ſaid, until no ſmoke is any longer perceived, the ſilver will at laſt be obtained pure. The ſame obſervation holds good here alſo, which was made about the gold, that, as none but very little bits of ores can be employed in theſe experiments, it will be difficult to extract the ſilver out of a poor ore; for ſome part of it will fly off with the lead, and what might be left is too ſmall to be diſcerned by the eye. The ſilver, which by this means is obtained, is eaſily diſtinguiſhed from lead by the following external marks, *viz.* that it muſt be red-hot before it can be melted: it cools ſooner than lead: it has a ſilver colour; that is to ſay, brighter and whiter than lead: and is harder under the hammer.

The *mineræ cupri calciformes* (at leaſt ſome of them), when not mixed with too much ſtone or earth, are eaſily reduced to copper with any flux; if the copper is found not to have its natural bright colour, it muſt be melted with a little borax, which purifies it. Some of theſe ores do not all diſcover their metal if not immediately melted with borax; the heterogenea contained in them hindering the fuſion before theſe are ſcorified by the flux.

The grey copper ores, which only conſiſt of copper and ſulphur, are tried almoſt in the ſame manner as above mentioned. Being expoſed to the flame by themſelves, they will be found inſtantly to melt, and part of their ſulphur to go off. The copper may afterwards be obtained in two ways: the one, by keeping the proof in fuſion for about a minute, and afterwards ſuffering it to cool; when it will be found to have a dark and uneven appearance externally, but which after being broken diſcovers the metallic copper of a globular form in its centre, ſurrounded with a regulus, which ſtill contains ſome ſulphur and a portion of the metal: the other, by being melted with borax, which laſt way ſometimes makes the metal appear ſooner.

The *mineræ cupri pyritaceæ*, containing copper, ſulphur, and iron, may be tried with the blow-pipe if they are not too poor. In theſe experiments the ore ought to be calcined, and after that the iron ſcorified. For this purpoſe a bit of the ore muſt be expoſed to a ſlow flame, that as much of the ſulphur as poſſible may part from it before it is melted, becauſe the ore commonly melts very ſoon, and then the ſulphur is more difficultly driven off. After being melted, it muſt be kept in fuſion with a ſtrong fire for about a minute, that a great part of the iron may be calcined; and after that, ſome borax muſt be added, which ſcorifies the iron, and turns with it to a black ſlag. If the ore is very rich, metallic copper will be had in the ſlag after the ſcorification. If the ore be of a moderate richneſs, the copper will ſtill retain a little ſulphur, and ſometimes iron: the product will therefore be brittle, and muſt with great caution be ſeparated from the ſlag, that it may not break into pieces; and if this product is afterwards treated in the ſame manner as before ſaid, in ſpeaking of the grey copper-ores, the metal will ſoon be produced. But if the ore is poor, the product after the firſt ſcorification muſt be brought into fuſion, and afterwards melted with ſome freſh borax, in order to calcine and ſcorify the remaining portion of iron; after which it may be treated as mentioned in the preceding paragraph. The copper will in this laſt caſe be found in a very ſmall globule.

The copper is not very eaſily ſcorified with this apparatus, when it is melted together with borax, unleſs it has firſt been expoſed to the fire by itſelf for a while in order to be calcined. When only a little of this metal is diſſolved, it inſtantly tinges the ſlag of a red-

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diſh brown colour, and moſtly opaque; but as ſoon as this flag is kept in fuſion for a little while, it becomes quite green and tranſparent: and thus the preſence of the copper may be diſcovered by the colour, when it is concealed in heterogeneous bodies, ſo as not to be diſcovered by any other experiment.

If metallic copper is melted with borax by a ſlow fire, and only for a very little time, the glaſs or flag becomes of a fine tranſparent blue or violet colour, inclining more or leſs to the green: but this colour is not properly owing to the copper, but it may rather be to its phlogiſton; becauſe the ſame colour is to be had in the ſame manner from iron; and theſe glaſſes, which are coloured with either of thoſe two metals, ſoon loſe their colour if expoſed to a ſtrong fire, in which they become quite clear and colourleſs. Beſides, if this glaſs, tinged blue with the copper, is again melted with more of this metal, it becomes of a good green colour, which for a long time keeps unchanged in the fire.

The iron ores, when pure, can never be melted *per ſe*, by the means of the blow-pipe alone; nor do they yield their metal when melted with fluxes; becauſe they require too ſtrong a heat to be brought into fuſion; and as both the ore and the metal itſelf very ſoon loſe their phlogiſton in the fire, and cannot be ſupplied with a ſufficient quantity from the charcoal, ſo likewiſe they are very ſoon calcined in the fire. This eaſy calcination is alſo the reaſon why the fluxes, for inſtance borax, readily ſcorify this ore, and even the metal itſelf. The iron loſes its phlogiſton in the fire ſooner than the copper, and is therefore more eaſily ſcorified.

The iron is, however, diſcovered without much difficulty, although it were mixed but in a very ſmall quantity with heterogeneous bodies. The ore, or thoſe bodies which contain any large quantity of the metal, are all attracted by the loadſtone, ſome without any previous calcination, and others without having being roaſted. When a clay is mixed with a little iron, it commonly melts by itſelf in the fire; but if this metal is contained in a limeſtone, it does not promote the fuſion, but gives the ſtone a dark and ſometimes a deep black colour, which always is the character of iron. A *minera ferri calciformis pura cryſtalliſata*, is commonly of a red colour: This being expoſed to the flame, becomes quite black; and is then readily attracted by the loadſtone, which it was not before. Beſides theſe ſigns, the iron diſcovers itſelf, by tinging the ſlag of a green tranſparent colour, inclining to brown, when only a little of the metal is ſcorified; but as ſoon as any larger quantity thereof is diſſolved in the ſlag, this becomes firſt a blackiſh brown, and afterwards quite black and opaque.

Biſmuth is known by its communicating a yellowiſh brown colour to borax; and arſenic by its volatility and garlick ſmell. Antimony, both in form of regulus and ore, is wholly volatile in the fire when it is not mixed with any other metal except arſenic; and is known by its particular ſmell, eaſier to be diſtinguiſhed when once known than deſcribed. When the ore of antimony is melted upon the charcoal, it bubbles conſtantly during its volatiliſing.

Zinc ores are not eaſily tried upon the coal; but the regulus of zinc expoſed to the fire upon the charcoal burns with a beautiful blue flame, and forms itſelf almoſt inſtantly into white flowers, which are the common flowers of zinc.

Cobalt is particularly remarkable for giving to the glaſs a blue colour, which is the zaffre or ſmalt. To produce this, a piece of cobalt ore muſt be calcined in the fire, and afterwards melted with borax. As ſoon as the glaſs, during the fuſion, from being clear, ſeems to grow opaque, it is a ſign that it is already tinged a little; the fire is then to be diſcontinued, and the operator muſt take hold, with the nippers, of a little of the glaſs, whilſt yet hot, and draw it out ſlowly in the beginning, but afterwards very quick, before it cools, whereby a thread of the coloured glaſs is procured, more or leſs thick, wherein the colour may eaſier be ſeen than in a globular form. This thread melts eaſily, if only put in the flame of the candle without the help of the blow-pipe.—If this glaſs be melted again with more of the cobalt, and kept in fuſion for a while, the colour becomes very deep; and thus the colour may be altered at pleaſure.

When the cobalt ore is pure, or at leaſt contains but little iron, a cobalt regulus is almoſt inſtantly produced in the borax during the fuſion; but when it is mixed with a quantity of iron, this laſt metal ought firſt to be ſeparated, which is eaſily performed ſince it ſcorifies ſooner than the cobalt; therefore, as long as the flag retains any brown or black colour, it muſt be ſeparated, and melted again with freſh borax, until it ſhows the blue colour.

Nickel is very ſeldom to be had; and as its ores are ſeldom free from mixtures of other metals, it is very difficultly tried with the blow-pipe. However, when this ſemimetal is mixed with iron and cobalt, it is eaſily freed from theſe heterogeneous metals, and reduced to a pure nickel regulus by means of ſcorification with borax, becauſe both the iron and cobalt ſooner ſcorify than the nickel. The regulus of nickel itſelf is of a green colour when calcined: it requires a pretty ſtrong fire before it melts, and tinges the borax with a hyacinth colour. Manganeſe gives the ſame colour to borax; but its other qualities are quite different, ſo as not be confounded with the nickel.

By means of the foregoing explanations, and thoſe given under the article *Blow-Pipe*, any gentleman, who is a lover of this ſcience, will be able, in an eaſy manner, to amuſe himſelf in diſcovering the properties of thoſe works of nature, with which the mineral kingdom furniſhes us; or more uſefully to employ himſelf by finding out what ſorts of ſtones, earths, ores, &c. there are on his eſtate, and to what economical purpoſes they may be employed. The ſcientific mineraliſt may, by examining into the properties and effects of the mineral bodies, diſcover the natural relation theſe bodies ſtand in to each other, and thereby furniſh himſelf with materials for eſtabliſhing a mineral ſyſtem, founded on ſuch principles as Nature herſelf has laid down in them; and this in his own ſtudy, without being forced to have recourſe to great laboratories, crucibles, furnaces, &c. which is attended with much trouble, and is the reaſon why ſo few can have an opportunity of gratifying their deſire of knowledge in

this

Portable Apparatus.

this part of natural hiſtory. Farther improvements of this apparatus may ſtill be made by thoſe who chooſe to beſtow their attention upon it.

A great number of fluxes might, perhaps, be found out, whoſe effects might be different from thoſe already in uſe, whereby more diſtinct characters of thoſe mineral bodies might be diſcovered, which now either ſhow ambiguous ones, or which it is almoſt impoſſible to try exactly with the blow-pipe. Inſtead of the *ſal ſodæ*, ſome other ſalt might be diſcovered better adapted to theſe experiments. But it is very neceſſary not to make uſe of any other fluxes on the charcoal than ſuch as have no attraction to it: if they, at the ſame time, be clear and tranſparent, when melted, as the borax and the *ſal fuſibile microcoſmicum*, it is ſtill better: however, the tranſparency and opacity are of no great conſequence, if a ſubſtance be eſſayed only in order to diſcover its fuſibility, without any attention to its colour; in which caſe, ſome metallic ſlag, perhaps, might be uſeful.

When ſuch ores are to be reduced whoſe metals are very eaſily calcined, as tin, zinc, &c. it might perhaps be of ſervice to add ſome phlogiſtic body, ſuch as hard reſin, ſince the charcoal cannot afford enough of it in the open fire of theſe eſſays. The manner of melting the volatile metals out of their ores *per deſcenſum* might alſo, perhaps, be imitated: for inſtance, a hole might be made in the charcoal, wide above and very narrow at the bottom; a little piece of the ore being then laid at the upper end of the hole, and covered with ſome very ſmall pieces of the charcoal, the flame muſt be directed on the top: the metal might, perhaps, by this method, run into the hole below, concealed from the violence of the fire, particularly if the ore is very fuſible, &c.

The uſe of the apparatus above referred to, and which may be called a *pocket laboratory* (as the whole admits of being eaſily packed into a ſmall caſe), is chiefly calculated for a travelling mineraliſt. But a perſon who always reſides at one and the ſame place, may by ſome alteration make it more commodious to himſelf, and avoid the trouble of blowing with the mouth. For this purpoſe he may have the blow-pipe go through a hole in a table, and fixed underneath to a ſmall pair of bellows with double bottoms, ſuch as ſome of the glaſs-blowers uſe, and then nothing more is required than to move the bellows with the feet during the experiment; but in this caſe a lamp may be uſed inſtead of a candle. This method would be attended with a ſtill greater advantage, if there were many ſuch parts as *c*, fig. 13. the openings of which were of different dimenſions: thoſe parts might by means of a ſcrew be faſtened to the main body of the blow-pipe, and taken away at pleaſure. The advantage of having theſe nozzles of different capacities at their ends, would be that of exciting a ſtronger or weaker heat as occaſion might require. It would only be neceſſary to obſerve, that in proportion as the opening or nozzle of the pipe is enlarged, the quantity of the flame muſt be augmented by a thicker wick in the lamp, and the force of blowing encreaſed by means of weights laid on the bellows; a much intenſer heat would thus be produced by a pipe of a conſiderable opening at the end, by which the experiments muſt undoubtedly be carried farther than the common blow-pipe.

Plate CCCXIII.

Portable Apparatus.

A traveller, who has ſeldom an opportunity of carrying many things along with him, may very well be contented with this laboratory and its apparatus, which are ſufficient for moſt part of ſuch experiments as can be made on a journey. There are, however, other things very uſeful to have at hand on a journey, which ought to make a ſeparate part of a portable laboratory, if the manner of travelling does not oppoſe it: this conſiſts of a little box including the different acids, and one or two matraſſes, in order to try the mineral bodies in liquid menſtrua if required.

Theſe acids are, the acid of nitre, of vitriol, and of common ſalt. Moſt of the ſtones and earths are attacked, at leaſt in ſome degree, by the acids; but the calcareous are the eaſieſt of all to be diſſolved by them, which is accounted for by their calcareous properties. The acid of nitre is that which is moſt uſed in theſe experiments; it diſſolves the limeſtone, when pure, perfectly, with a violent efferveſcence, and the ſolution becomes clear: when the limeſtone enters into ſome other body, it is nevertheleſs diſcovered by this acid, through a greater or leſs efferveſcence in proportion to the quantity of the calcareous particles, unleſs there are ſo few as to be almoſt concealed from the acid by the heterogeneous ones. In this manner a calcareous body, which ſometimes nearly reſembles a ſiliceous or argillaceous one, may be known from theſe latter, without the help of the blow-pipe, only by pouring one or two drops of this acid upon the ſubject; which is very convenient when there is no opportunity nor time of uſing this inſtrument.

The gypſa, which conſiſt of lime and the vitriolic acid, are not in the leaſt attacked by the acid of nitre, if they contain a ſufficient quantity of their own acid; becauſe the vitriolic acid has a ſtronger attraction to the lime than the acid of nitre: but if the calcareous ſubſtance is not perfectly ſaturated with the acid of vitriol, then an efferveſcence ariſes with the acid of nitre, more or leſs in proportion to the want of the vitriolic acid. Theſe circumſtances are often very eſſential in diſtinguiſhing the *calcarea* and *gypſa* from one another.

The acid of nitre is likewiſe neceſſary in trying the zeolites, of which ſome ſpecies have the ſingular effect to diſſolve with efferveſcence in the above mentioned acid; and within a quarter of an hour, or even ſometimes not until ſeveral hours after, to change the whole ſolution into a clear jelly, of ſo firm a conſiſtence, that the glaſs wherein it is contained may be reverſed without its falling out.

If any mineral body is tried in this menſtruum, and only a ſmall quantity is ſuſpected to be diſſolved, though it was impoſſible to diſtinguiſh it with the eye during the ſolution, it can be eaſily diſcovered by adding to it *ad ſaturitatem* a clear ſolution of the alkali, when the diſſolved part will be precipitated, and fall to the bottom. For this purpoſe the *ſal ſodæ* may be very uſeful.

The acid of nitre will ſuffice for making experiments upon ſtones and earths; but if the experiments are to be extended to the metals, the other two acids are alſo neceſſary.

Another inſtrument is likewiſe neceſſary to a

Portable Apparatus.

complete Pocket-Laboratory, viz. a waſhing-trough (fig. 21.), in which the mineral bodies, and particularly the ores, may be ſeparated from each other, and from the adherent rock, by means of water. This trough is very common in laboratories, and is uſed of different ſizes; but here only one is required of a moderate ſize, ſuch as 12 inches and a half long, three inches broad at the one end and one inch and a half at the other end, ſloping down from the ſides and the broad end to the bottom, where it is three quarters of an inch deep. It may, however, be made of much ſmaller dimenſions. It is commonly made of wood, which ought to be choſen ſmooth, hard, and compact, wherein are no pores in which the minute grains of the pounded matter may conceal themſelves. It is to be obſerved, that if any ſuch matter is to be waſhed as is ſuſpected to contain ſome native metal, ſuch as ſilver or gold, a trough ſhould be procured for this purpoſe of a very ſhallow ſlope; becauſe the minute particles of the native metal have then more power to aſſemble together at the broad end, and ſeparate from the other matter.

The management of this trough, or the manner of waſhing, conſiſts in this: That when the matter is mixed with about three or four times its quantity of water in the trough, this is kept very looſe between two fingers of the left hand, and ſome light ſtrokes given on its broad end with the right, that it may move backwards and forwards; by which means the heavieſt particles aſſemble at the broad and lower end, from which the lighter ones are to be ſeparated by inclining the trough and pouring a little water on them. By repeating this proceſs, all ſuch particles as are of the ſame gravity may be collected together, and ſeparated from thoſe of different gravity, provided they were before equally pounded: though ſuch as are of a clayey nature, are often very difficult to ſeparate from the reſt, which, however, is of no great conſequence to a ſkilful and experienced waſher. The waſhing proceſs is very neceſſary, as there are often rich ores, and even native metals, found concealed in earths and ſand in ſuch minute particles as not to be diſcovered by any other means.

Sect. III. *Deſcription of an Improved Portable Laboratory for aſſaying Minerals.*

The chief pieces and implements of the portable laboratories are repreſented in Plate XCIX. at *Blow-Pipe*, and in Plate CCCXIII. annexed to the preſent article.

I. The firſt contains thoſe belonging to the *Dry* Laboratory, ſo called on account of its containing whatever is required to try all kinds of foſſils in the dry way by fire, without any of the humid menſtruums. They are made to pack in a box of the ſize of an octavo book, lined with green velvet, and covered with black fiſh-ſkin; the inſide divided into different compartments, ſuited to the ſize, form, and number of the implements it is to contain. Of theſe the principal are deſcribed under *Blow-Pipe*. We muſt here, however, add the following remarks and alterations of that inſtrument by Mr Magellan.

Plate CCCXIII.

D and Q (fig. 13.) are the two pieces that form the blow-pipe, which is here repreſented entire. This very uſeful inſtrument has been conſiderably improved of late in England. The mouth-piece *aa* is made of ivory, to avoid the diſagreeable ſenſation of having a piece of metal a long time between the teeth and lips, which, if not of ſilver or gold, may be very noxious to the operator; a circumſtance that has been hardly noticed before. Portable Apparatus.

1. If the mouth-piece *aa* be made of a round form, it cannot be held for any length of time between the teeth and lips, to blow through it, without ſtraining the muſcles of the mouth, which produces a painful ſenſation. It muſt, therefore, have ſuch an external figure, as to adapt itſelf accurately to the lateral angles of the lips, having a flattiſh oval form externally, with two oppoſite corners to fit thoſe internal angles of the mouth, when it is held between the lips, as may be ſeen in that repreſented in the figure.

2. The ſmall globe *bb* is hollow, for receiving the moiſture of the breath; and muſt be compoſed of two hemiſpheres, exactly ſcrewing into one another in *bb*; the male-ſcrew is to be in the lower part, and ſoldered on the crooked part Q of the tube Q D, at ſuch a diſtance, that the inſide end of the crooked tube be even with the edge of the hemiſphere, as repreſented by the pointed lines in the figure. But the upper hemiſphere is to be ſoldered at the end of the ſtraight tube D. By theſe means, the moiſture ariſing from the breath falls into the hollow of the lower hemiſphere, where it is collected round the upper inſide end of the crooked part Q of the blow-pipe, without being apt to fall into it.

3. The ſmall nozzles, or hollow conical tubes, adviſed by Meſſrs Engeſtrom, Bergman, and others, are wrong in the principle; becauſe the wind that paſſes from the mouth through ſuch long cones loſes its velocity by the lateral friction, as happens in hydraulic ſpouts; which, when formed in this manner, do never throw the fluid ſo far as when the fluid paſſes through a hole of the ſame diameter, made in a thin plate of a little metallic cap that ſcrews at the end of the large pipe. It is on this account that the little cap *c* is employed, having a ſmall hole in the thin plate, which ſerves as a cover to it; and there are ſeveral of theſe little caps, with holes of ſmaller and larger ſizes, to be changed and applied whenever a flame is required to be more or leſs ſtrong.

4. Another convenience of theſe little caps is, that even in caſe any moiſture ſhould eſcape falling into the hemiſphere *bb*, and paſs along with the wind through the crooked pipe Q, it never can arrive at nor obſtruct the little hole of the cap *c*, there being room enough under the hole in the inſide, where this moiſture muſt be ſtopped till it is cleaned and wiped out.

The ſtream of air that is impelled by the blow-pipe (as ſeen in fig. 3.) upon the flame, muſt be conſtant and even, and muſt laſt as long as the experiment continues to require it. This labour will fatigue the lungs, unleſs an equable and uninterrupted inſpiration can at the ſame time be continued. To ſucceed in this operation without inconvenience, ſome labour and practice are neceſſary, as already explained under the detached article.

Every aſſay ought always to begin by the exterior flame, which muſt be firſt directed upon the maſs under examination; and, when its efficacy is well known, then the interior blue flame is to be employed.

Portable Apparatus.

After the ore is roaſted, it is to be rounded upon the ſteel plate by the hammer; the particles being prevented from being diſſipated by the ring H (fig. 9. Plate XCIX.), within which the pieces to be broken are to be put.

Among the apparatus, beſide the particulars already mentioned, three phials are neceſſary, containing the required fluxes, viz. the *borax*, the *ſal ſodæ*, and *ſal fuſibile microcoſmicum*. Other uſeful particulars are, A ſmall link of hard ſteel, to try the hardneſs or ſoftneſs of mineral ſubſtances, and alſo to ſtrike fire for lighting the candle when required: A piece of black flint, to ſerve as a touch-ſtone; (for being rubbed with any metal, if it be gold the marks will not be corroded by aqua fortis); and alſo to ſtrike fire, when neceſſary, with the link of ſteel: An artificial load-ſtone, properly armed with iron, for the better preſervation of its attractive power; (it ſerves to diſcover the ferrugineous particles of any ore after it has been roaſted and powdered:) A triple magnifier, which, differently combined, produces ſeven magnifying powers, the better to diſtinguiſh the ſtructure and metallic parts of ores, and the minute particles of native gold, whenever they contain that metal: A file, to try the hardneſs of ſtones and cryſtals, &c.: Some pieces of dry agaric or tinder, and ſmall bits or ſplinters of wood tipped with brimſtone, to ſerve as matches for lighting the candle; and various other little articles of uſe in theſe experiments.

II. For performing experiments in the *Humid Way*, the chief additional articles (and which muſt be kep in a ſeparare caſe) conſiſt of a collection of phials, containing the principal acids, teſts, precipitants, and re-agents, both for examining mineral bodies by the humid way, and for analyſing the various kinds of mineral waters. Thoſe with acids and corroſive ſolutions have not only ground ſtoples, but alſo an external cap to each, ground over the ſtople, and ſecured downward by a bit of wax between both, in order to confine the corroſive and volatile fluids within. But thoſe which contain mild fluid liquors have not ſuch external caps; and thoſe with dry inoffenſive ſubſtances are only ſtopped with cork. Beſides theſe phials, there are two ſmaller cylindrical ones, which ſerve to exhibit the changes of colour produced by ſome of the re-agents in thoſe analytical aſſays. There are alſo two or three ſmall matraſſes, to hold the ſubſtances with their ſolvents over the fire; a ſmall glaſs funnel for pouring the fluids; a ſmall porcelain mortar, with its peſtle; one or two crucibles of the ſame ſubſtance; a ſmall wooden trough to waſh the ground ores; ſome glaſs ſticks to ſtir up the fluid mixtures; and, finally, pieces of paper tinged red, yellow, and blue, by the tinctures of Fernambuc wood (commonly called Braſil wood), turmeric, and litmus, thickened with a little ſtarch.

The following liſt contains the names of the various fluid teſts and re-agents that are neceſſary for theſe aſſays. But the whole number being too large to be all contained in a portable caſe, every one may give the preference to thoſe he likes beſt.

1. Concentrated vitriolic acid, whoſe ſpecific gravity may be expreſſed in the outſide.
2. Nitrous acid, purified by the nitrous ſolution of ſilver.
3. Concentrated marine acid, with its ſpecific gravity.
4. Marine acid dephlogiſticated.
5. Aqua regia for gold, viz. 2 nit. and 1 marine.
6. Aqua regia for platina, viz. half marine and half nitrous acid.
7. Nitrous ſolution of ſilver.
8. Nitrous ſolution of mercury, made in the cold.
9. Muriatic ſolution of barytes.
10. Nitrous ſolution of lime.
11. Muriatic ſolution of lime.
12. Mercury in its metallic ſtate.
13. Corroſive ſublimate of mercury
14. White arſenic.
15. Nitrous ſolution of ſilver.
16. Nitrous ſolution of copper.
17. Acid of ſugar.
18. Liquor probatorius vini.
19. Hepar ſulphuris.
20. Oil of tartar *per deliquium*.
21. Salt of tartar.
22. Cauſtic vegetable alkali.
23. Pearl-aſhes.
24. Soap-makers ley.
25. Common ſalt.
26. Vitriolated argilla (alum.)
27. Vitriol of iron (copperas.)
28. Nitrous ſolution of ſilver.
29. Acetous ſolution of lead.
30. Acetous ſolution of barytes.
31. Phlogiſticated alkali by the Pruſſian blue.
32. Lime-water.
33. Lime-water phlogiſticated by the Pruſſian blue.
34. Cauſtic volatil alkali.
35. Mild volatile alkali (dry.)
36. Rectified ſpirit (alcohol.)
37. Æther.
38. Spirituous tincture of galls.

The following teſts are very fit alſo for theſe aſſays, viz. 39. Spirituous ſolutions of ſoap; 40. Syrup of violets; 41. Tincture of litmus; 42. Tincture of Braſil wood; 43. Tincture of turmeric; 44. Oil of olives; 45. Oil of linſeed; 46. Oil of turpentine; 47. Eſſential ſalt of wild-ſorrel; 48. Hepar ſulphuris; 49. Sugar of lead; 50. Solution of alum.

The method of applying the above teſts of acids and re-agents may be ſeen in Bergman's treatiſes of the Analyſis of Waters, and of Aſſaying by the Humid Way; in Kirwan's Elements of Mineralogy; in the Elements of Chemiſtry of Dijon; in the Memoirs of the ſame Academy; in Fourcroy's Lectures of Chemiſtry, &c.

III. The *Lamp-furnace* Laboratory, for experiments both by the *humid* and the *dry* way, is a very curious and uſeful, though ſmall apparatus. It is an improvement of that which was contrived by M. de Morveau, in conſequence of the information he received from his friend the preſident de Virly, who ſaw at Upſal how advantageouſly the late eminent profeſſor Bergman availed himſelf of this convenience for many analytical proceſſes in miniature, by the uſe of very ſmall glaſs veſſels about one inch diameter, and other implements of proportional ſize, for performing various chemical operations. (See the Dijon Memoirs for 1783, Part 1. p. 171.)

Portable Apparatus.

There can be no doubt but that whenever theſe proceſſes are properly conducted, though in miniature, the lamp-furnace will prove amply ſufficient to perform in a few minutes, and with very little expence, the various ſolutions, digeſtions, and diſtillations, which otherwiſe would require large veſſels, ſtills, retorts, reverberatory furnaces, &c. to aſcertain the component parts of natural bodies; though it is not always ſufficient to aſcertain their reſpective quantities. In this laſt caſe, operations muſt be performed in great laboratories, and on a large ſcale, at a conſiderable expence. But the ſubſtances are ſometimes too valuable; as, for inſtance, when precious ſtones are examined; and of courſe the laſt way never can be attempted in ſuch caſes.

Theſe ſmall proceſſes have likewiſe another advantage before noticed, which cannot be obtained in works at large. It conſiſts in one's being able to obſerve the gradual progreſs of each operation; of eaſily retarding or urging it, as it may require; and of aſcertaining at pleaſure each ſtep of every experiment, together with the phenomena attending the ſame.

Plate CCCXIII.

The lamp-furnace is mounted in a ſmall parallelogram of mahogany, about ſix inches long and four wide, marked fig. 5. This is kept ſteady over the edge of a common table, by means of the metallic clamp *wxw*, which is faſtened by the ſcrew *x*. The pillar *rs* is ſcrewed in a vertical poſition on the plate *s*, being about ten inches high; the other is ſcrewed to the oppoſite corner, marked *pk*, and is only $7\frac{1}{2}$ inches long; both are compoſed of two halves, that ſcrew at *tt*, to be eaſily packed up with all the implements in a caſe covered with black fiſh-ſkin, and lined with green velvet, like the other laboratory already deſcribed.

The lamp *k*, fig. 3. is ſupported on the plate *f*, which has a ring *l* that runs in the column *pk*, and may be fixed by its ſcrew *l* at the required height.—This lamp has three ſmall pipes of different ſizes, to receive as many wicks of different thickneſs, and to be filled with ſpirit of wine. By a ſimilar method, a piece of charcoal is mounted and ſupported by the pliers or little forceps ſcrewed to the arm *ac*, fig. 1. which has all the motions requiſite for being fixed by means of proper ſcrews, at a proper diſtance from the flame of the wick *b*. The blow-pipe, fig. 4. is, by a ſimilar mechaniſm, mounted on the ſmaller column *pq*, at ſuch a diſtance as to blow the flame *hi* to the piece of ore *m*, which is upon the charcoal *gf*.

Every thing being diſpoſed in this manner, the operator blows through the mouth-piece of the blow-pipe, fig. 4. and remains with his hands free to make the changes and alterations he may think proper.—

[*N. B.* The large round cavity *e* in the middle of the parallelogram, fig. 5. is to receive the lamp *k*, fig. 3. when all the implements are packed up in their caſe of black fiſh-ſkin; and the cover of the lamp is repreſented by fig. 12.]

But if the operator has the double bellows, fig. 14. and 15. he fixes them, at a due diſtance, to the ſame table by the braſs clamp *y*. He then unſcrews the blow-pipe at *zz*: joins the mouth *m* of the flexible tube to the hemiſphere *zz*, paſſing each orifice, thro' the leather tube fig. 11. and tying both ends with a waxed thin pack-thread. If he works with his foot on the pedal, the ſtring of which is ſeen hanging from the end of the bellows, fig. 15. (and is always up, on account of the weight *e*), then the air is abſorbed by the bellows fig. 15. from whence it is propelled by the motion of the foot on the pedal to the bellows, fig. 14. whoſe conſtant weight *r* drives it out through the flexible pipe, fig. 10. it of courſe enters the curbed part *zzi* of the blow-pipe, and drives the flame on the piece *m* of the ore, that is to be examined upon the charcoal.

Portable Apparatus.

[*N. B.* 1. This double bellows is packed up by itſelf in a mahogany caſe, about 9 inches long, $6\frac{1}{2}$ wide, and about $3\frac{1}{4}$ deep, outſide meaſure. 2. The laſt blowing bellows, fig. 14. has an inſide valve, which opens when the upper ſurface of it is at its greateſt height; in order to let the ſuperfluous air eſcape out, as it would otherwiſe iſſue with great velocity out of the tube, fig. 11. and ſpoil the operation.]

If the operator chooſes to apply the vital or dephlogiſticated air in his proceſs, let him fill the glaſs-jar *b*, fig. 17. with this air; and put it within the tub marked by *abze*, filled with water, faſtening the neck of the jar within by a croſs-board *ed*, which has a hole in it for that purpoſe; then introducing the two ends of the flexible hollow tube, fig. 16. both to the mouth of the jar and to the hole of the bellows fig. 15. he opens the hole *m* of the jar, that was ſtopped with the ſtople *n*; the column of the water paſſes in through *m*, and forces up the vital air, which enters the bellows, and of courſe, by the alternate motion of the pedal, paſſes through the end of the blow-pipe, to urge the flame upon the piece of ore *m*, fig. 2. on the charcoal *g*. But the dephlogiſticated air may be alſo received at the ſame time that it is produced, by tying the pipe, fig. 16. to the mouth of an earthen retort, or even of a glaſs retort well-coated, according to the method of Mr Willis, deſcribed in the Tranſactions of the Society of Arts, Vol. V. p. 96. This laſt conſiſts in diſſolving two ounces of borax in a pint of boiling water, and adding to the ſolution as much ſlacked lime as is neceſſary to form a thin paſte. this glaſs retort is to be covered all over with it, by means of a painter's bruſh, and then ſuffered to dry. It muſt then be covered with a thin paſte made of linſeed oil and ſlacked lime, except the neck that enters into the receiver. In two or three days it will dry of itſelf; and the retort will then bear the greateſt fire without cracking Two ounces of good nitre, being urged in the retort, by a good fire on a chafingdiſh, will afford about 700 or 800 ounce-meaſures of dephlogiſticated air.

To make any other kind of chemical aſſays, the forceps of fig. 2. which ſupports the charcoal, is taken off, by unſcrewing the ſcrew *b*; the blow-pipe is alſo taken off, by looſening the ſcrew *n*; the hoop fig. 7. is put in its place, where the metallic baſin of fig. 19. is put filled with ſand: the piece of fig. 8. is ſet on the other pillar *rs*, fig. 1. to hold the matraſs, fig. 18. upright, or the receiver fig. 20. &c.

In the ſame manner, the retort, fig. 9. may be put in the ſand-bath inſtead of the matraſs, with its receiver fig. 20. which may be ſupported on a bit of cork or wood, hollowed to its figure, and held by the pliers, inſtead of the charcoal fig. 2.

But if the operation is to be made in the naked fire,

Fig. 9.

Fig. 6.

Fig. 1.

Fig. 7.

Fig. 8.

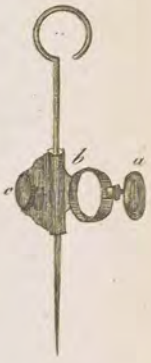

Fig. 4.

Fig. 21.

Fig. 3.

Fig. 2.

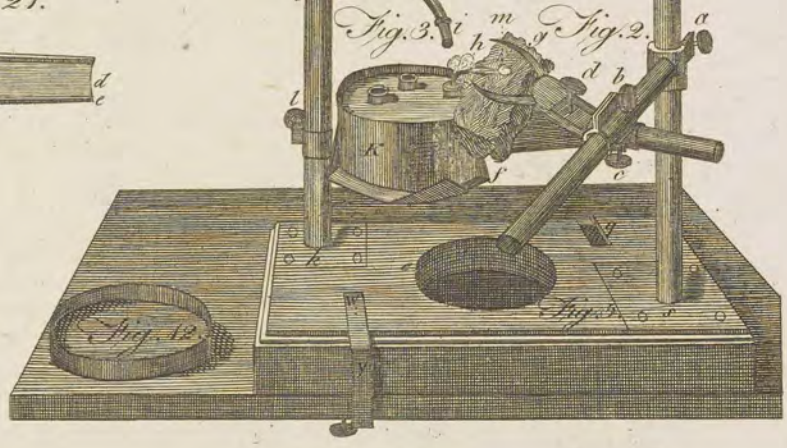

Fig. 19.

Fig. 13.

Fig. 20.

Fig. 10.

Fig. 18.

Fig. 16.

Fig. 15.

Fig. 14.

Fig. 17.

Fig. 11.

A. Bell Prin. Mat. Sculptor fecit.

Of Arrangement.

fire, the neck of the retort, fig. 9. being luted to the receiver, or balloon, fig. 20. may be hanged by a little chain with its ring over the flame, being ſuſpended from the piece of fig. 7. or 8. ſcrewed to either of the pillars as may be moſt convenient. Otherwiſe the receiver, fig. 20. may be ſupported by the round hoop of braſs, fig. 8. or 7. ſcrewed at a proper height to the pillar, fig. 1. tying round it ſome packthread to defend the glaſs from the contact with the metallic ſupport.

The piece of fig. 6. may be ſcrewed by its collar and ſcrew *ef* to any of the pillars; carrying with it the retort and its receiver, at proper diſtances, higher or nearer to the lamp according as the flame is more or leſs violent.

It eaſily may be conceived, that theſe implements afford all ſorts of conveniences for making any kind of ſmall operations and aſſays in miniature, provided the operator pays a proper attention to the diſpoſition requiſite for each proceſs or operation.

Every glaſs retort, receiver, matraſs, baſon, ſmall funnels, &c. are made by the lamp-workers, that blow beads, thermometers, and other ſmall glaſs inſtruments.

It is directed that the lamp *k*, fig. 3. be filled with ſpirit of wine, becauſe it gives no diſagreeable ſmell, and does not produce any fuliginous and diſagreeable cruſt on the veſſels as oil does: moreover, the ſpirit gives a dry flame, without ſmoke, and ſtronger than oil; beſides the ſpots and diſagreeable conſequences this laſt cauſes, if ſplit, &c. M. de Morveau adds, that the expence of ſpirit is quite inconſiderable; and that he performed in eight or ten minutes, with this apparatus, various diſſolutions, evaporations, and other proceſſes, which otherwiſe would have taken more than three hours, with the expence only of two or three halfpence for the ſpirit of wine, whilſt the fuel of charcoal would have coſt near ten or eleven pence.

Of Arrangement.

But a very important circumſtance is, as Morveau obſerves likewiſe, that many philoſophers do not apply themſelves to chemical operations, for want of opportunity of having a laboratory to perform them: it requiring a proper room, and ſuitable expences of many large furnaces, retorts, crucibles, and numerous other implements, &c. whilſt theſe miniature laboratories may in great meaſure afford the ſame advantages; at leaſt to that degree of ſatisfaction ſufficient to aſcertain the contents and products of any ſubſtance that is ſubjected to trial: for with this ſimple apparatus a man of ſome abilities may, without any embaraſſment, in a very ſhort time, and with little expence, perform ſuch diſtillations as require a reverbatory furnace; all ſorts of proceſſes, digeſtions, and evaporations, which require a regular ſand heat; he may vary his experiments or trials, and multiply them to a great number of various performances, draw up his concluſions, and reaſon upon them, without loſs of time, without the hinderance of long preparations to work at large. And even when ſuch large works are to be performed, he may obſerve beforehand various phenomena of ſome ſubſtances, which being known in time, would otherwiſe impede the proceſſes at large, or make them fail abſolutely; and all this without the riſk of a conſiderable loſs, and without expoſing himſelf to a great fire, &c.

PART II. ARRANGEMENT (A) of MINERAL BODIES (B).

THE bodies belonging to the mineral kingdom are divided into four different claſſes, viz.

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

Here, however, it muſt be obſerved, that theſe claſſes are unavoidably 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 ſemimetals. In the fourth claſs it is to be obſerved, that the metals and ſemimetals, 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, while others are by no means to be rendered ſo. That the 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 borax, *ſal fuſibile microcoſmicum*, and others do, when melted upon a piece of charcoal: therefore, with regard to all that has

(A) According to the ſyſtem of *Cronſtedt* †; altered, augmented, and improved from the Obſervations of other Mineralogiſts.

† *Cronſtedt's Mineralogy*, 2d edition, in 2 vols, by Magellan.

(B) Of the different bodies enumerated in the following claſſification, full explanations are given under their reſpective names as they occur in the courſe of this Work. See alſo METALLURGY, and CHEMISTRY-*Index*.

(C) By *earths*, the author (Mr Cronſtedt) does not mean (ſtrictly ſpeaking) only earths, but includes under that title all the kinds of ſtones or foſſils not inflammable, ſaline, or metallic.

Earths. 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.

Class I. EARTHS.

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

Theſe bodies are here arranged according to their conſtituent parts, ſo far as hitherto diſcovered; and are divided into five orders. See the article Earth. Calcareous Earths.

Order I. Calcareous Earths (d).

The properties of theſe are as follow:

1. Friability and falling into a fine white powder after calcination.

2 Partial ſolution in water, with which they contract

(d) Calcareous earth is moſt commonly found in the form of lime-ſtone; hard, compact, and of various colours; under which general name may be comprehended all the different kinds of marbles. Near Bath in England is found a kind of grey ſtone, rather ſoft than hard. This contains calcareous earth in a mild ſtate, and likewiſe ſome in a ſtate of cauſticity: hence, when newly dug out of the earth, it will diſſolve ſulphur, or make lime-water without any calcination. By attraction of fixed air from the atmoſphere, it ſoon hardens after it has been dug up.

Mr Williams * divides the lime-ſtones of Scotland into the following ſpecies:

1. Grey, whitiſh, and pure white; regularly ſtratified; of a granulated texture; and much uſed in the Highlands for building bridges. Some of it is compoſed of fine glittering ſpangles like the ſcales of fiſhes; and ſome is as pure white as the beſt refined ſugar, which kind he thinks may be called *Parian marble.*

2. Coarſe-looking grey mountain limeſtone, hard and ſtrong, of a granulated texture, difficult to work in ſome places rough and unequal, in others ſmooth and even. Sometimes regularly ſtratified, at other times appearing like one vaſt irregular bed or rock, of various thickneſſes.

3. Aſh-coloured mountain-limeſtones, conſiſting of ſmall grains of a fine ſmooth texture; when broken reſembling flint. In the Highlands there are hills of this kind of ſtone, which our author informs us he has ſeen; ſome of which have regular ſtrata, while others appear in one vaſt maſs like a rock of granite.

4. Regularly-ſtratified lime-ſtone, found in the low countries, exhibiting a vaſt variety of colours; as black, blue, grey, brown, purple, red, and aſh-coloured, with various mixtures, of all degrees of hardneſs and purity.

5. Limeſtone accompanying coal, and frequently the immediate roof of the vein. This likewiſe ſhows a great variety of colour, texture, and quality; ſome being ſo much adulterated with clay and other heterogeneous mixtures as to be good for nothing, while others are very pure and fine. Theſe limeſtones are always found in regular ſtrata. "They are found (ſays our author) as regular as the coals they accompany; and the coal-ſtrata are more regular in continuation upon the bearing, as far as the claſs of ſtrata belonging to the coal reaches, than any other that I have inveſtigated; and I look upon it, that this obſervation may be of uſe in practice."

For diſcovering limeſtone at ſome diſtance, Mr Williams gives the following directions:—"Let them keep the line of ſtretch, or bearing of the ſtrata; and, in the coal-country, they will be ſure to diſcover it at nearly the ſame parallel diſtance from a ſeam of coal or other given ſtratum, as the place where it was laſt ſeen. But many of the mountain-limeſtones are not much to be depended on. Though you may have a good and plentiful quarry in one place, yet, perhaps, half a mile, or half a quarter of a mile farther forward, you cannot diſcover it: it is dwindled away to nothing, and yet will appear again farther forward; which makes the mountain-limeſtones uncertain to be diſcovered where you do not ſee them; as theſe rocks very frequently grow thicker or thinner, and ſometimes ſqueezes out to nothing: and I comprehend under this denomination all the limeſtones not accompanying the coals and coal-metals.—The limeſtones of the coal-fields are often diſtinguiſhable by containing a great variety of ſhells, coral, and other marine bodies, which are found blended in the heart and compoſition of the ſtone."

6. The Scotch marbles are of great variety and beauty; and the parts of the kingdom moſt unfit for cultivation are found to abound moſt in them. Aſſint in Sutherland has a kind of white ſtatuary marble, which Mr Williams ſays is the pureſt and beſt he ever ſaw. "I am perſuaded (ſays he) there is none better, if any ſo good, in all Europe, and there is enough of it to ſerve all Britain; perfectly ſolid and pure, free of any blemiſhes, flaws, or ſtains, and blocks or ſlabs of any ſize may be cut out: but there is bad acceſs to it; nor would it be eaſily quarried, there being a little cover above it, of a ſoft, looſe, whitiſh limeſtone. This marble accompanies a prodigious rock of grey limeſtone, of a granulated texture, appearing in regular ſtrata at Aſſint; but it is one of thoſe which varies in thickneſs as you advance along the bearing of the ſtrata. The good white marble of Aſſint is only to be ſeen in the bed of the river, near a conſiderable houſe a mile or two ſouth of the church; but I cannot remember the name of the particular place."

Near Blairgourie in Perthſhire, not far from the ſide of the high road, is an excellent, granulated, broad-bedded limeſtone, of a ſugar-loaf texture, and as white as the fineſt ſtatuary marble, which Mr Williams ſuppoſes to be a good ſpecies of the true Parian marble, and that it requires only to be known and brought into uſe to become of great value. In the duke of Gordon's lands, in the foreſt of Glenavon, there is alſo a kind of marble compoſed of broad glittering grains like ſpangles, as large as the ſcales of fiſhes; but the ſituation is remote, and difficult of acceſs.

* *Nat. Hiſt. of the Mineral Kingdom*, 2 vols.

In

Calcareous Earths.

tract great heat, and by ſprinkling with water they fall more readily into powder.

3. Infuſibility without addition.

4. They attract the fixed air from the vegetable and mineral alkalies, and thus rendering them much more cauſtic, becoming at the ſame time mild themſelves.

5. Solubility in all acids except the vitriolic, tartarous, and ſome anomalous vegetable acids.

6. Fuſibility with borax and microcoſmic ſalts.—The fuſion is attended with effervescence, and the reſult is a tranſparent and colourleſs glaſs.

7. With metalline calces they melt into a curroſive ſlag.

8. They imperfectly reduce the calces of lead and biſmuth, and have even ſome effect upon thoſe of copper and iron.

The calcareous earth is found,

I. Pure.

1. In form of powder. *Agaricus mineralis*, or *lac lunæ*.
   a. White, in moors, and at the bottom of lakes.
   b. Red.
   c. Yellow.
2. Friable and compact. Chalk, *creta*.
   a. White, *creta alba*. Chalk is a nam aelſo applied to other earths; whence we hear of chalks of various colours: but there are none which are known to be of a calcareous nature, except this 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.
3. Indurated, or hard; Limeſtone; *Lapis calcareous*.

A. Solid, or not granulated.
   a. White.
   b. Whitiſh yellow.
   c. Fleſh-coloured, found in looſe maſſes.
   d. Reddiſh brown.
   e. Grey.
   f. Variegated with many colours, and particularly called *marble*.
   g. Black.

B. Grained or granulated limeſtone.
   1. Coarſe-grained, and of a looſe texture, called *ſalt-ſlag* in Swediſh, from its reſemblance to lumps of ſalt.
      a Reddiſh yellow. *b*. White.
   2. Fine-grained.
      a. White. *b*. Semi-tranſparent, from Solfatara in Italy, in which native brimſtone is found.
   3. Very fine grained.
      a. White and green. *b*. White and black.

C. Scaly limeſtone.
   1. With coarſe or large ſcales.
      a. White. *b*. Reddiſh yellow.
   2. With ſmall ſcales.
      a. White.
   3. Fine glittering or ſparkling.
      a. White. *b*. Of many colours.

D. Lime or calcareous ſpars.

(1.) Of a rhomboidal figure.

A. Tranſparent or diaphanous.
   1. Refracting ſpar; *Spatum iſlandicum*; Iceland ſpar, or Iceland cryſtal.—This repreſents the objects ſeen through it double,
   2. Common ſpar, which ſhows the object ſingle.
      a. White, or colourleſs.
      b. Yellowiſh and phoſphoreſcent.

B. Opaque.
   1. White. 2. Black. 3. Browniſh yellow.

(2.) Foliated or plated ſpar.
   a. Opaque white.

E. Cryſtallized calcareous ſpars. *Spar. Druſen* (B.)

(1.) Tranſparent.
   a. Hexagonal truncated.
   b. Pyramidal.
      1. Dog's teeth; *Pyramidales diſtinctæ*.
      2. Balls of cryſtallized ſpar, *Pyramidales concretæ*.

F. Stalactitical ſpar; *Stalactites calcareus*. Stalactites, Stone-icicle, or Drop-ſtone.

(1.) Scaled ſtalactites of very fine particles.
   a. Of a globular form.
   1. White, the pea-ſtone.
   2. Grey, *piſolithus*, *oolithus*. Alſo the hammites, from its reſemblance to the roes or ſpawn of fiſh. It has been exhibited by authors as petrified roes. The Ketton free-ſtone, of Rutlandſhire, is a remarkable ſtone of this ſort.
   b. Hollow, in the form of a cone.
   1. White.
   c. Of an indeterminate figure.
   d. Of coherent hollow cones.

(2.) Solid ſtalactites of a ſparry texture.
   a. Hollow, and in form of a cone.
   1. White, and ſemitranſparent.

II. Sa-

In Lochaber, near the farm-houſes on the north ſide of the ferry of Ballachyliſh, is a limeſtone or marble rock, of a beautiful aſhen-grey colour, and a fine regular uniform grain or texture; capable of being raiſed in blocks or ſlabs of any ſize, and of receiving a fine poliſh. It is beautifully ſprinkled with fine bright grains of mundick or pyrites, and likewiſe with grains or ſpecks of beautiful lead ore of a fine texture.

About three miles ſouth of Fort-William, in the bed of a river, is a curious kind of marble with a black ground, flowered with white, like fine needle-work, or rather reſembling the froſt flowering upon glaſs windows in winter; and this flowering is not only on the outſide, but quite through all parts of the body of the ſtone.

Scotland has alſo chalk in abundace; ſome of which is regularly ſtratified, and much appears in thick irregular maſſes like ſediment.

(B) The tranſlator of Mr Cronſtedt's Treatiſe has adopted this German term *druſen* into the 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.

Calcareous Earths.

II. Saturated or combined with the acid of vitriol. Gypſum, Plaſter-ſtone, or Parget.

1. Looſer and more friable than a pure calcareou 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 complete the ſaturation.
3. It readily falls into a powder in the fire.
4. If burnt, without being red-hot, its powder readily concretes with water into a maſs, which ſoon hardens; and then,
5. No heat is perceived in the operation.
6. It is nearly as difficult to be melted by itſelf as the limeſtone, and ſhows moſtly the ſame effects with other bodies as the lime-ſtone: 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.
8. When a ſmall quantity of any gypſum is melted together with borax, the glaſs becomes colourleſs and tranſparent; but ſome ſorts of alabaſter and ſparry gypſa, when melted in ſome quantity with borax, yield a fine tranſparent yellow coloured glaſs, reſembling that of the beſt topazes. This phenomenon might probably happen with every one of the gypſeous kind. But it is to be obſerved, that if too much of ſuch gypſum is uſed in proportion to the borax, the glaſs becomes opaque, juſt as it happens with the pure limeſtone.
9. Burnt with any inflammable matter, it emits a ſulphureous ſmell; and may as well by that means, as by both the alkaline ſalts, be decompounded; but for this purpoſe there ought to be five or ſix times as much weight of ſalt as of gypſum.
10. Being thus decompounded, the calx or earth which is left ſhows commonly ſome marks of iron.

The gypſeous earth is found,

(1.) Looſe and friable. Gypſeous earth, properly ſo called; *Guhr*.
A. White.

(2.) Indurated.
A. Solid, or of no viſible particles, Alabaſter.
a. White, alabaſter.
1. Clear and tranſparent.
2. Opaque.
b. Yellow.
1. Tranſparent, from the Eaſtern countries.
2. Opaque.
B. Gypſum of a ſcaled or granulated ſtructure. This is the common plaſter-ſtone.
1. With coarſe ſcales. *a*. White.
2. With ſmall ſcales. *a*. Yellowiſh. *b*. Greyiſh.
C. Fibrous gypſum, or plaſter-ſtone, improperly (though commonly) called *Engliſh talc* by our druggiſts.
1. With the fibres coarſe. *a*. White, from Livonia.
2. With fine fibres. *a*. White.
D. Spar-like gypſum. Selenites, by ſome alſo called *glacies mariæ*; and confounded with the clear and tranſparent mica.
1. Pure ſelenites.
A. Tranſparent.
a. Colourleſs. *b*. Yellowiſh.
2. Liverſtone, ſo called by the Swedes and Germans.
E. Cryſtalliſed gypſum. Gypſeous druſen.
(1.) Druſen of cryſtals of pure ſparry gypſum.
A. Wedge-formed, compoſed of a pure ſpar-like gypſum.
a. Clear and colourleſs. *b*. Whitiſh yellow.
B. Capillary.
a. Opaque, whitiſh yellow. *b*. Hexagonal, priſmatic. *c*. Globular, conſiſting of cuneated rays proceeding from the centre.
F. Stalactitical gypſum. *Gipſum ſinter*.
1. Of no viſible particles; in French, *grignard*.
A. Of an irregular figure.
a. Yellow. *b*. White.
2. Of a ſpar-like texture.
A. In form of a cone.
a. White and yellow.
B. Of an irregular figure.
a. White.

III. Calcareous earth ſaturated with the acid of common ſalt. *Sal ammoniacum fixum naturale*.
This is found, 1. In ſea-water. 2. In ſalt-pits.

IV. Calcareous earth combined or ſaturated with ſparry acid, known by the name of *ſparry fluor* and *blue john*.

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

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

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. But,
4. In mixtures with all other earths they are (generally) very fuſible, and eſpecially with calcareous earth, with which they melt into a corroding glaſs that diſſolves the ſtrongeſt crucibles, unleſs ſome quartz or apyrous clay be added thereto.
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.

A. Indurated fluor.

Calcareous Earths.

(1.) Solid, of an indeterminate figure; of a dulll texture, ſemitranſparent, and full of cracks in the rock.
a. White.

(2.) Sparry fluor. This 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. *b.* Blue. *c.* Violet. *d.* Deep green. *e.* Pale green. *f.* Yellow.

(3.) Cryſtalliſed fluor.
1. Of an irregular figure. *a.* White. *b.* Blue. *c.* Red.
2. Of a cubical figure. *a.* Yellow. *b.* Violet.
3. Of a polygonal ſpherical figure. *a.* White. *b.* Blue.
4. Of an octoedral figure. *a.* Clear, colourleſs.

V. Calcareous earth ſaturated with a particular acid, perhaps of the metallic kind, *viz.* the tungſtenic acid. The *tungſtein* of the Swedes.

This reſembles the garnet-ſtone and the tin-grains; is nearly as heavy as pure tin; very refractory in the are, and exceſſively difficult to reduce to metal. Iron has, however, been melted out of it to more than 30 *per cent.* It is very difficultly diſſolved by borax and alkaline ſalts, but melts very eaſily with the microcoſmic ſalt, giving a black ſlag; and for this reaſon the laſt mentioned ſalt muſt be employed in the aſſays of this ſtone. It is found,
1. Solid and fine-grained.
a. Reddiſh or fleſh-coloured. *b.* Yellow.
2. Spathoſe, and with an unctuous ſurface.
a. White. *b.* Pearl-coloured.

VI. Calcareous earth united with the inflammable ſubſtance.

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

(1.) Calcareous earth mixed with phlogiſton alone; *Lapis ſuillus*, fetid ſtone and ſpar, or ſwine-ſtone and ſpar.
A. Solid, or of no viſible or diſtinct particles.
a. Black.
B. Grained.
a. Blackiſh brown.
C. Scaly, *particulis micaceis.*
1. With coarſe ſcales, *a.* Black.
2. With fine ſparkling ſcales. *a.* Brown.
D. Sparry.
a. Black. *b.* Light brown. *c.* Whitiſh yellow.
E. Cryſtalliſed.
1. In a globular form.

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

The varieties of this kind worthy to be taken notice of, depend on the different quantities of each of their component parts, and on the quality of the clay. The following are ſpecified as examples.
A. Looſe and compact, *Marga friabilis.*
a. Reddiſh brown.
b. Pale red. This, when burnt, is of a yellowiſh colour, and uſed for making earthen ware in ſome places.
B. Semi-indurated; which is nearly as hard as ſtone when firſt dug up, but moulders in the open air.
a. Grey. *b.* Red.
C. Indurated or ſtone marle.
A. in looſe pieces, *Marga indurata amorpha;* by the Germans called *duckſtein* or *tophſtein.*
a. White. *b.* Grey, formed from a ſediment which the water carries along with it.
B. In continued ſtrata. Hard ſlaty marle.

VIII. Calcareous earth united with a metallic calx.

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

The ſubjects belonging to this diviſion loſe the property of raiſing an effervеſcence with acids, when they are rich in metal, or contain any vitriolic acid. However, there have been found ſome that contained 20 or 30 *per cent.* of metal, and yet have ſhown their calcareous nature by the nitrous acid.

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

(1.) With iron. 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 30 or 40 *per cent.* of its weight, which by diſtillation has been found owing to the water that evaporates; and it is poſſible that ſome ſmall quantity of vitriolic acid may, at the ſame time, evaporate with the water.
4. It is of all the iron ores the moſt eaſy to melt, and is very corroſive when melted.
This kind is found,
A. Looſe; the mouldered part of the indurated ſort.
a. Black, like ſoot.
b. Dark brown, ſomewhat reſembling umbre.
B. Indurated.
1. Solid, of no diſtinct particles.
a. Red, Looks like red ochre, or the red hæmatites, but diſſolves in the acid of nitre with a great effervеſcence.
2. Scaly, *particulis micaceis.*
a. White.
b. Blackiſh grey.
3. Spar-like.
a. Light brown.

4. Druſen.
a. Blackiſh brown.
b. White.
1. Porous. This is often called *eiſenblute*, or *flos ferri*.
2. Cellular.

(2.) With copper.
A. Looſe and friable. Mountain blue; Germanicè, *Bergblau*. This diſſolves in aquafortis with efferveſcence.
B. Indurated.
1. Pure calcareous earth mixed with calx of copper. Armenian ſtone, *lapis Armenus*.
2. Gypſeous earth united with calx of copper. Is of a green colour; and might perhaps be called *turquoiſe ore*, or *malachites*; though we do not know if all ſorts of turquoiſe ore are of this nature.
a. Semi-tranſparent, is found at Ardal in Norway.

(3.) With the calx of lead.
This is a lead ochre, or a ſpar-like lead-ore, which, in its formation, has been mixed with a calcareous earth, and for that reaſon efferveſces with acids.
A. Looſe and friable.
1. White.
B. Indurated.
1. Scaly.
a. Yellowiſh.
Both theſe varieties contain a conſiderable quantity of lead, *viz.* 40 *per cent.* more or leſs; and the calcareous earth is as equally and intimately mixed with it, as in the white iron ore.

IX. The following compounds of calcareous earth with different mineral ſubſtances are added from Mr Kirwan's Elements of Mineralogy.
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. 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 Cronſtedt *kolmord marble*. 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 62 parts of mild calcareous earth, 30 of green talc, 1 of magneſia, and 1 of ſemiphlogiſticated iron.
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.
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. Calcareous Earths.
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 reddiſh ſchiſtus, 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 ſchiſtus, and 2 of ſemiphlogiſticated iron. The cellular appearance proceeds from the ſchiſtus.
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 efferveſces 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 quarts; 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 anthor.
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 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 efferveſcence; calcines in a ſtrong fire; makes nitre ſlightly detonate; and if diſtilled affords a ſmall portion of vitriolic acid, and ſome ſulphur ſublimes. Its component

Ponderous Earth.

ponent 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 II. Ponderous Earth.

Ponderous earth, (*Terra Ponderoſa*): Cauk, or calk. See Earth, Art. I. This is a particular kind of earth (like chalk in appearance, but with ſome very different properties), 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 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, which is inſoluble in water.
4. Its cryſtallization, after being combined with the nitrous, or with the muriatic acids, is hardly ſoluble;
5. But with acetous acid, it becomes deliqueſcent.
6. When pure; viz. without any mixture of acid or alkali, it does not vitrify in the fire.
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, chiefly if the water has been impregnated alſo with the ſame aerial acid.
9. It expels the cauſtic volatile alkali from ammoniacal ſalt.
10. Mixed with brimſtone it produces a hepar ſulphuris, whoſe ſolution in water is but incompletely 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.

I. Combined with aerial acid; *Terra ponderoſa aërata.* See Chemistry-*Index.*

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

A. Spar-like gypſum.
1. Semitranſparent, *ſpatum Bononienſe.* The Bononian ſtone, or native phoſphorus.
2. Opaque. *a.* White. *b.* Reddiſh.

B. Ponderous Druſen ſpar.
1. Jagged, *criſtatum.* Theſe reſemble cock's combs, and are found in clefts and fiſſures accreted on the ſurfaces of balls of the ſame ſubſtance.
2. White.
3. Reddiſh.

II. United with phlogiſton and the vitriolic acid. *Leberſtein* of the Germans and Swedes. *Lapis hepaticus.*

Magneſian Earths.

This ſtone in ſome ſpecimens conſtantly, but in others only when rubbed, ſmells like the *hepar ſulphuris*, or gun-powder.

It is found.

A. Scaly.
1. With coarſe ſcales. *a.* Whitiſh yellow.
2. With fine ſparkling ſcales. *a.* Black.

Order III. Magnesian, Micaceous, and Asbestine Earths.

§ 1. *Magneſian Earths.*

Magnesia is a white, looſe, and light earth, only known ſince the beginning of this century. It is generally found combined or mixed with other heterogeneous ſubſtances, as other ſimple earths are.

1. When pure 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.
3. But it melts eaſily with borax, or microcoſmic ſalt; though it is ſcarcely affected by fixed alkalis or calces of lead.
4. Mixed with other earths, it produces by fire different hard maſſes.
5. It gives no cauſticity except to the volatile alkali: and
6. Does not effervеſce with any acid.
7. When mixed with water it ſhows a very ſmall degree of heat, but without any effervеſcence. And when the water exceeds the weight of magneſia about 7,692 times, it is totally diſſolved.
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.
10. This earth combined with aerial acid is more ſoluble in cold than in hot water.
11. Combined with vitriolic acid it cryſtallizes into a bitter ſalt, known by the name of *Epſom* and *Seydlitz* or *Seidſchulitz* 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 cryſtallize: 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 cryſtallizes with it into hexangular priſms whoſe ends are formed of two low pyramids, of three rhombs (*Romé de l'Iſle*).
15. It is not precipitated from other acids by the vitriolic, as calcareous earth is.
16. According to Lavoiſier and Macquer, when magneſia is calcined, it becomes phoſphoreſcent.

I. Magneſia combined with vitriolic and other acids.

A. When ſaturated with the vitriolic acid, it forms a bitter ſalt, called *Engliſh* or *Epſom*, *Seydſhutz* or *Sedlitz* ſalt. The ſalts known under theſe dif-

ferent 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.

II. Combined with other earths.

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, shows a dull and porous texture.

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

(1.) Compact and soft; *Smectis*, *Briançon* or French chalk.
- *a.* White, from the Lands-End, in Cornwall.
- *b.* Yellow.
- *c.* Red and white, from the Lands-End: the soap-earth, from Switzerland: it looks like Castile-soap.

(2.) Solid and compact; of impalpable particles: Steatites or soap-rock.
- *a.* White, or light green. *b.* Deep green — *c.* Yellow.

(3.) Solid, and of visible particles; serpentine stone.

A. Of fibrous and coherent particles.

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. It is sold for the *lapis nephriticus*, and is dug at some unknown place in Germany. *b.* Light green, from Skienshyttan, in Westmanland; is used by the plate-smiths instead of French chalk.

B. Of granulated particles; fine grained sepentine stone, 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.

B. Porcelain earth mixed with iron; *terra porcellanea* This is,

A. Diffusible in water.
- *a.* Red, from Montmartre, and China. The water-clinkers which are imported from certain places in Germany seem to be made of this kind.

B. Indurated.
1. Martial soap earth.
   - *a.* Red.
2. Martial soap rock.
   - *a* Black.
   - *b.* Red.

C. The telgsten of the Swedes; *lapis ollaris*.
- *a.* Light grey. *b.* Whitish yellow. *c.* Dark grey. *d.* Dark green.

The serpentine stone 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 barofelenite. (6.) Veined or spotted with shistus — And, (7.) With veins of quartz, feltspar, or shoerl. (*Kirwan's 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, (*Kirwan.*)

§ 2. *Micaceous Earths.*

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 inner 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 alkaline salt: and may by means of the blow-pipe be brought to a clear glass with the two former salts. The martial mica is, however, more fusible than the uncoloured ones: its specific gravity is 3,000.

A. Colourless or pure mica; daze, glimmer, or glist.
1. Of large parallel plates; Muscovy glass. This is transparent as glass; found in Siberia and Elfdalen in the province of Wermeland.
2. Of small plates, from Silfverberget, at Runneby, in the province of Blekinge.
3. Of fine particles like chaff; chaffy mica.
4. Of twisted plates; crumpled mica.

B. Coloured and martial glimmer.
1. Brown, semi-transparent.
2. Of fine and minute scales.
   - *a.* Brown. *b.* Deep green. *c.* Light green. *d.* Black.
3. Twisted or crumpled glimmer.
   - *a.* Light green.
4. Chaffy glimmer.
   - *a.* Black.

Magnesian Earths.

5. Chryſtallized glimmer.
   a. Of concentrated and erect ſcales.
   b. Of hexagonal horizontal plates.

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.

§ 3. *Aſbeſtine Earths.*

Theſe are only yet diſcovered in an indurated ſtate; and 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 alkali.

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

I. Aſbeſtus, which is compounded of ſoft and thin membranes; *amiantus Wallerii.*
   A. Of parallel membranes: *Corium, ſive caro montana,* Mountain-leather.
      1. Pure. *a.* White.
      2. Martial. *a.* Yellowiſh brown.
   B. Of twiſted ſoft membranes; mountain-cork.
      1. Pure. *a.* White.
      2. Martial. *a.* Yellowiſh brown.

II. Of fine and flexible fibres; or earth flax: *aſbeſtus Wallerii.*
   A. With parallel fibres: *Byſſus.*
      1. Pure and ſoft. *a.* Light green. *b.* White.
      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.
   B. Of broken and recombined fibres.
      1. Martial. *a.* Light green.

Order IV. Siliceous Earths.

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 reverbatory 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 effervеſcence with acids.
5. In the fire it melts eaſieſt of all to a glaſs with the fixed alkaline ſalt; and hence it has got the name of vitreſcent, though this name is, properly ſpeaking, leſs applicable to this order than to a great many other earths.

To the above we may add the following properties, from Bergman.

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 fixed alkali is only half the weight of the ſiliceous earth, it produces a diaphonous 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.

Siliceous Earths. *Gems.*

§ 1. *Gems, or precious ſtones.*

I. Diamond. *Adamas gemma.* See Diamond.
   1. Of all ſtones, it is the hardeſt.
   2. Is commonly clear, or tranſparent; which quality, however, may, perhaps, only belong to its cryſtals, but not to the rock itſelf from which they have their origin.
   3. Its ſpecific gravity is neareſt 3,500. When brought to Europe in its rough ſtate, it is in the form either of round pebbles with ſhining ſurfaces, or of cryſtals of an octoedral form.
   a. Colourleſs, or diaphonous, or the *diamond* properly ſo called.
   But it alſo retains this name when it is tinged ſomewhat red or yellow. Being rubbed, it diſcovers ſome electrical qualities, and attracts the maſtic.
   b. Red; Ruby. *Adamas ruber; Rubinus.*— Which, by lapidaries and jewellers, is, in regard to the colour, divided into,
      1. The ruby of a deep red colour inclining a little to purple.
      2. Spinell, of a dark colour.
      3. The balaſs, pale red, inclining to violet. This is ſuppoſed to be the mother of the rubies.
      4. The rubicell, reddiſh yellow.
      However, all others do not agree in the characters of theſe ſtones.

II. Sapphire. *Sapphyrus gemma.*
   It is tranſparent, of a blue colour; and is ſaid to be in hardneſs next to the ruby, or diamond.

III. To-

Siliceous Earths. Gems.

III. Topaz. *Topazius gemma.*

a. The pale yellow topaz; which is nearly uncoloured.

b. The yellow topaz.

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

d. Orange-coloured topaz.

e. The yellowiſh green topaz, or *chryſolite.*

f. The yellowiſh green, and cloudy topaz, the *chryſopraſe* (A).

g. Bluiſh green topaz, or the beryl.

This varies in its colours; and is called, when

1. Of a ſea-green colour, the *aqua-marine.*
2. When more green, the *beryl.*

IV. Emerald. *Smaragdus gemma.*

Its chief colour is green and tranſparent. It is the ſofteſt of precious ſtones, and when heated it is phoſphoreſcent like the fluors.

V. To the precious ſtones belong alſo the jacinths, or hyacinths; which are cryſtals harder than quartz cryſtals, tranſparent, of a fine reddiſh-yellow colour when in their full luſtre, and formed in priſms pointed at both ends: theſe points are always regular, in regard to the number of the facets, being four on each point; but the facets ſeldom tally: the ſides alſo which form the main body, or column, are very uncertain in regard both to their number and ſhape; for they are found of four, five, ſix, ſeven, and ſometimes of eight, ſides: further, the column or priſm is in ſome alſo ſo compreſſed, as almoſt to reſemble the face of a ſpherical facetted garnet.

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Mr Cronſtedt ſays, he got ſome jacinths of a quadrangular figure, which did not melt in the fire, but only became colourleſs.

VI. The amethyſt 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 amethyſt;* 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 amethyſts 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 the Weſt Indies.

The amethyſts called *occidental,* are of the ſame nature as rock cryſtals, and have the ſame gradations. viz. of a violet inclining to the purple

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(A) In the *Annals of Chemiſtry,* Vol. I. we have the following account of the method of digging for the chryſopraſus, and of the earths and ſtones with which it is accompanied.

This precious ſtone is found in certain mountains in Sileſia, which ſeem to begin thoſe of Tradas, extending to within half a league of Glatz. Theſe mountains appear, in general, to conſiſt of a number of ſtrata, horizontal or inclined, compoſed chiefly of ſubſtances containing magneſia, but likewiſe mixed with calcareous, argillaceous, and ſiliceous earths. The greateſt part of theſe conſiſt of ſerpentine, mixed with aſbeſtos and aniantbus, grey argillaceous earths, boles, and red or green ochres, ſtone marrow, ſteatites, or ſoap-ſtone, and talc. In thoſe mountains alſo we meet with quartz, petroſilex, opal, and chalcedony, in detached fragments, and ſometimes in continued veins. We alſo diſcover in them veins of ſand, of the nature of granite. Sometimes the ſerpentine is met with at the ſurface; ſometimes at the depth of 20 or 30 feet. The ſtone marrow ſeems here to be produced by the decompoſition of a very milky ſpecies of opal agate named *cacholong;* for at the depth of 50 feet and upwards the veins of this ſoapy earth aſſume a degree of ſolidity, and we find nothing but hard and ſemitranſparent cacholongs.

The above-mentioned ſtrata are croſſed by a great number of cracks filled with green-coloured earths and ſtones; but theſe frequently do not contain a ſingle true chryſopraſus. They are ſometimes found immediately under the vegetable mould, or at the depth of ſome feet, in ſhapeleſs maſſes, covered with a heavy clay, and ſometimes enveloped by an unctuous earth of a beautiful green colour, which it derives from the calx of nickel. In other places, the chryſopraſus has been found in uneven laminæ of ſeveral yards in length and breadth, either immediately under the mould, or in the upper ſtrata of ſerpentine, which have little ſolidity; and very beautiful ones have been found at the depth of ſeven or eight fathoms; and ſome have been met with in grey clay at the depth of four fathoms. In ſome places alſo they are met with in a kind of red ochre, which is attracted by the magnet; in others they are found in the clefts of rocks. The beautiful green chryſopraſus is found moſt plentifully in the mountain of Glaſſendorf. In another mountain named Koſmutz, where it is alſo found, the pieces are ſo porous, and ſo much ſpotted with white, &c. that ſometimes upwards of 1000 of them have not afforded one large enough for the uſe of the jewellers. The defects are frequently only diſcoverable on poliſhing, as the green opal, while rough, perfectly reſembles the chryſopraſus; but, on poliſhing the ſtones in which it is contained, it is detected by its want of luſtre.

The quantity in which theſe ſtones are found is not ſufficient to afford the expences of regular mining; the moſt profitable way, therefore, of obtaining them is by making trenches in the earth from four to ſix feet deep. Almoſt all the mountain of Koſemutz, however, has already been examined in this manner; ſo that they now dig for the chryſopraſus in quarries by uncovering a bank of earth or ſtone, and deſcending to other banks by ſteps in the open air, ſo as to throw the rubbiſh back from bank to bank. This method, however, cannot be continued farther than 24 or 30 feet, otherwiſe the produce would not defray the expence. The only tools employed in digging for the chryſopraſus are a ſpade and pick-ax; the former to remove the earth, the latter to detach the chryſopraſus itſelf from the ſtones which ſurround it.

Various accounts have been given of the component parts of this precious ſtone. Lehmann thinks, that the

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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.

What we call *amethyſt 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.

VII. The garnet, (*Granatus.*) 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 cryſtals and in its colour, ſome being of a deep and dark red, ſome yellowiſh and purpliſh, and ſome brown, blackiſh, and quite opaque. 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 cryſtals take almoſt all ſorts of figures, as the rhomboidal, tetradecaedral, &c. and ſome are of an irregular form.

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Their colour proceeds from the iron which enters into their compoſition; and, according to M. 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*,

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the colour of it is owing to ſome ferruginous particles modified in a particular manner: but the experiments he adduces for this opinion are not ſatisfactory. Mr Sage attributes the colour to cobalt from the blue colour it imparts to glaſs. Mr Achard thinks the ſtone contains calx of copper as well as calx of iron; becauſe a part of the metal ſeparable from it may be diſſolved in volatile alkali. The following are the experiments of M. Klaproth upon the ſubject.

1. On heating ſeveral pieces of very pure chryſopraſus red hot, and quenching them in water, the colour was changed from green to bluiſh grey; and, on repeating the operation, it became a white grey. They were found to have loſt in weight one and an half per cent. and were eaſily pulverable in a glaſs mortar.

2. Three hundred grains of chryſopraſus were mixed with double its weight of mild mineral alkali, and the mixture heated for ſome hours red hot, in a porcelain crucible. The maſs was then powdered, and digeſted in diſtilled water. By filtration, a yellowiſh grey reſiduum was obtained, weighing 44 grains; the filtered liquor was limpid and colourleſs, a copious precipitate being formed with muriatic acid, which being waſhed and dried was found to be ſiliceous earth.

3. The 44 grains of yellowiſh grey reſiduum were digeſted in a retort, with 352 grains of aqua regia; a great part of which was evaporated. The acid which came over was returned into the retort, and filtered after a ſecond digeſtion. The reſiduum was a very fine white ſiliceous earth, which, after being waſhed, dried, and heated red hot, weighed 20 grains.

4. The filtrated ſolution was of a pale green, but on ſuperſaturation with volatile alkali immediately turned of a bluiſh colour, precipitating a ſmall quantity of browniſh gelatinous matter; which, when collected, twice diſtilled with nitrous acid, and afterwards ſtrongly heated, yielded a brown calx of iron, weighing no more than a quarter of a grain: whence our author concludes, that iron does not contribute to the colour of the chryſopraſus, as we know many colourleſs ſtones which contain as great a quantity of that metal. This ſmall quantity of calx was left after digeſting the gelatinous reſiduum. On precipitating the ſoluble parts, they appeared to conſiſt of aluminous earth, in an exceſſively divided ſtate; which being waſhed and dried, weighed half a grain.

5. To find whether the ſolution contained calcareous earth or not, he mixed with that, ſuperſaturated with volatile alkali, a ſaturated ſolution of mild mineral alkali, which precipitated four grains and an half of white and very pure calcareous earth.

6. Nothing more was precipitated from the ſolution, either by acids or alkalies, after the ſeparation of the calcareous earth, though it ſtill retained a bluiſh colour. It was poured into a retort, and evaporated to dryneſs; the reſiduum was of a yellowiſh colour, which became green on being diſſolved in diſtilled water. Mild mineral alkali threw down only a little earth of a greeniſh white colour; which being re-diſſolved in dephlogiſticated nitrous acid, and precipitated with Pruſſian alkali, the liquor yielded 17 grains of a ſea-green powder. This precipitate, in our author's opinion, is the colouring principle of the chryſopraſus; and this principle he afterwards found to be calx of nickel.

7. Our author likewiſe attempted to analyſe the chryſopraſus in the moiſt way by concentrated vitriolic acid; in which proceſs his chief view was to diſcover whether or not the ſtone contained any volatile particles or not. On an ounce of crude chryſopraſus, therefore, when put into a retort, he poured an equal quantity of rectified vitriolic acid, and two parts of diſtilled water. After the latter had paſſed over into the receiver, the fire was increaſed to force over the ſuperabundant acid; a part aroſe in white vapours, and ſome fell into the receiver with an hiſſing noiſe. Boiling water, which had been diſtilled, was then poured upon the reſiduum, and the ſolution filtered. The powdered chryſopraſus left on the filter had not been perfectly diſſolved, and, in

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rocca, and is found in Syria, Calcutta, Cananor, Camboya, and Ethiopia.

The fine garnet of a red inclining to a yellow colour, is the *foranus* of the ancients, 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 alſo found 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 loadſtone; 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.

VIII. Tourmalin; *Lapis electricus*.

This is a kind of hard ſtone, lately brought into notice by its electrical properties. See TOURMALIN.

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1. Its form is a priſm of nine ſides of different breadths, moſtly truncated, and ſeldom terminating in a pyramid at each end, which is 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. But many of theſe ſtones are not in the leaſt electric. However, on being rubbed, they become electric in their ſides, like other diaphanous gems.
3. It is as hard almoſt as the topaz, and ſtrikes fire with ſteel.
4. It melts by itſelf in a ſtrong fire, though with difficulty.
5. With the microcoſmic ſalt it melts perfectly; but only in part with borax.
6. With mineral alkali it is divided into a kind of powder.
7. The three mineral acids diſſolve it when firſt reduced to a powder.
8. It bears a greater ſimilarity to ſchoerl than to any other ſtone: but its component parts ſhow

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in general, had undergone but little alteration, ſo that he could not by this method determine the component parts. M. Achard, however, was more ſucceſsful, and by a ſimilar method determined the component parts of this gem to be five grains of an earth, which, diſtilled with vitriolic acid, became volatile; eight grains of calcareous earth, ſix grains of magneſia, two grains of calx of iron, three grains of calx of copper, and 456 of ſiliceous earth.

M. Klaproth never met with any volatile earth or magneſia in his experiments on this gem; and therefore concludes, that the chryſopraſus uſed by him had been eſſentially different from that made uſe of by M. Achard; and he ſeems not to give credit to the account of any copper being found in it.

8. One part of crude chryſopraſus, well powdered and waſhed with two parts of mild vegetable alkali, yielded a violet-coloured glaſs, which in the atmoſphere ran into a browniſh coloured liquor.

9. Five parts of the gem, with four of mild alkali, gave a beautiful violet-coloured glaſs after being two hours in fuſion.

10. Equal parts of crude chryſopraſus and mild mineral alkali, yielded a tranſparent glaſs in thin laminæ, of a brown colour, reſembling that of the tourmalin, the ſurface being marked with fine reticulated veins; which veins aroſe from ſmall grains of very fine reduced nickel placed in lines againſt one another.

11. Equal parts of crude chryſopraſus and calcined borax, gave a clear, tranſparent, and brown glaſs, reſembling the ſmoky topaz.

12. Equal parts of chryſopraſus, extracted by vitriolic acid and calcined borax, yielded a ſimilar glaſs of a clear brown colour; "which proves (ſays our author), that the vitriolic acid was incapable of perfectly analyſing the chryſopraſus, though I had uſed a double portion of the earth."

13. Eighty grains of prepared ſiliceous earth, ſixty grains of mild fixed alkali, with three grains of calx of nickel procured from the chryſopraſus, yielded a beautiful, clear, and violet-coloured glaſs.

14. On ſubſtituting three grains of calx produced from an ore of nickel, a glaſs was produced exactly like the former.

15. Sixty grains of prepared ſiliceous earth and calcined borax, with three grains of calx of nickel from the chryſopraſus, yielded a tranſparent glaſs of a clear brown colour.

16. Sixty grains of prepared ſiliceous earth and vitrified phoſphoric acid, with three grains of calx of nickel from the chryſopraſus, gave a glaſs of the colour of honey.

17. Thus the attempts of M. Klaproth to recompoſe the chryſopraſus proved abortive. From his experiments, however, he deduces the following concluſions: 1. The blue colour obſervable in the glaſs produced by fuſing the chryſopraſus with vegetable alkali, ariſes entirely from the nickel contained in the gem; and the experiment ſhows that the calx of nickel, when purified as much as poſſible, has the ſurpriſing property of tinging glaſs frits prepared with vegetable alkali of a blue colour. "But (ſays he) why was not this colour alſo obtained with ſoda? and what is the cauſe of a difference ſo little to be expected?" 2. By theſe experiments the ſuppoſition of M. Sage is refuted, that the metallic matter which colours the chryſopraſus is cobalt: "many metallic ſubſtances beſides cobalt, it is well known, give by certain proceſſes a blue glaſs; thus cobalt,

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ſhow that it may be ranged with propriety in this place, along with other precious ſtones: as the argillaceous earth is alſo the moſt prevalent in its 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 3062 to 3295.

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 3075 to 3180.

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

d. From the mountains of Old Caſtile in Spain. Theſe are tranſparent, and have the ſame properties as the preceding ones.

IX. The opal, *Opalus*; the *girafole* of the Italians.—This 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.

1. The opal of Nonnius, the *Sangenon* of the Indians. This appears olive-coloured by reflection, and ſeems then to be opaque; but when held againſt the light, is found tranſparent and of a fine ruby red colour.

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.

2. 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.

a. Of many colours; the oriental opal.

b. Of a milky colour.

c. Bluiſh, and ſemi-tranſparent. This is not ſo much valued as thoſe which are more opaque, becauſe it is eaſier to be imitated by art.

Siliceous Earths. Gems.

§ 2. *Of Quartz.*

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

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

According to Mr Kirwan, quartz neither loſes its hardneſs nor its weight by calcination. Its texture is lamellar. Theſe ſtones are in general the pureſt of the ſiliceous kind, though moſt contain a ſlight mixture of other earths; the moſt obvious diſtinction among them ariſes from their tranſparency or opacity.

Quartz is found,

(1.) Pure.

A. Solid, of no viſible particles, with a gloſſy ſurface. Fat quartz.

a. Uncoloured and clear. This has no cryſtalliſed form, but is nevertheleſs as clear as quartz cryſtals of the beſt water.

b. White, the common fat quartz.

c. Blue

cobalt gives a blue colour to combinations of the mineral alkali with phoſphoric acid, to mineral alkali itſelf, to potaſh, and to borax. The acid of tungſten (falſely ſo called) alſo gives a blue colour to frits made with phoſphoric ſalts, but not to thoſe made with borax; the calx of nickel gives a blue colour only to frits made with potaſh, brown to thoſe with mineral alkali and borax, and yellow, like honey, to combinations of phoſphoric acid with mineral alkali." 3. As the chryſoprafus gives a brown colour with borax, and the ſolution of this ſtone in muriatic acid gives no ſigns of cobalt diſſolved in the ſame acid; this ſhows that there is no cobalt in the ſtone. Mr Sage, indeed, pretends, that he has obtained a blue glaſs from the chryſoprafus and borax; but this is contradicted by experience. 4. The mineralogical character of the chryſoprafus, therefore, is a quartz coloured green by nickel. Three hundred grains of it contain 288½ of ſiliceous earth calcined to redneſs, one quarter of a grain of pure aluminous earth, two grains and an half of calcareous earth calcined to redneſs, three grains of calx of nickel, and one quarter of a grain of calx of iron. All theſe were extracted in the experiments; and there were beſides five grains and an half of waſte.

Our author mentions, that in the collections of chryſoprafus which have been brought to him, he has conſtantly obſerved green opal, in bits of vein from half an inch to an inch, and fixed in its borders: the reddiſh, yellow, and white opals, on the contrary, are generally met with on a green or browniſh petroſilex. But the white opal, which, as well as the green, is found in pieces of the nature of matrix, differs from the true opal, approaching the chalcedony and the opaque milky quartzes. This kind of tranſparent opal, radiated with a whitiſh blue, contains the following ingredients in its compoſition: Siliceous earth, 237 grains; aluminous earth, a quarter of a grain; calx of iron, a quarter of a grain—in all, 2 7½ grains. In 240 grains were two and an half of waſte. The colour of this ſtone, as well as the chryſoprafus, in our author's opinion, is derived from nickel.

Siliceous Earths. *Gems.*

c. Blue.
d. Violet.

B. Grained.
a. White. *b.* Pale green.

C. Sparry quartz.
This is the ſcarceſt; and ought not to be confounded with the white felt-ſpat, being of a ſmoother appearance, and breaking into larger and more irregular planes.
a. Whitiſh yellow. *b.* White.

D. Cryſtalliſed quartz. Rock cryſtal. Quartz cryſtal.
1. Opaque, or ſemi-tranſparent.
a. White, or of a milk colour.
b. Red, or of a carnelian colour.
c. Black.
2. Clear.
a. Blackiſh brown, ſmoky topaz, or *raunch topaz* of the Germans.
b. Yellow; found in Bohemia, and ſold inſtead of topazes.
c. Violet; the amethyſt from Saxony, Bohemia, and Dammemore in Upland (B.)
d. Uncoloured; rock cryſtal, properly ſo called. When theſe coloured cryſtals are not clear, they are called *fluſs*; for inſtance, *topaz-fluſs*, *amethyſt-fluſs*, &c. (C.)

(2.) Impure quartz.
A. Mixed with iron, in form of a black calx.—This is of a gloſſy texture, and contains a great quantity of iron.
B. Mixed with copper in form of a red calx.
a. Red.

§ 3. *Of Flints.*

The flint (*Silex pyromachus*, *Lapis corneus*, or the *hornſtein* of the Germans) forms a kind of intermediate ſubſtance between quartz and jaſper; both which, however, it ſo nearly reſembles, that it is not eaſy to point out ſuch characters as ſhall readily diſtinguiſh it from them. We can only, therefore, ſpeak of its properties comparatively.

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 ſhows moſt evident marks of having been originally in a ſoft and ſlimy tough ſtate like glue or jelly.

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.

I. 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

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(B) The moſt tranſparent are called *falſe diamonds*, *Briſtol*, *Kerry ſtones*, and *Alençon diamonds*, &c. The coloured tranſparent 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.

(C) M. 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 opaque earth. He 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 refraction, or ſhow two images of the ſame object when looked through. 2. Hexagonal cryſtals united, having one or two points. 3. Tetrædral, dodecædral, 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 diaphonous, reddiſh, ſmokey, 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 form, as the pebbles of the Rhine: ſome have a cruſt of metallic calces, or of a pyrites: ſome are of a geodical form, viz. cryſtalliſed 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 ſapphire, and the amethyſt. Mr Daubenton has always looked on this laſt as a quartzous cryſtal.

den 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. M. 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.

II. Cat's eye; *Pſeudopalus*. The ſun-ſtone of the Turks, called *guneche*.

This ſtone is opaque, and reflects green and yellowiſh rays from its ſurface: it is found in Siberia. It is very hard and ſemi-tranſparent, 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.

III. *Hydrophanes*, or *Oculus Mundi*; alſo called *Lapis mutabilis*.

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

IV. The onyx. *Onyx camehuja*. Memphites. It is found of two ſorts.

a. Nail-coloured onyx, having pale fleſh-coloured and white lines.

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

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

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

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

c. Bluiſh grey; from Ceylon and Siberia.

VI. The carnelian. *Carniolus*.

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

a. Red.

b. Yellowiſh brown, looks like yellow amber. It is ſaid not to be ſo hard as the chalcedony.

VII. The ſardonyx.

This is a mixture of the chalcedony and carnelian, ſometimes ſtratumwiſe, and ſometimes confuſedly blended and mixed together.

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

b. White, with red dendritical figures. This very much reſembles that agate which is called the *mocha ſtone*; but with this difference, that the figures are of a red colour in this, inſtead of black, as in that agate.

Between the onyx, carnelian, chalcedony, ſardonyx, and agate, there ſeems to be no real difference, except ſome inexplicable degrees of hardneſs.

VIII. The agate; *Achates*.

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

a. Brown opaque agate, with black veins, and dendritical figures; the Egyptian pebble.

b. Of a chalcedony colour; *achates chalcedoniſans*.

c. Semi-tranſparent, with lines of a blackiſh brown colour, and dendritical figures; the mocha ſtone.

d. Semi-tranſparent, with red dots; *Gemma divi Stephani*. When the points are very minute, ſo as to give the ſtone a red appearance, it is by ſome called *Sardea*.

(D) On the ſide of a hill near the church of Rothes in Moray, is a quantity of fine agate of elegant red and white colours. It is very hard, heavy, of a ſmooth uniform texture, and of a conſiderable brightneſs; in which the red are remarkably clear, and finely mixed and ſhaded through the ſtone. Mr Williams ſays that this is the largeſt and moſt beautiful agate rock he ever ſaw; and ſo fine and hard as to be capable of the higheſt luſtre in poliſhing.

Siliceous Earths. Gems.

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

IX. Common Flint; *Pyromachus.*

This, in reality, is 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.*

X. Chert; *Petroſilex, Lapis Corneus.* The *hornſtein* of the Germans.

This is of a coarſer texture than the preceding, and alſo leſs hard, which makes it conſequently not ſo capable of a poliſh. It is ſemi-tranſparent at the edges, or 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.

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 decrepitates 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 microcoſmic ſalt diſſolve it without effervеſcence. Its appearance is duller and leſs tranſparent than common flint. The reddiſh Petro-ſilex uſed in the Count de Lauragar's porcelain manufacture, and called there *felt ſpat,* contained 72 *per cent.* of ſilex, 22 of argill, and 6 of calcareous earth.

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 cherts) appearing tranſparent, and of a fine ſparkling texture, on being broken; whereas the jaſper is grained, dull, and opaque, 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 limeſtone, 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 nodules, each ſurrounded with its proper cruſt; and that the matter which conſtitutes this cruſt has been ſeparated from the reſt of the ſubſtance, in like manner as ſandiver or glaſs-gall ſeparates from, and ſwims upon, glaſs, during its vitrification; though ſometimes the formation of this cruſt may be prevented by the too ſudden hardening of the matter itſelf.

Other ſpecies of ſtones, which are found in looſe pieces or nodules, except ores and ſome ſorts of ſtalactites, ſhow 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, M. Cronſtedt obſerves, 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.

§ 4. *Of Jaſpers.*

Jasper, *jaſpis,* (the *diaſpro* of the Italians), is a name given to all the opaque flints 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 from the heterogeneous mixture, probably of iron.

I. Pure jaſper; which by no means yet known can be decompounded.

a. Green with red ſpecks or dots; the *heliotrope,* or blood-ſtone. *b.* Green. *c.* Red. *d.* Yellow. *e.* Red with yellow ſpots and veins. *f.* Black.

II. Jaſper containing iron; *Jaſpis martialis Sinople.*

A. Coarſe-grained.
a. Red and reddiſh brown; *ſinople.*
B. Steel-grained, or fine-grained.
a. Reddiſh brown: looks like the red ochre or chalk uſed for drawing; and has partition veins, which are unctuous to the touch, like a fine clay, and other like kinds.
C. Of a ſolid and ſhining texture, like a flag.
a. Liver-coloured; and, *b.* Deep red. *c.* Yellow. This laſt mentioned, when calcined, is attracted by the loadſtone; and being aſſayed, yields from 12 to 15 *per cent.* of iron. (E.)

§ 5.

(E) Near Portſoy in Banff-ſhire is an extenſive rock of jaſper; ſome parts of which contain a beautiful mixture of green and red, which appear finely ſhaded and clouded through the body of the ſtone when poliſhed. Mr Williams is of opinion that it would be a very valuable quarry if worked.

§ 5. *Felt-ſpars.*

I. Rhombic quartz; *Spatum ſcintillans.*
This has its name from its figure, but ſeems to be of the ſame ſubſtance as the jaſper. We 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. *c.* Pale yellow. *d.* Greeniſh.
2. Cryſtalliſed.
a. In ſeparate or diſtinct rhomboidal cryſtals.

II. Labradore ſtone; *Spatum rutilum verſicolor.*
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 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 tombac-grey; beſides other colours between grey and violet. Theſe colours are ſeen for moſt part in ſpots; but ſometimes in ſtripes, on the ſame piece.

III. White feltſpar; *Terra Silicea Magneſia & ferro intimè mixta.*
This ſtone has been deſcribed by Mr Bayen: and is found at St Marie aux mines in Lorrain. —It is of a white opaque colour, ſpotted with ochre on the outſide.

§ 6. *Of the Garnet Kinds.*

The ſubſtances of this *genus* (which is conſidered by Cronſtedt as an *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 opaque and black garnets contain about 20 hundredths of iron: but the diaphanous ones only two 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.
The ſpecies are,

I. Garnet; *Granatus.*
This is a heavy and hard kind of ſtone, cryſtalliſing in form of polygonal balls, and moſtly of a red, or reddiſh brown colour.
A. Garnet mixed with iron; *Granatus martialis.*
1. Coarſe-grained garnet-ſtones, without any particular figure; in Swediſh called *Granatberg*; in German, *Granatſtein.*
a. Reddiſh-brown garnet. *b.* Whitiſh-yellow. *c.* Pale yellow.
2. Cryſtalliſed garnet.
a. Black. *b.* Red: ſemi-tranſparent, and cracked; tranſparent. *c.* Reddiſh-yellow; tranſparent; the jacinth, or hyacinth. *d.* Reddiſh brown. *e.* Green. *f.* Yellowiſh-green. *g.* Black.
B. Garnet mixed with iron and tin.
1. Coarſe-grained, without any particular figure.
a. Blackiſh-brown.
2. Cryſtalliſed.
a. Blackiſh-brown.
b. Light-green or white.
C. Garnet mixed with iron and lead.
1. Cryſtalliſed.
a. Reddiſh-brown.

II. Cockle, or ſhirl. *Corneous cryſtalliſatus Wallerii; Stannum cryſtallis columnaribus nigris Linnæi.*
This is a heavy and hard kind of ſtone which ſhoots into cryſtals of a priſmatical figure, and whoſe chief colours are black or green. Its ſpecific gravity is the ſame as the garnets, viz. between 3000 and 3400, though always proportionable to their different ſolidity.
A. Cockle, or ſhirl, mixed with iron.
1. Coarſe, without any determined figure.
a. Green,
2. Sparry.
a. Deep green, (the mother of the emeralds), from Egypt.
b. Pale green.
c. White. This occurs very frequently in the ſcaly limeſtones; and its colour changes from deep green to white, in proportion as it contains more or leſs of iron.
3. Fibrous, ſtriated cockle, or ſhirl: it looks like fibres or threads made of glaſs.
A. Of parallel fibres. *a.* Black. *b.* Green *c.* White.
B. Of concentrated fibres: The ſtarred cockle, or ſhirl, from its fibres being laid ſtellarwiſe.
a. Blackiſh green. *b.* Light green. *c.* White.
4. Cryſtalliſed cockle, or ſhirl.
a. Black. To this variety 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. 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.
b. Deep green.
c. Light green.
d. Reddiſh brown. The *tauffſtein* is of this colour, and conſiſts of two hexagonal cryſtals of cockle grown together in form of a croſs; this the Roman Catholics wear as an amulet, and is called in Latin *lapis crucifer*, or the croſs ſtone.

The figure of the cockle cryſtals 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 name *cockle* for theſe ſubſtances is an old Corniſh mineral name; but is alſo given ſometimes to other very different matters.

We

Siliceous Earths. *Gems.*

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

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

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

III. Rowley rag, (*Kirwan.*) This ſtone is of a duſky or dark grey colour, with numerous minute ſhining cryſtals. 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.

IV. Siliceous muriatic ſpar, (*Id.*) 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*. One hundred parts of this ſtone contain fifty parts of ſilex: the remainder is mild magneſia and iron; but in what proportion is not mentioned (See *Journal de Phyſique*, Supplement, vol. xiii. p. 216.)

V. Turky ſtone; *cos Turcica*, (*Id.*) 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 2,598. 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.

VI. 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 effervesces 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 a ſubſequent diviſion of this article.]

Obſervations on the œconomical Uſes of the Siliceous Order.

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 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.

Siliceous Earths. *Gems.*

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 cryſtals, have been employed for ornaments and economical utenſils, in which the price of the workmanſhip greatly exceeds the intrinſic value of the ſtones. The ancients uſed to engrave concave and convex figures on them, which now-a-days are very highly valued, but often with leſs reaſon than modern performances of the ſame kind. Theſe ſtones are worked by means of emery on plates 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, howmuchſoever the natural beauties of theſe ſtones ſeem 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. The quartz, however, is the beſt; and if uſed in due proportion with reſpect to the alkali, there is no danger of the glaſs being eaſily attacked by the acids, as has ſometimes happened with glaſs made of other ſubſtances, of which we had an inſtance of bottles filled with Rheniſh and Moſelle wines during the time of a voyage to China.

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

Argillaceous Earths.

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. (*Magellan.*)

Order V. *The* Argillaceous Earths.

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

I. *Argilla aerata; lac lunæ.*

This fanciful name was heretofore thought to denote a very fine ſpecies of calcareous earth; but Mr Screber has lately ſhown, 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 mieroſcope, it is found to conſiſt of ſmall tranſparent cryſtals; and by his experiments it appears plainly to be an argill ſaturated with fixed air. It efferveſces with acids, and contains a very ſmall proportion of calcareous earth and ſometimes of gypſum, beſides ſome feeble traces of iron. It is found near Halles.

II. Porcelain clay; *Terra porcellanea*, vulgo *Argylla apyra*, very refractory; the *kaolin* of the Chineſe.

(1.) Pure.

A Diffuſible in water.

1. Coherent and dry.

a White.

2. Friable and lean.

a. White.

(2.) Mixed with phlogiſton

A. Diffuſible in water.

a. White and fat pipeclay. *b.* Of a pearl colour. *c.* Bluiſh grey. *d.* Grey. *e.* Black. *f.* Violet.

Theſe contain a phlogiſton, which is diſcovered by expoſing them to quick and ſtrong fire, in which they become quite black interiorly, aſſuming the appearance of the common flints, not only in regard to colour, but alſo in regard to hardneſs: but if heated by degrees, they are firſt white, and afterwards of a pearl colour. The latter 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 inherent phlogiſton be the cauſe of the above-mentioned pearl-colour, or prevents them from being burnt white in a ſtrong fire; yet no heterogeneous ſubſtance can be extracted from them, except ſand, which may be ſeparated from ſome by means of water; but which ſand does not form any of the conſtituent parts of the clays. If they be boiled in aqua regis in order to extract any iron, they are found to loſe their viſcoſity.

III. Stone-marrow; *Lithomarga. Keffekil* of the Tartars.

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

A. Of coarſe particles: Coarſe ſtone-marrow.

a. Grey.

b. Whitiſh yellow, from the Crim Tartary, where it is called *keffekil*, and is ſaid to be uſed for waſhing inſtead of ſoap.

B. Of very fine particles; fine ſtone-marrow.

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

IV. Bole, (iron clay.)

This 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, contrary to what the porcelain and the common clays are, (I. & VI.); 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 loadſtone.

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

a. Fleſh-coloured bole.

b. Red.

1. Fine; *Bolus Armenus.*
2. Coarſe; *Bolus communis officinalis.*
3. Hard: *Terra rubrica.*

c. Green; *Terre verte.*

1. Fine.
2. Coarſe.

d. Bluiſh-grey, is ductile as long as it is in the rock, but even then repels the water; it contains 40 per cent. of iron; which metal being melted out of it in a cloſe veſſel, the iron cryſtalliſes on its ſurface.

e. Grey.

1. Cryſtalliſed in a ſpherical polygonal figure.
2. Of an undeterminate figure.

B. Indurated bole.

A. Of no viſible particles.

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

a. Reddiſh-brown; in moſt collieries, between the ſeams of coal.

b. Grey.

B. Of ſcaly particles.—The *hornblende* of the Swedes.

Argillaceous Earths.

It is diſtinguiſhed from the martial glimmer, or mica, by the ſcales being leſs ſhining, thicker, and rectangular.

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

b. Greeniſh.

V. Zeolyte.

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

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.
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 alkali (*ſal ſodæ*), than by borax or the microcoſmic ſalt.
4. It does not ferment with this laſt ſalt, as lime does; nor with the borax, as thoſe of the gypſeous kind,
5. It diſſolves very ſlowly, and without any effervescence, in acids, as in oil of vitriol and ſpirit of nitre. If concentrated oil of vitriol be poured on pounded zeolites, a heat ariſes, and the powder unites into a maſs.
6. In the very moment of fuſion it gives a phoſphoric light.

There have lately been diſcovered ſome 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.

The zeolyte is found in an indurated ſtate:

(1.) Solid, or of no viſible particles.

A. Pure.

a. White.

B. Mixed with ſilver and iron.

a. Blue, *Lapis lazuli.*

(2.) Sparry zeolite. This reſembles a calcareous ſpar, though it is of a more irregular figure, and is more brittle.

a. Light red, or orange-coloured.

(3.) Cryſtalliſed zeolite. This is more common than the two preceding kinds; and is found,

A. In groupes of cryſtals, in form of balls, and with concentrical points.

a Yellow.

b White.

B. Priſmatical and truncated cryſtals.

a White.

C. Capillary cryſtals, which are partly united in groupes, and partly ſeparate. In this latter accretion they reſemble the capillary or feathery ſilver ore; and are perhaps ſometimes called *flos ferri*, at places where the nature of that kind of ſtone is not yet fully known.

a. White.

VI. Tripoli.

This is known by its quality of rubbing or wearing hard bodies, and making their ſurfaces to ſhine; the particles of the tripoli being ſo fine as to leave even no ſcratches on the ſurface. This effect, which is called *poliſhing*, may likewiſe be effected by other fine clays when they have been burnt a little. The tripoli grows ſomewhat harder in the fire, and is very refractory: it is with difficulty diſſolved by borax, and ſtill with greater difficulty by the microcoſmic ſalt. It becomes white when it is heated: when crude, it imbibes water, but is not diffuſible in it: it taſtes like common chalk, and is rough or ſandy between the teeth, although no ſand can by any means be ſeparated from it. It has no quality common with any other kind of earth, by which it might be conſidered as a variety of any other. That which is here deſcribed is of a yellow colour, and is ſold by druggiſts. This kind of tripoli has been lately diſcovered in Scotland. But the *rotten-ſtone*, ſo called, is another ſort found in England, viz. in Derbyſhire. It is in common uſe in England among workmen for all ſorts of finer grinding and poliſhing, and is alſo ſometimes uſed by lapidaries for cutting of ſtones, &c.

The tripoli is found,

1. Solid: of a rough texture.
   a. Brown.
   b. Yellowiſh.
   c. Spotted like marble.
2. Friable and compact.
   a. Granulated.
   b. Brown.
   c. Yellowiſh.

VII. Common clay, or brick clay.

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

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

It is found,

A. Diffuſible in water.

1. Pure.
   a. Red clay.
   b. Fleſh-coloured, or pale-red.
   c. Grey.
   d. Blue.
   e. White.
   f. Fermenting clay.
2. Mixed with lime. See MARLE, above.

B. Indurated.

1. Pure.
   a. Grey ſlaty.
   b. Red ſlaty.
2. Mixed with phlogiſton, and a great deal of the vitriolic acid. See *Alum Ores*, above.
3. Mixed with lime. See LIME, above.

VIII. Argillaceous fiſſile ſtones.

Theſe and many other different kinds of earth have been comprehended under the denomination

Argillaceous Earths.

of *ſchiſti*; but to avoid ambiguity we will confine this name to ſtones of the argillaceous kind.

1. The bluiſh purple ſchiſtus, or common roof ſlate; *ſchiſtus tegularis*.
   Its colour varies to the pale, to the ſlightly purple, and to the bluiſh.
   a. The dark-blue ſlate, *ſchiſtus ſcriptorius*.
2. The pyritaceous ſchiſtus.
   This is of a grey colour, brown, blue, or black.
3. The bituminous ſchiſtus.
   This is generally black, of a lamellar texture, and of different degrees of hardneſs.
4. Flag ſtone.
   This is of a grey, yelloviſh, or reddiſh white colour.
5. The argillaceous grit.
   This is called alſo *ſand ſtone* and *free ſtone*, becauſe it may be cut eaſily in all directions.
6. *Killas*.
   This ſtone is of a pale grey or greeniſh colour; either lamellar, or coarſely granular. It is found chiefly in Cornwall.
7. *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 cryſtalliſed ſpar, and is fuſible *per ſe* in a ſtrong heat. It is found in Derbyſhire. See Toadstone.

For the œconomical uſes of the argillaceous earths, ſee the article Clay.

[The compounds of this and other earths will fall to be mentioned under a ſubſequent diviſion.]

Class II. SALTS.

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

In regard to the prinoipal known circumſtances or qualities of the mineral ſalts, they are divided into

1. Acid ſalts, or mineral acids.
2. Alkaline ſalts, or mineral alkalies.

Acid Salts.

Order I. Acid Salts.

For the characters, properties, and phenomena of theſe, ſee the article Acid, and Chemistry-*Index*.

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 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*. See the article Acid, and Chemistry-*Index*.

I. The vitriolic acid. See Chemistry-*Index*.
II. Nitrous acid.
   This 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. For the nature of this acid, ſee Chemistry-*Index*.
III. Acid of common or ſea-ſalt. See Chemistry-*Index*, at *Acid* and *Marine*.
IV. The *fluor* acid, or ſparry fluor acid. See Chemistry-*Index*.
   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 *amethyſt root*, when of a purple colour. See p. 72. col. 2. concerning the ſubſtances ariſing from the combination of this acid with calcareous earth.
V. The acid of *arſenic*. See Chemistry-*Index*.
VI. The acid of *molybdena*. *Ibid*.
VII. The acid of *tungſten*. *Ibid*.
VIII. The *phoſphoric* acid. *Ibid*.
IX. The *boracic* acid. *Ibid*.
X. The ſuccinous or *amber* acid. *Ibid*.
XI. Aerial acid, or *fixed air*. *Ibid*.

* See *Fluor Spar*

Order II. Alkaline Mineral Salts.

For the characters, properties, and phenomea of theſe, ſee the article Alkali; alſo Chemistry-*Index*, at *Alkali* and *Alkalies*.

New acids are daily detected; but no additions have been made to the three ſpecies of alkali long ſince known.

Theſe alkaline ſalts are,

I. Vegetable fixed alkali (A.)

(A) With regard to the origin of the vegetable fixed alkali, there are ſufficient proofs that it exiſts already formed in plants, 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.

Pot-aſh 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 pure of all. On the contrary,

Alkaline Salts.

Vegetable fixed alkali, deprived of every acid, is not found any where by itſelf; 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 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 odour.
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.
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 effervеſcence, and produces vitriolated tartar.
11. With the nitrous acid, it forms the cryſtalliſable 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.
16. It attracts 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*.
17. It diſſolves in the dry way all the dephlogiſticated metallic calces.
18. It unites with oils and other fat ſubſtances, with which it forms ſoap.
19. This alkali becomes opaque when expoſed to the flame of the blow-pipe: it decrepitates 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.

II. Foſſile fixed alkalis.

A. Alkali of the ſea, or of common ſalt (E.)

1. Pure.

This has nearly the ſame qualities with the lixivious ſalt, which is prepared from the aſhes of burnt vegetables. It is the ſame with the *ſal ſodæ*, or kelp: for 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 (F).

The properties of the foſſile alkali are as follows:

1. It

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trary, that which is got from tartar, properly burned, then diſſolved in boiling water, and purified by filtration and cryſtalliſation, is called *ſalt of water*. It is the beſt.

(B) The vegetable alkali is ſeldom found in the earth, except in wells of towns, as at Doway, or in the argillaceous 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.

(C) Common vegetable alkali, ſalt of tartar, and pot-aſh, were formerly conſidered by chemiſts as ſimple alkalis; but Dr Black 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 alkalies, 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 vial before it be entirely 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.*)

(E) 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 efflorеſcence 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 ancients meant this ſalt by their *natron* or *baurach*. (*Magellan.*)

(F) The mineral alkali is often combined with the vitriolic and marine acid, and alſo with the aerial acid;

1. It effervefces with acids, and unites with them.
2. Turns the fyrup of violets to a green colour.
3. Precipitates fublimate mercury in an orange-coloured powder.
4. Unites with fat fubftances, and forms foap.
5. Diffolves the filiceous earth in the fire, and makes glafs with it, &c. It diftinguifhes itfelf from the falt of the pot-afhes by the following properties (G).
6. It fhoots eafily into rhomboidal cryftals; which
7. Fall to powder in the air, merely by the lofs of their humidity (H).
8. Mixed with the vitriolic acid, it makes the *fal mirabile Glauberi.*
9. It melts more eafily, and is fitter for producing the *fal commune regeneratum, nitrum cubicum*, &c. Perhaps it is alfo more conveniently applied in the preparation of feveral medicines.
10. It is fomewhat volatile in the fire.

III. Volatile mineral alkali.

This perfectly refembles that falt which is extracted from animals and vegetables, under the name of *alkali volatile*, or *fal urinofum*, and is commonly confidered as not belonging to the mineral kingdom; but fince it is difcovered, not only in moft part of the clays, but likewife in the fublimations at Solfatara, near Naples, it cannot poffibly be quite excluded from the mineral king-kingdom (I).

Its principal qualities are,

a. In the fire it rifes in *forma ficca*, and volatilifes in the air in form of corrofive vapours, which are offenfive to the eyes and nofe (K).

b. It precipitates the folution of the mercurial fublimate in a white powder.

c. It alfo precipitates gold out of aqua-regia, and detonates with it; becaufe,

d. It has a re-action in regard to the acids, tho' not fo ftrongly as other alkalies.

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acid; with which laft it retains not only the name but many of the properties of a pure alkali, becaufe this laft acid is eafily expelled.

It is eafily known by its cryftallifation and its folubility in two times and an half of its weight of water, at the temperature of 60 degrees.

One hundred parts of this alkali, when pure and recently cryftallifed, contain 20 of mere alkali, 16 of aerial acid, and 64 of water. (*Macquer.*)

Mineral alkali is found in Hungary, in marfhy grounds, of an argillaceous or marly nature, either mixed with water or cryftallifed and efflorefcing. It is found alfo in Egypt at the bottom of lakes, and dried up by the fummer's heat; and alfo in the province of Suchena, 28 days journey from Tripoli, where it has the name of *Trona;* in Syria, Perfia, as well as in the Eaft-Indies, and China, where it is called *kien.* It fometimes germinates on walls, and is called by many *aphronitron.* In its native ftate, is frequently mixed with magnefian earth, common falt, muriatic magnefia, and marine felenite. (*Kirwan.*)

(G) This mineral alkali likewife differs from the vegetable, 1. By its tafte, which is lefs corrofive and burning. 2. By its not deliquefcing. 3. By the fmall degree of heat it produces if calcined, and afterwards added to water. 4. By its property of cryftallifing, by evaporating the water from its folution, as is practifed with neutral falts; whereas the vegetable alkali does not cryftallife unlefs combined with a large portion of aerial acid.

(H) This alkali being a very ufeful commodity, and effentially neceffary in a number of manufactories, many ingenious proceffes have been contrived and attempted to procure it at a cheap rate, by decompofing the fea-falt; but it is believed, that till lately none of thefe new manufactures have fucceeded, except that of Mr Turner, mentioned by Mr Kirwan in the fecond part of the Philofophical Tranfactions for 1782.—The procefs is faid to confift in mixing a quantity of litharge with half its weight of common falt, which, on being triturated with water till it affumes a white colour, is left to ftand fome hours; after which, a decompofition enfues, the alkali being left alone, whilft the acid unites to the metallic calx; and this laft being urged by a proper degree of fire, produces a fine pigment of a greenifh yellow colour, whofe fale pays for the moft part of the expences.

Mr Kirwan fays, in the place already quoted, that if common falt perfectly dry be projected on lead heated to incandefcence, the common falt will be decompofed, and a horn-lead formed, according to Margraaf. He adds alfo, that according to Scheele, if a folution of common falt be digefted with litharge, the common falt will be decompofed, and a cauftic alkali produced; and, finally, that Mr Scheele decompofed common falt, by letting its folution flowly pafs through a funnel filled with litharge.

(I) It is eafily known by its fmell, though in a mild ftate, by its volatility, and by its action on copper; the folutions of which, in the mineral acids, are turned blue by an addition of this alkali. It is frequently found, though in fmall quantities, in mould, marl, clay, fchiftus, and in fome mineral waters. It probably derives its origin, in the mineral kingdom, from the putrefaction or combuftion of animal or vegetable fubftances. (*Kirwan.*)

The fame is cauftic when uncombined with any acid, not excepting even the aerial acid. It differs from the other two alkalies in many effential particulars. 1. By its aeriform or gafeous nature. For the volatile alkali, in a ftate of purity, is nothing more than an alkaline gas diffufed in water, as Dr Prieftley has demonftrated. 2. By its volatility. 3. By the nature of the falts it forms with acids, which are very different from thofe whofe bafes are formed either of the vegetable or mineral alkali. (*Mongez.*)

(K) Pure volatile alkali, in an aerial form, refembles atmofpheric air, but is more heavy. Its fmell is pene-

e. It tinges the ſolution of copper blue, and diſſolves this metal afreſh if a great quantity is added (L).

f. It deflagrates with nitre, which proves that it contains a phlogiſton.

It is never found pure.

Order III. Neutral Salts.

Acids united to alkalies form neutral ſalts. Theſe diſſolved in water are no ways diſturbed by the addition of an alkali; and generally, by evaporation, concrete into cryſtals. If, by proper teſts, they ſhow neither acid nor alkaline properties, they are ſaid to be *perfect* nautrals; but *imperfect*, when, from defect in quantity or ſtrength of one ingredient, the peculiar properties of the other more or leſs prevail.

I. Vitriolated tartar, vitriolated vegetable alkali, or (as Morveau calls it) the *vitriol of pot-aſh*.

This 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. See Chemistry-*Index*.

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 cryſtalliſation ſucceeds better by evaporation than by cooling, according to Mongez.

The taſte of this ſalt is diſagreeable, though ſomewhat reſembling common ſalt.

II. 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 after-mentioned.—It is perfect neutral ſalt; reſulting from the combination of the nitrous acid with the pure vegetable alkali.

According to Bergman, it is formed upon the ſurface of the earth, where vegetables, eſpecially when mixed with animal-ſubſtances, putrify.—See Chemistry-*Index*, at *Nitre*.

III. Digeſtive ſalt, ſalt of Sylvius, (*Alkali vegetabile ſalitum*).

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 ſuch a property. But M. 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.—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 components parts are abundantly produced by nature. See Chemistry-*Index*, at *Digeſtive*.

IV. Mild vegetable alkali, (*alkali vegetabile aeratum.*)

This ſalt was formerly conſidered as a pure alkali, known by the name of *potaſh* and *ſalt of tartar*: but ſince the diſcovery of the aerial acid, it is very properly claſſed among the neutral ſalts, and ought to be called *aerated potaſſe*.

It reſults from a combination of the vegetable alkali with the aerial acid, and is hardly ever found native, unleſs in the neighbourhood of wood; deſtroyed by fire.

On being expoſed on a piece of charcoal, urged by the blow-pipe, it melts, and is abſorbed by the coal; but,

In the metallic ſpoon, it forms a glaſſy bead, which becomes opaque when cold.

V. Vitriolated acid ſaturated with mineral alkali; Glauber's ſalt. *Alkali minerale vitriolatum.*

This is a neutral ſalt, prepared by nature (as well as by art), containing more or leſs of iron, or of a calcareous earth; from which ariſes alſo ſome difference in its effects when internally uſed. It ſhoots eaſily into priſmatical cryſtals, which become larger in proportion to the quantity of water evaporated before the chryſtalliſation. 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. Some of the lakes in Siberia and Aſtra-

can,

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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.*)

(L) 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.

Neutral Salts.

can, and many ſprings in other places, contain this ſalt, according to Bergman. It is found in the ſea-water; alſo in the earth, at ſeveral parts of Dauphiné in France, and in Lorraine; and ſometimes it germinates on the ſurface of the earth, according to Monet, quoted by Kirwan. It is found, 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 roaſted in the open air. This ſalt is often confounded with the aphronitum or mild mineral alkali.

VI. Cubic or quadrangular nitre. *Alkali minerale nitratum.*

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, from which it only differs on account of its baſe; and takes its denomination from the figure of its cryſtals, which appear cubic.

This ſalt rarely occurs but where marine plants putrify. According to Bowles, quoted by Kirwan, it is found native in Spain. See CHEMISTRY, n° 741, &c.

VII. Common ſalt, or ſea-ſalt; *Alkali minerale ſalitum, ſal commune.*

This ſalt ſhoots into cubical cryſtals during the very evaporation; crackles in the fire, and attracts the humidity of the air. It is a perfectly neutral ſalt, compoſed of marine acid, ſaturated with mineral alkali. It has a ſaline but agreeable flavour. See CHEMISTRY-*Index*, at *Sea-ſalt*.

A. Rock ſalt, foſſile ſalt; *Sal montanum.* Occurs in the form of ſolid ſtrata in the earth.

1. With ſcaly and irregular particles.
   a. Grey, and
   b. White. Theſe are the moſt common, but the following are ſcarcer:
   c. Red;
   d. Blue; and
   e. Yellow, from Cracow in Poland, England, Salzberg, and Tirol.
2. Cryſtalliſed rock ſalt; *ſal gemmæ.*
   a. Tranſparent, from Cracow in Poland, and from Tranſylvania.

B. Sea-ſalt.

This 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. In Siberia and Tartary there are lakes that contain great quantities of it.

C. Spring ſea-ſalt.

This is produced by boiling the water of the fountains near Halle in Germany, and other places.

Near the city of Lidkoping, in the province of Weſtergotland, and in the province of Dal, ſalt-ſprings are found, but they contain very little ſalt: and ſuch weak water is called *ſolen* by the Swedes.

VIII. Borax.

This is a peculiar alkaline ſalt, which is ſuppoſed to belong to the mineral kingdom, and cannot be otherwiſe deſcribed, than that it is . . . . . diſſoluble in water, and vitreſcible; . . . . . that it is fixed in the fire; and melts to a glaſs; which glaſs is afterwards diſſoluble in water. See the detached article BORAX.

IX. Mild mineral alkali; *Alkali minerale æratum.* Natron, the nitre of the ancients.

This neutral ſalt is a combination of the mineral alkali with the aerial acid or fixed air. It is found plentifully in many places, particularly in Africa and Aſia, either concreted into cryſtallifed ſtrata, or fallen to a powder; or effloreſcing on old brick walls; or laſtly, diſſolved in ſprings. It frequently originates from decompoſed common ſalt.

This is an imperfect neutral ſalt, and was formerly conſidered as a pure alkali; but the diſcovery of the aerial acid has ſhown the miſtake.

1. It has nearly all the properties of the *pure* mineral *alkali* N° II. *A*. 1. (p. 90.), but with leſs energy.
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 *aphronitrum* after-mentioned, and calls it *halinitrum*, when it contains ſome phlogiſton. Mr Kulbel, quoted by Wallerius, ſhowed that it exiſts in ſome vegetable earths, and takes it to be the cauſe of their fertility; but this (M. Magellan obſerves) can only 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.

X. Vitriolic ammoniac, (*Alkali volatile vitriolatum.*)

This neutral ſalt was called *ſecret ſalt of Glauber*, and is a combination of the volatile alkali with vitriolic acid. According to Bergman, 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 alkali. Thus at Fahlun the acid vapour from the roaſted minerals produces this ſalt in the neceſſary-houſes. Dr Withering, however, obſerves, that as volatile alkali may be obtained in large quantities from pit-coal, and produced by proceſſes not dependent upon putrefaction, there is reaſon to believe that the vitriolic ammoniac may be formed in ſeveral ways not noticed by the above author.

Neutral Salts.

It is ſaid to have been found in the neighbourhood of volcanoes, 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 (according to M. Magellan) 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 volcanoes. 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 likewiſe that this neutral ſalt is found on the ſurface of the earth in the neighbourhood of Turin.

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 volatile alkali. But
7. Lime, ponderous earth, and pure fixed alkali, ſet the volatile alkali free, and combine with the vitriolic acid.
8. According to Kirwan, 100 parts of this ſalt contain about 42 of real vitriolic acid, 40 of volatile alkali, and 18 of water.

This vitriolic ammoniac is eaſily known; for if quicklime 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.

XI. 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 alkali itſelf poſſeſs a great ſhare of phlogiſton.
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.
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.

XII. Native ſal ammoniac. The muriatic (or marine) acid ſaturated with a volatile alkali.

This is of a yellowiſh colour, and is ſublimed from the flaming crevices, or fire-ſprings, at Solfatara, near Naples.

XIII. Aerated or mild volatile alkali.

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 ſhown it to be a true neutral ſalt, though imperfect; as it retains ſtill all the properties of an alkali, 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 ammonial 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; and in the ſame manner it turns the blue vegetable juices green. But,
2. It effervesces with other acids ſtronger than the aerial one, which the pure or cauſtic volatil alkali 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 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.—Meſſrs. Hierne, Henkel, and Brandt, have found alſo this ſalt in the vegetable earth, in various kinds of argil, 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.

M. Magellan obſerves, that the borax and the three aerated alkalis are called *imperfect* neutrals; 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

Neutral Salts.

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.

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 alkalis, but alſo by their property of cryſtalliſing, and by their effervеſcing with other acids, which expel the aerial one, the weakeſt of all acids we know.

Order IV. Earthy *Neutral Salts.*

The compounds of earths and acids which poſſeſs ſolubility are decompoſed and precipitated by mild, but not by phlogiſticated alkalis.

I. Calcareous earth combined with vitriolic acid.—

Vitriolated calx; Selenite; Gypſum. See p. 72. col. 1. *ſupra.*

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, it generates heat with water, but in a leſs degree than lime does. 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 lie heavy on the ſtomach.

It is unalterable whilſt kept in a dry place; but on being expoſed to a moiſt air, it is much altered, and ſuffers a kind of decompoſition.

When expoſed to fire ſo as to loſe the water off its cryſtalliſation, it aſſumes a dead white colour; and it is then what we call plaſter of Paris; but if the fire is too ſtrong, it melts and vitrifies, after loſing the vitriolic acid with which it is ſaturated. See Gypsum.

The moſt famous quarries of gypſum in Europe, are thoſe of Montmartre, near Paris. See *Journal de Phyſique;* 1780, vol. xvi. p. 289 and 1782, vol. xix. 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 p. 71. col. 1. and from the lac lunæ p. 87. col. 1.; as it is a true gypſeous earth, already deſcribed p. 72. col. 1. which, according to Mongez, is of a white and ſhining colour, though ſometimes it aſſumes a reddiſh or blueiſh colour, on account of ſome martial mixture.

II. Nitre of lime, (*Calx nitrata.*)

This earthy ſalt is ſometimes found in water, but very ſparingly. It is ſaid that the chalk 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. It is a combination of the nitrous acid with calcareous earth. (*Berg. Sciagr.*)

1. It 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 and the priſmatic nitres.
4. But cauſtic volatile alkali cannot decompoſe it.
5. It does not deflagrate in the fire; yet paper moiſtened with a ſaturated ſolution of it crackles in burning.
6. In a ſtrong 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.*)

III. Muriatic chalk, or fixed ſalt ammoniac. *Acidum ſalis communis terra calcarea ſaturatum.*

This ſomewhat deliqueſces, or attracts the humidity of the air. It is found in the ſea water.

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 volatile 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
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.*)

IV. 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 p. 71. col. 2. and is properly referred to the class of earths, p. 71. col. 1.

V. 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 p. 75. col. 1. with the vitriolic acid; and has been already treated of.

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.

VI. 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.

VII. Aerated ponderous earth. *Barytes aerata.*

This earthy neutral salt was found by Dr Withering in a mine at Alstonmore in the county of Cumberland in England. He 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.

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 effervescing 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 salts, as the Glauber's 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. See CHEMISTRY, n° 1049. *et seq.*

VIII. Vitriolated magnesia.

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 coaly 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 crystallisation, and is reduced into a friable mass.
5. This earthy salt is decomposed by fixed and volatile 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 shows 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 blow-pipe, it froths; and may be melted by being repeatedly urged with that instrument.
9. With borax it effervesces, and also when burned with the microcosmic salt.
10. According to Bergman, 100 weight of this salt contains only 19 parts of pure magnesia, 33 of vitriolic acid: and 48 of water. But
11. According to Kirwan, 100 parts of it contain about 24 of real vitriolic acid, 19 of magnesian earth, and 57 of water.

IX. Nitrated magnesia; nitrous Epsom salt.

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.

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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 36 of real nitrous acid, 27 of magneſian earth, and 37 of water.

It exiſts in old mortar, and is found alſo in the mother liquor of nitre. As lime-water decompoſes it, M. de Morveau has indicated the uſe of this proceſs, not only to complete its analyſis; but alſo to ſeparate, in large quantities, and at a very cheap rate, the magneſian from the calcareous earth, as M. Mongez relates upon this ſubject.

X. 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 volatile 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.

XI. Aerated magneſia.

Common magneſia, with an exceſs of aerial acid, is a true neutral ſalt, like the aerated ſelenite of p. 96. col. 1. and becomes ſoluble in cold water. Otherwiſe it is ſcarce ſoluble at all; and is then claſſed among the earths.

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 it muſt be in an impure ſtate to vitrify at all.

The three mineral acids, and the alkalies, diſſolve this ſalt with effervescence, by expelling the aerial acid.

XII. Argillaceous earth combined with vitriolic acid. The *alum* kind. See ALUM, and CHEMISTRY-*Index*.

a. With a ſmall quantity of clay; native or plumoſe alum.

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

b. With a greater quantity of pure clay; white alum ore.

1. Indurated pale-red alum ore, (*ſchiſtus aluminis Romanus.*) It is employed at Lumini, not far from Civita Vecchia in Italy, to make the pale-red alum called *roch alum*. This is, of all alum ores, the moſt free from iron; and the reddiſh earth which can be precipitated from it, does not ſhow the leaſt marks of any metallic ſubſtance.

c. With a very large quantity of martial clay, which likewiſe contains an inflammable ſubſtance: Common alum ore. This is commonly indurated and ſlaty, and is therefore generally called *alum ſlate*.

It is found,

1. With parallel plates, having a dull ſurface; 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. In England, the great alum works at Whitby in Yorkſhire are of this kind.
2. Undulated and wedge-like, with a ſhining ſurface. This at the firſt ſight reſembles pit-coal; it is found in great abundance in the pariſh of Nas in Jemtland.

XIII. Argillaceous earth ſaturated with muriatic acid. *Argilla ſalita.*

Profeſſor Bergman ſays, that the combinations of the argillaceous earth with the nitrous, muriatic, and aerial acids, had not yet been found naturally formed as far as he knew. But Dr Withering affirms, that he found the muriatic argil to exiſt in a conſiderable quantity, in the Nevil Holt water, when he analyſed that mineral water about the year 1777: and he adds, that it is probably contained alſo in the Ballycaſtle water in Ireland.

XIV. Argillaceous earth mixed with volatile alkali.

[Although this mixture is by no means a neutral ſalt, this ſeems to be the place to treat of it according to the order of ſaline ſubſtances adopted in this article.]

The greateſt part of the clays contain a volatile alkali, which diſcovers itſelf in the diſtillation of the ſpirit of ſea-ſalt. &c.

Order V. METALLIC SALTS.

THE native ſalts belonging to this diviſion may be diſtinguiſhed by the phlogiſticated alkali, which precipitates them all. The few which have ſaline properties, according to the definition of ſalts formerly given, ſhall be mentioned here; referring the reſt to the mineraliſed metals; as the *luna cornea*, the ſaline quickſilver or muriatic mercury, &c.

Metallic Neutral Salts.

I. Vitriol of copper; blue vitriol. *Vitriolum veneris, ſeu cyprium.*

This neutral metallic ſalt is a combination of the vitriolic acid with copper, and is found in all *ziment waters*, as they are called. Its colour is a deep blue; and being long expoſed to the air, it degenerates into a ruſty yellow blue. 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 ſhining globule of copper, leaving an irregularly figured ſcoria. But with borax the ſcoria is diſſolved, and forms a green glaſs.

This ſalt rarely occurs cryſtalliſed: 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. See CHEMISTRY-*Index*, at *Vitriol*.

II. Muriatic copper, or marine ſalt of copper. *Cuprum ſalitum.*

This ſalt has been found in Saxony, in the mine of Johngeorgenſtadt. 1. It is of a greeniſh colour, and foliated texture. 2. It is moderately hard. 3. Sometimes it is tranſparent and cryſtalliſed.

It has been taken for a kind of mica: but Profeſſor Bergman found it to conſiſt of copper and marine acid, with a little argillaceous earth.

Another ſpecimen of a purer ſort was depoſited in the muſeum of Upſal. This is of a bluiſh green colour, and friable. It effervеſced with nitrous acid, to which it gave a green colour: and by adding a proper ſolution of ſilver, a *luna cornea* was formed, by which the preſence of the muriatic acid was aſcertained. (*Kirwan* and *Bergman*)

III. Martial vitriol; vitriol of iron. Common green vitriol or copperas.

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

This metallic neutral ſalt reſults from the combination of the vitriolic acid with iron.

1. It is of a greeniſh colour when perfectly and recently cryſtalliſed; but,
2. Efflоreſces by being expoſed to the air, becomes yellowiſh, and is covered with a kind of ruſt. Sometimes it becomes white by long ſtanding.
3. It requires ſix times its weight of water, in the temperature of 60 degrees, to be diſſolved.
4. It has an aſtringent, harſh, and acidulous taſte.
5. Expoſed to a moderate heat, even to that of the ſunſhine, it falls into a 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 enamelling, &c.

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8. Pure fixed alkali precipitates the iron from its ſolution in deep green flakes; the mild alkali, in a greeniſh white colour; pure volatile alkali, in ſo deep a green, that it appears black; but the mild volatile alkali precipitates it in a greyiſh-green colour.
9. All vegetable aſtringents, as the tincture of tea, quinquina, gales, &c. precipitate the iron in a black colour: hence 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.
10. One hundred parts of this ſalt, recently cryſtalliſed, contain 20 of real vitriolic acid, 25 of iron, and 55 of water.
11. Its acid is known by this, 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.
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 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 ſchiſtus or ſlaty pyritaceous ſtones. But the greateſt part of that in uſe is prepared by art, from the martial pyrites or mundic. See CHEMISTRY, n° 619.

IV. Aerated iron. *Ferrum aeratum.*

This metallic ſalt is a combination of the aerial acid with iron; and is found in the light chalybeate waters, where it is diſſolved by an exceſs of this acid.

Mr Lane was the firſt who diſcovered in England the action of the acrial acid on iron, when the water is impregnated with that menſtruum. The late M. Rouelle demonſtrated the ſame phenomenon in France upon this and other metals. But Profeſſor Bergman ſeems to have preceded them both nearly about the ſame time, though neither had any knowledge of each other's diſcoveries.

The great volatility of this acid is the cauſe why this neutral ſalt is not often found. For the mere evaporation of the ferruginous mineral waters, in order to analyſe 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 $\frac{1}{10500}$ of the weight of the water; and when

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when freſh retains ſo much phlogiſton as to obey the magnet, as Bergman ſays.

V. Vitriol of cobalt, or vitriolated cobalt.

This metallic ſalt reſults from the combination of the vitriolic acid with cobalt.

1. When found native, it is always in an efflorescent ſtate; whence it ariſes that, in this caſe,
2. Its colour is greeniſh, mixed with a grey tint: but,
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 *Lilias colour*, as the French call it.
6. It is difficultly ſoluble in water; and,
7. Its ſolution is of a red colour.
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 efflorescence in cobalt mines. (*Kirwan* and *Mongez*.)

VI. Vitriol of zinc, vitriolated zinc, or white vitriol.

This neutral metallic ſalt reſults from the combination of vitriolic acid with zinc.

1. Its colour is white. It,
2. Requires little more than twice its weight of water to diſſolve it in the temperature of 60 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 zinc, precipitate it: by which circumſtance its baſis is ſufficiently indicated.
9. If it contains any other metallic principle, this may be precipitated by adding more zinc 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 22 of vitriolic acid, 20 of zinc, and 58 of water.
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, or as an efflorescence 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, it is ſometimes produced by the decompoſition of pſeudogalæna, or black-jack; but this rarely happens, becauſe this ſubſtance does not readily decompoſe ſpontaneouſly.

But that in common uſe is moſtly prepared at Goſlaar, from an ore which contains zinc, copper, and lead, mineraliſed 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. (*Kirwan*, *Mongez*.)

Triple Neutral SALTS.

VII. Vitriolated nickel, or vitriol of nickel

This neutral metallic ſalt 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, effloreſcing 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 ſulphureous ore of Kupfer-nickel, mentioned by Wallerius. 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 (*Mongez*, *Kirwan*).

VIII. Muriatic manganeſe. *Manganeſium ſalitum.*

M. 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 cryſtalliſe 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. (*Kirwan*.)

Order VI. TRIPLE SALTS.

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. Bergman generally diſtinguiſhes compound ſalts according to

Triple Neutral Salts.

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. The moſt remarkable examples of triple and quadruple native ſalts which have yet occurred are,

I. Mineral alkali, with a ſmall quantity of calcareous earth. *Alkali ſalis communis.* Aphronitrum.

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.

Hence it would appear, that this is not only a *triple*, but a *multiple* ſalt; as theſe pieces of old mortar covered with this white froſt, on ancient 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. M. 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 chemiſts of Dijon add the *digeſtive ſalt of Sylvius*, and in ſome caſes various *vitriols* with *alkaline* or *earthy baſes*.

When it contains any conſiderable quantity of the calcareous earth, its cryſtals become rhomboidal, a figure which the calcareous earth often aſſumes in ſhooting into cryſtals: but when it is purer, the cryſtals ſhoot into a priſmatic figure.

This is a circumſtance which neceſſarily muſt confuſe thoſe who know the ſalts only by their figure; and ſhows, 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*.

II. Common ſalt with magneſia; or muriatic mineral alkali contaminated by muriatic magneſia.

This is a compound of the common ſalt with muriatic magneſia: and by the expreſſion *contaminated (inquinatum)* of profeſſor Bergman, we may ſuppoſe that the magneſian ſalt is not intimately united to the alkaline baſe.

This triple ſalt is very deliqueſcent; a quality it owes to its integrant part the muriatic magneſia, (p. 97. col. 1.) For the pure muriatic alkali does not deliqueſce: but this degree of purity is ſeldom found, even in the native foſſil or *ſal gem*, (p. 93. col. 2.) In general all the earthy marine ſalts are very deliqueſcent, as the muriatic chalk, the muriatic barytes, and the muriatic magneſia. *Bergman*, *Macquer*, and *Mongez*.

III. Mineral alkali with ſuccinous acid and phlogiſton.

This ſubſtance will be afterwards mentioned among the *inflammables*.

IV. Vitriolated magneſia with vitriol of iron. Epſom ſalt contaminated with copperas.

Found in ſome mineral waters, according to Mr Monet, *(Treatiſe on Mineral Waters)*.

Triple Neutral Salts.

V. Native-alum contaminated by copperas. Vitriolated argil with vitriol of iron.

Found in the aluminous ſchiſtus. It ſometimes effloreſces in a feathery form. Perhaps this is the *plumoſe alum* of the ancients.

VI. Native alum, contaminated by ſulphur.

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.

A ſimilar compound ſubſtance ſublimes at the Solfaterra near Naples.

VII. Native alum contaminated by vitriolated cobalt.

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 addition of terra poderoſa ſalita (muriatic acid ſaturated with heavy earth).
2. By the addition of phlogiſticated alkali, a precipitate of cobalt is thrown down, which makes blue glaſs with borax or microcoſmic ſalt. *(Berg. Sciag.)*

VIII. Vitriol of copper with iron.

This ſalt is of a bluiſh green colour. It 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.)*

IX. Vitriol of copper, iron, and zinc.

This 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; which ſhows that the vitriolic acid is perfectly ſaturated in this ſalt by the three metallic baſes.

X. Vitriol of copper and zinc.

This is the blue vitriol from Goſlar. According to Mongez it is the *vitriolum zinceo-cupreum cæruleum* of Linnæus.

XI. Vitriol of iron and zinc.

This is the green vitriol from Goſlar in the Hartz. According to Mongez, this is the *vitriolum zinceo-ferreum viride* of Linnæus, 105. 6. Its colour is a pale-green caſt.

XII. Vitriol of iron and nickel.

This ſalt is of a deep-green colour, and is contained in the ochre, or decayed parts, of the nickel, at the cobalt-mines of Los, in the province of Helſingland.

Class III. Mineral INFLAMMABLE Substances.

To this claſs belong all thoſe ſubterraneous bodies that are diſſoluble in oils, but not in water, which they repel;

Inflammables.

repel; that catch flame in the fire; and that are electrical.

It is difficult to determine what conſtitutes the difference between the purer ſorts of this claſs, ſince they all muſt be tried by fire, in which they all yield the ſame product; but thoſe which in the fire ſhow their differences by containing different ſubſtances, are here conſidered as being mixed with heterogeneous bodies: that ſmall quantity of earthy ſubſtance, which all phlogiſta leave behind in the fire, is, however, not attended to.

I. Inflammable air; fire damp.

This aeriform ſubſtance is eaſily known by its property of inflaming when mixed with twice or thrice its bulk of common atmoſpheric air; and it is aſſerted to be the real phlogiſton almoſt pure. See AEROLOGY-*Index*, and *INFLAMMABLE Air*.

It admits conſiderable varieties, acording to the nature of the ſubſtances from which it is produced, and often gives different reſiduums upon combuſtion, ſome of which are of the acid kind. If it is produced from charcoal, it yields aerial acid or fixed air: from ſolutions of metallic ſubſtances in the vitriolic, nitrous, or marine acids, it yields theſe reſpective acids, as M. Lavoiſier aſſerts.

Æther, converted into vapour in a vacuum, gives a permanent elaſtic vapour, which is inflammable. The atmoſphere, which floats round the fraxinella, is inflammable from the admixture of its vapours, which ſeem to be of the nature of an eſſential oil: ſo that on approaching the flame of a candle under this plant, in hot weather, it takes fire in an inſtant; although the eſſential oil, extracted from this plant by diſtillation, is not inflammable on account of the watery particles mixed with it, as M. Bomare aſſerts.

Mr Scheele is of opinion, that every inflammable air is compoſed of a very ſubtile oil. This coincides with the idea entertained by chemiſts of their phlogiſton; and is confirmed by the fact, of its being naturally found in thoſe ſprings from whence iſſues petrol, whoſe exhalations are very inflammable.

The reſiduum, which remains in the atmoſphere after the combuſtion of inflammable air, is extremely noxious to animals. Doctor Prieſtley takes it to be a combination of phlogiſton with pure air, and on this account calls it *phlogiſticated air*. But M. Lavoiſier, on the contrary, conſiders it to be a primitive ſubſtance of an unchangeable nature, and gives it the ſingular name of *atmoſpheric mephitis*.

II. Hepatic air.

This air ſeems to conſiſt of ſulphur, held in ſolution in vitriolic or marine air. It is inflammable when mixed with three quarters of its bulk of common air. Nitre will take up about half the bulk of this air; and when ſaturated with it, will turn ſilver black: but if ſtrong dephlogiſticated nitrous acid be dropped into this water, the ſulphur will be precipitated.

Inflammables.

One hundred cubic inches of this air may hold eight grains of ſulphur in ſolution in the temperature of 60°; and more, if hotter.

Atmoſpheric air alſo decompoſes hepatic air.

It is found in many mineral waters, and particularly in the hot baths of Aix-la-Chapelle. The cauſe and manner of their containing ſulphur, which was long a problem, has at laſt been happily explained by Mr Bergman.

It plentifully occurs in the neighbourhood of volcanoes and in ſeveral mines.

Hepatic air is eaſily obtained by art, from all ſorts of liver of ſulphur, whether the baſe be an alkali, an earth, or a metal, if any acid is poured upon it; and the better, if uſe be made of the marine acid, becauſe it contains phlogiſton enough, and does not ſo ſtrongly attract that of the *hepar ſulphuris*. For this reaſon the nitrous acid is not fit for this proceſs, as it combines itſelf with the phlogiſton, and produces nitrous air. It may alſo be produced, by diſtilling a mixture of ſulphur and powdered charcoal, or of ſulphur and oil, &c. See the detatched article *HEPATIC Air*, and AEROLOGY-*Index*.

III. Phlogiſton combined with aerial acid; black lead, or wadd. *Plumbago*. See the detached article *Black-LEAD*.

It is found,

a. Of a ſteel-grained and dull texture. It is naturally black, but when rubbed it gives a dark lead colour.

b. Of a fine ſcaly and coarſe-grained texture; coarſe black-lead.

IV. Mineral tallow. *Serum minerale*.

This was found in the ſea on the coaſts of Finland in the year 1736. Its ſpecific gravity is 0.770; whereas that of tallow is 0.969. It burns with a blue flame, and a ſmell of greaſe, leaving a black viſcid matter, which is with more difficulty conſumed.

It is ſoluble in ſpirit of wine only when tartariſed: and even then leaves an inſoluble reſiduum; but expreſſed oils diſſolve it when boiling.

It is alſo found in ſome rocky parts of Perſia, but ſeems mixed with petrol, and is there called *ſchebennaad, tſienpen, kodreti*.

Dr Herman of Straſburg mentions a ſpring in the neighbourhood of that city, which contains a ſubſtance of this ſort diffuſed through it, which ſeparates on ebullition, and may then be collected. *(Kirwan)*.

V. Ambergris. *Ambra griſea*.

It is commonly ſuppoſed to belong to the mineral kingdom, although it is ſaid to have doubtful marks of its origin (A).

a. It

(A) Ambergris, according to the aſſertion of M. Aublet (in his *Hiſtoire de la Guiane*), is nothing more than the juice of a tree inſpiſſated by evaporation into a concrete form. This tree grows in Guyana, and is called

Inflammables.

a. It has an agreeable ſmell, chiefly when burnt:
b. Is conſumed in an open fire:
c. Softens in a ſlight degree of warmth, ſo as to ſtick to the teeth like pitch.
d. It is of a black or grey colour; and of a dull or fine grained texture (B).

The grey is reckoned the beſt, and is ſold very dear. This drug is brought to Europe from the Indies. It is employed in medicine; and alſo as a perfume (C).

VI. Amber. *Ambra flava*, *ſuccinum*, *electrum*, Lat. *Carabé*, French. *Agtſtein*, *Bernſtein*, Germ.

This ſubſtance is dug out of the earth, and found on the ſea-coaſts. According to the experiments of M. Bourdelin, it conſiſts of an inflammable ſubſtance, united with the acid of common ſalt, which ſeems to have given it its hardneſs. It is ſuppoſed to be of vegetable origin, ſince it is ſaid to be found together with wood in the earth.

Inflammables.

By diſtillation it yields water, oil, and a volatile acid ſalt, which the above mentioned author has thought to be the acid of common ſalt united with a ſmall portion of phlogiſton.

Inſects, fiſh, and vegetables, are often found included in it, which teſtify its having once been liquid.

It is more tranſparent than moſt of the other bitumens; and is doubtleſs the ſubſtance which firſt gave riſe to *electrical experiments* (on account of the power it poſſeſſes of attracting little bits of ſtraw, or of other light ſubſtances, when rubbed).

Its varieties are reckoned from its colour and tranſparency. It is found,

A.

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called *cuma*, but has not been inveſtigated by other botaniſts. When ſome branches are broken by high winds, a large quantity of the juice comes out; and if it chances to have time to dry, various maſſes (ſome of which had been ſo large as to weigh 1200 pounds and more) are carried into the rivers by heavy rains, and through them into the ſea: afterwards they are either thrown into the ſhore or eaten by ſome fiſh, chiefly the ſpermaceti whale, known by the name of *Phyſeter-macrocephalus* among ichthyologiſts. This kind of whale is very greedy of this gum-reſin, and ſwallows ſuch large quantities when they meet with it, that they generally become ſick; ſo that thoſe employed in the fiſhery of theſe whales, always expect to find ſome amber mixed with the excrements and remains of other food in the bowels of thoſe whales who are lean. Various authors, among whom is Father Santos in his *Ethiopia Orientalis*, who travelled to various places of the African coaſt, and Bomare, ſay, that ſome ſpecies of birds are fond of eating this ſubſtance as well as the whales and other fiſhes. This accounts very well for the claws, beaks, bones, and feathers of birds, parts of vegetables, ſhells, and bones of fiſh, and particularly for the beaks of the cuttle fiſh or *ſepia octopedia*, that are ſometimes found in the maſs of this ſubſtance. Dr Swediar, however, attended only to theſe laſt, though he had mentioned alſo the other ſubſtances in his paper inſerted in the Philoſophical Tranſactions for 1783; wherein he attempts to eſtabliſh an opinion, that the amber is nothing elſe but a preternaturally hardened dung, or feces, of the phyſeter whale. Dr Withering and Mr Kirwan have embraced this notion; as did alſo, inadvertently, the editors of this Work. See AMBERGRIS.

(B) Mr Aublet brought ſpecimens of this gum-reſin, which he collected on the ſpot, from the cuma tree at Guiane. It is of a whitiſh-brown colour with a yellowiſh ſhade, and melts and burns like wax on the fire. The ſingularity of this gum-reſin is, that it imbibes very ſtrongly the ſmell of the aromatic ſubſtances which ſurround it; and it is well known that perfumers avail themſelves very conſiderably of this advantage. M. Rouelle examined very carefully this ſubſtance brought over by Mr Aublet, and found that it produced the very ſame reſults as in other good kind of amber. Beſides Mr Aublet's authority, which is deciſive, as being grounded upon direct proofs of fact, Rumphius, quoted by Bergman, long ſince mentioned a tree called *Nanarium*, whoſe inſpiſſated juice reſembles amber. It cannot therefore at preſent be doubted that the origin of this phlogiſtic ſubſtance is the vegetable kingdom, although it may be often found and reputed as a product of the foſſile kind.

This ſuſtance being analyſed by Meſſrs Geoffroy and Newman, quoted by M. Fourcroy, yielded them the ſame principles as the bitumens; viz. an acid ſpirit, a concrete acid ſalt, ſome oil, and a charry reſiduum; which evidently evinces, that all theſe fat and oily foſſile ſubſtances have their origin from the other two kingdoms of nature.

(C) Ambergris is not only brought from the Eaſt Indies, but from the coaſts of the Bahama Iſlands, Braſil, Madagaſcar, Africa, China, Japan, the Molucca iſlands, the coaſts of Coromandel, Sumatra, &c. Dr Lippert, in a treatiſe he publiſhed at Vienna in 1782, entitled *Phlogiſtologia Mineralis*, has copied chiefly from Wallerius what he aſſerts of this ſubſtance. He affirms that there are eight known ſpecies of amber; five of a ſingle colour, viz. the white and the black from the iſland of Nicobar, in the gulph of Bengal, the aſh-coloured, the yellow, and the blackiſh; and two variegated, viz. the grey coloured with black ſpecks, and the grey with yellow ſpecks. This laſt he aſſerts to be the moſt eſteemed on account of its very fragrant ſmell, and to come from the South coaſt of Africa and Madagaſcar, as well as from Sumatra; and that the black dark coloured amber is often found in the bowels of the cetaceous fiſhes. The ſame author adds alſo from Wallerius, that by diſtilling the oil of yellow amber (*ſuccinum*) with three parts and a half of fuming nitrous acid, a reſiduum remains like roſin, which emits a perfect ſmell of muſk; whence ſome conclude, that the ambergris belongs to the foſſile kind: the contrary, however, is evinced in the preceding note.

Inflammables.

A. Opaque.
a. Brown.
b. White.
c. Blackiſh.
B. Tranſparent.
a. Colourleſs.
b. Yellow.

The greateſt quantity of European amber is found in Pruſſia; but it is, beſides, collected on the ſea-coaſt of the province of Skone, and at Biorko; in the lake Malaren in the province of Upland; as alſo in France and in Siberia. It is chiefly employed in medicine and for making varniſhes (D).

VII. Rock-oil.

This is an inflammable mineral ſubſtance, or a thin bitumen, of a light brown colour, which cannot be decompoſed; but is often rendered impure by heterogeneous admixtures. By length of time it hardens in the open air, and then reſembles a vegetable reſin; in this ſtate it is of a black colour, whether pure or mixed with other bodies. It is found,

A. Liquid.

1. Naphtha.

This is of a very fragrant ſmell, tranſparent, extremely inflammable, and attracts gold. It is collected on the ſurface of the water in ſome wells in Perſia. See NAPHTHA.

2. Petrol.

This ſmells like the oil of amber, though more agreeable; and likewiſe very readily takes fire. It is collected in the ſame manner as the Naphtha from ſome wells in Italy. See PETROLEUM.

Inflammables.

B. Thick and pitchy; *Petroleum tenax.* Barbadoes-tar.

This reſembles ſoft pitch.

It is found at the Dead Sea in the Holy Land; in Perſia, in the chinks of rocks, and in ſtrata of gypſum and limeſtone, or floating on water; alſo in Siberia, Germany, and Switzerland, in coal-pits; and in America: likewiſe in Colebrookdale in England.

C. Elaſtic petrol.

This is a very ſingular foſſil, found of late in England.

By its colour and conſiſtency, it exactly reſembles the Indian-rubber, or the gum-reſin, from the north part of Braſil, called *caoutchouc.* It is of a dark brown colour, almoſt black; and ſome is found of a yellowiſh brown caſt, like the ſame gum-reſin.

With reſpect to its elaſtic conſiſtence, it hardly can be diſtinguiſhed from it, except in the coheſion of its particles, which is weaker.

It has the ſame property of rubbing off from paper the traces of black-lead pencils.

It burns likewiſe with a ſmoky flame; and alſo melts into a thick oily fluid; but emits a diſagreeable ſmell, like the foſſile pitch, or Barbadoes tar.

It

(D) Amber, ſays M. Fourcroy, is found in ſmall detached pieces, for the moſt part under coloured ſands, diſperſed in beds of pyritaceous earth; and above it is found wood, charged with a blackiſh bituminous matter. Hence it is ſtrongly ſuppoſed that it is a reſinous ſubſtance, which has been altered by the vitriolic acid of the pyrites, notwithſtanding that we know that acids, when concentrated, always blacken and charry reſinous ſubſtances. In fact, the chemical analyſis of this ſubſtance rather confirms that ſuppoſition.

The ſingular opinion of Dr Girtanner, about the yellow amber being produced by a kind of ants, may be ſeen in *Journal de Phyſique* for March 1786, page 227. Or ſee the article AMBER in this Dictionary.

The colour, texture, tranſparency, and opacity of this ſubſtance, have ſhown ſome other varieties beſides theſe mentioned in the text. The principal ones are the following:

6. The yellow ſuccinum,	opaque.	9. The white,	tranſparent.
7. The coloured green or blue by foreign matter,		10. The pale-yellow,	
8. The veined ſuccinum,		11. The citron-yellow,	
		12. The deep-red,	

The golden yellow tranſparent amber, mentioned in the text, is what the ancients called *chryſolectrum*, and the white opaque was called *leucolectrum*.

But we muſt be cautious about the value of the ſpecimens remarkable for their colour, ſize, tranſparency, and the well-preſerved inſects they contain internally; ſince there is a probability of deception, ſeveral perſons poſſeſſing the art of rendering it tranſparent and coloured, and of ſoftening it, ſo as to introduce foreign ſubſtances, &c. into it at pleaſure.

M. Fourcroy ſays, that two pieces of this ſubſtance may be united, by applying them to one another, after being wet with oil of tartar and heated. And Wallerius mentions, that pieces of yellow amber may be ſoftened, formed into one, and even diſſolved by means of oil of turnip-ſeed, in a gentle heat; and that according to ſome authors, it may be rendered pure and tranſparent, by boiling it in rape-ſeed oil, linſeed oil, ſalt-water, &c.

Mr Macquer ſays, that for the purpoſe of making varniſh, this ſubſtance muſt undergo beforehand a previous decompoſition by torrefaction, in order to be diſſolved by linſeed-oil or eſſential oils. See VARNISH.

Beſides the making of varniſhes, this ſubſtance was much employed formerly in making various pieces of ornament and jewellery. The beſt pieces were cut, turned, carved, or plained, to make vaſes, heads of canes, collars, bracelets, ſnuff-boxes, beads, and other toys, ſmall fine cheſts, &c. But after diamonds and beautiful hard ſtones were brought into uſe, theſe trinkets are little conſidered in Europe: nevertheleſs, they are ſtill ſent to Perſia, China, and to various other eaſtern nations, who eſteem them ſtill as great curioſities.

Inflammables.

It is found in the ſame earthy and ſtony beds as petrol. Some ſpecimens are of a cylindrical form, like bits of thin branches or ſtalks of vegetables, though much more flexible, being perfectly elaſtic.

M. Magellan obſerves, that this foſſil ſeems to favour the opinion of thoſe mineralogiſts, "who believe that theſe oily combuſtibles derive their origin from the vegetable kingdom. It ſeems worth trying, whether pieces of aſphaltum, buried in damp beds of ſparry rubbiſh, or other kind of earths, would take the ſame elaſtic conſiſtence. But ſince many beds of ſhells and other foſſile ſubſtances, both of the vegetable and animal kind, as impreſſions of various plants, and the remains of various quadrupeds, &c. have been found in different parts of the globe, whoſe individual ſpecies undoubtedly exiſt no longer alive unleſs in far diſtant climates, and in the moſt remote countries from the ſpot where their exuvia are dug out; why ſhould we not allow that this new foſſil may be the ſame original elaſtic gum, now growing naturally in Braſil, China, and other hot climates, only altered in its ſmell, and in the tenacity of its particles, by its long depoſition during centuries in the bowels of the earth?"

This elaſtic petrol was found in 1785, near Caſſeltown, in the county of Derbyſhire in England, but in very inconſiderable quantities.

D. Hardened rock-oil; foſſile pitch. *Petroleum induratum, Pix montana.*

1. Pure aſphaltum.

This leaves no aſhes or earthy ſubſtance when it is burnt.

It is a ſmooth, hard, brittle, inodorous, black or brown ſubſtance. When looked through in ſmall pieces, appears of a deep red colour. It ſwims in water.

It breaks with a ſmooth ſhining ſurface.—Melts eaſily; and, when pure, burns without leaving any aſhes; but if impure, leaves aſhes or a ſlag.

According to M. Monet, it contains ſulphur, or at leaſt the vitriolic acid.

It is ſlightly and partially acted on by alcohol and æther.

From this, or the preceding ſubſtance, it is probable the aſphaltum was prepared that the Egyptians uſed in embalming their dead bodies, and which is now called *mummia*.

It is found alſo on the ſhores of the Red Sea, in the Dead Sea, in Germany, and France.—(*Kirwan.*)

And it comes likewiſe from Porto Principe, in the iſland of Cuba. (*Brun.*)

It is found alſo in many parts of China: and is employed as a covering to ſhips by the Arabs and Indians. (*Fourcroy.*)

2. Impure; *Pix montana impura.* Piſſaphaltum.

This contains a great quantity of earthy matter, which is left in the retort after diſtillation, or upon the piece of charcoal, if burnt in an open fire; it coheres like a ſlag, and is of the colour of black-lead: but in a calcining heat, this earth quickly volatiliſes, ſo that the nature of it is not yet known.

It is found in Moſſgrufvan in Norberg, and in Grengierberget, both in the province of Weſtmanland; and alſo in other places.

The piſſaphaltum is of a mean conſiſtence between the aſphaltum and the common petroleum. It is the very bitumen which is collected in Auvergne in France in the well called *de la Pege*, near Clermont Ferrand.

VIII. Jet. *Gagas, Succinum nigrum.*

This is a very compact bitumen, harder than aſphaltum, always black, and ſuſceptible of a good poliſh. It becomes electrical when rubbed; attracts light bodies like the yellow amber; and it ſwims on water.

It ſeems to be nothing elſe than a black amber, or ſuccinum; but ſpecifically lighter, on account of the greater portion of bitumen that enters into its compoſition. When burned, it emits a bituminous ſmell. See the article JET.

IX. Mineral phlogiſton united with earths.

A. With calcareous earth.

1. With pure calcareous earth. This is the fetid or ſwine ſpar formerly deſcribed.

B. United with calcareous, argillaceous, ponderous, and ſiliceous earth and vitriolic acid. Liverſtone: *Lapis hepaticus.*

C. With an argillaceous earth; Pit or Stone Coal.

1. With a ſmall quantity of argillaceous earth and vitriolic acid. *Lithanthrax.* See the articles COAL and PIT-COAL.

This is of a black colour, and of a ſhining texture: it burns with a flame, and is moſtly conſumed in the fire; but leaves, however, a ſmall quantity of aſhes.

a. Solid coal. *b*. Slaty coal.

2. Culm-coal, called *kolm* by the Swedes.

This has a greater quantity of argillaceous earth and vitriolic acid, and a moderate proportion of petrol.

It has the ſame appearance with the preceding one, though of a more dull texture: it burns with a flame; and yet is not conſumed, but leaves behind a ſlag of the ſame bulk or volume as the coal was.

From England, and among the alum rock at Moltorp and Billingen in the province of Weſtergottland.

3. Slate-coal.

This coal contains abundance of argillaceous earth. It burns with a flame by itſelf, otherwiſe it looks like other ſlates.

It is found at Gullerafen in the pariſh of Rettwik, in the province of Dalarne, and alſo with the coals at Boſerup in Skone.

This ſeems to be the ſame with the bituminous ſchiſtus, already deſcribed among the argillaceous earths.

4. Cannel-coal.

Mr Kirwan has put together this variety of coal with that other called *Killkenny-coal*, tho' they have ſome different properties.

The cannel-coal is of a dull black colour; breaks eaſily in any direction; and, in its fracture, preſents a ſmooth conchoidal ſurface, if broken tranſverſely.

It contains a conſiderable quantity of petrol,

in

Inflammables.

in a leſs denſer ſtate than other coals; and burns with a bright lively flame, but is very apt to fly in pieces in the fire. It is ſaid, however, to be entirely deprived of this property, by being previouſly immerſed in water for ſome hours.

Its ſpecific gravity is about 1270; and being of an uniform hard texture may be eaſily turned in the lathe, and receive a good poliſh.

It is from this kind of coal that ſmall vaſes, as ink-ſtands, various trinkets, and other curioſities, are made in England, which appear as if made of the fineſt jet.

5. Kilkenny-coal.

This contains the largeſt proportion of petrol or aſphaltum; burns with leſs flame and ſmoke, and more ſlowly, though intenſely, than the cannel-coal.

The quantity of earth in this coal does not exceed one twentieth of its weight. Its ſpecific gravity is about 1400. It is frequently mixed with pyrites.

It is found in the county of Kilkenny, belonging to the province of Leinſter in Ireland. The quality of this coal burning almoſt without ſmoke, is mentioned in a proverb by which the good qualities of this county are expreſſed.

6. Sulphureous coal.

This conſiſts of the former kinds of coal, mixed with a notable proportion of pyrites: hence it is apt to moulder and break when expoſed to the air. It contains yellow ſpots that look like metal; and burns with a ſulphureous ſmell, leaving either red aſhes, or a ſlag, or both. Water acts upon it, after it has mouldered. Its ſpecific gravity is = 1500, or more.

Beſides the above varieties, ſchiſtus, micaceous ſchiſtus, and gneiſs, are frequently found in the neighbourhood of coal-mines, ſo penetrated with petrol bitumen as to conſtitute an inferior ſpecies of coal; but the bitumen being burnt, they preſerve their form, and in ſome meaſure their hardneſs. Alſo ſome grey ſlates, that are ſo ſoft as to be ſcraped with the nail, and are greaſy to the touch, burn like coal.

All the differences of coal ariſe from a mixture of the varieties already mentioned; and it is obſervable, that wherever coals exiſt, ſlates are generally found near them. Salt or mineral ſprings are alſo often found in their neighbourhood. (*Kirwan.*)

7. Bovey coal. *Xylanthrax.*

This is of a brown, or browniſh black colour, and of a yellow laminar texture.

The laminæ are frequently flexible when firſt dug, though generally they harden when expoſed to the air.

It conſiſts of wood penetrated with petrol or bitumen; and frequently contains pyrites, alum, and vitriol.

Its aſhes afford a ſmall quantity of fixed alkali, according to the German chemiſts; but according to Mr Mills they contain none.

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By diſtillation it yields an ill ſmelling liquor, mixed with a volatile alkali and oil, part of which is ſoluble in ſpirit of wine, and part inſuſible, being of a mineral nature.

It is found in England, France, Italy, Switzerland, Germany, Ireland, &c. (*Kirwan.*)

8. Peat. *Geanthrax.*

There are two ſorts of inflammable ſubſtances known by this name, viz.

The firſt of a brown, yellowiſh brown, or black colour, found in mooriſh grounds; in Scotland, Holland, and Germany. When freſh, it is of a viſcid conſiſtence, but hardens by expoſure to the air. It conſiſts of clay mixed with calcareous earth and pyrites; and ſometimes contains common ſalt. While ſoft, it is formed into oblong pieces for fuel, after the pyritaceous and ſtony matters are ſeparated. When diſtilled, it affords water, acid, oil, and volatile alkali. Its aſhes contain a ſmall proportion of fixed alkali. They are either white or red, according as it contains more or leſs ochre or pyrites.

The ſecond is found near Newbury in Berkſhire. It contains but little earth; but conſiſts chiefly of wood, branches, twigs, roots of trees, with leaves, graſs, ſtraw, and weeds. (*Kirwan.*)

9. Stone-turf.

Cronſtedt has ranged the turf among the foſſils of his Appendix; but as that called in England by the name of *ſtone-turf* contains a conſiderable proportion of peat, it may be mentioned with propriety in this claſs.

Soon after it is dug out from the ground, where it keeps a ſoft conſiſtence, it at firſt hardens; but afterwards it crumbles by long expoſure to the air.

As to the other common turf, it only conſiſts of mould interwoven with the roots of vegetables; but when theſe roots are of the bulbous kind, or in a large proportion, they form the worſt kind of turf.

Although it may appear incredible, it is nevertheleſs a real fact, that in England pit-turf is advantageouſly employed in Lancaſhire to ſmelt the iron-ore of that county. Mr Wilkinſon, brother-in-law to Dr Prieſtley, and famous for his undertakings in the extenſive iron-works, perhaps the greateſt in Europe, makes uſe of pit-turf in his large ſmelting furnaces of that province.

Those foſſil ſubſtances, which furniſh fuel for the various purpoſes of human life, are diſtinguiſhed by the name of *coals*, on account of their being a ſucedaneum for wood and other vegetable productions, which when dry or of an oleaginous kind ſerve for the ſame uſes. If theſe vegetable ſubſtances are deprived of the acceſs of air, by covering them after ignition, the half-conſumed remainder, which is of a black colour, is called by the name of *coal* or *charcoal*; and from hence the foſſil which affords fuel has

Inflammables.

also been called by the same name, though of a very different nature.

Pit-coal and earth-coal are synonymous, and mean coals dug out of a pit or from the earth. But the lithanthrax denotes stone-coal, and more properly indicates the cannel-coal, which has the greatest similarity to a stony substance, by the dull appearance of its fracture and by the uniform texture of its parts.

All these coals are in general a bituminous black or brown and dark substance: for the most part they have a lamellated texture, which breaks easily, and always with a shining surface.

The varieties of pit-coals above-mentioned are the most remarkable, by which they may be distinguished from one another. But they are far from being homogeneous in each kind; as the accidental qualities, and the various proportions of their component parts, produce a far greater number of properties, which renders them more or less fit for different purposes; though these are generally overlooked, and confounded with the common one of affording fuel for making fire to warm our rooms, or for culinary operations.

This fossile bitumen, as Fourcroy remarks, being heated in contact with a body in combustion, and a free access of air, kindles the more slowly, and with more difficulty, as it is more weighty and compact. When once kindled, it emits a brisk and very durable heat, and burns for a long time before it is consumed. If extinguished at a proper time, the remaining cinders may serve several times for a new firing with a small addition of fresh coals. The matter that is burned, and produces the flame, appears very dense, as if united to another substance which retards its destruction. Upon burning, it emits a particular strong smell, which is not at all sulphureous when the earth-coal is pure, and contains no pyrites.

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When the combustible, oily, and most volatile parts, contained in the earth-coal, are dissipated and set on fire by the first application of heat; if the combustion is stopped, the bitumen retains only the most fixed and least inflammable part of its oil, and is reduced to a true charry state, in combination with the earthy and fixed base. Pit-coals in this charry state are called *coaks*, which are capable of exciting the most intense heat; and are employed all over Britain in the smelting of iron, copper, and other metallic ores, to the greatest advantage. See COAKS, COAL, COALERY, and PIT-COAL (E).

X. The

‡ *Nat. Hist. of the Mineral Kingdom.*

(E) The coal-metals, or stone strata inclosing coals, are very numerous. Mr Williams ‡ gives the following general account of those in Scotland.

The sand-stones. Of these there is a great variety, distinguishable by colour, texture, and degrees of hardness, generally disposed into thick, middling, and thin strata. The only species our author takes notice of is the regular broad-bedded free-stone of a laminated texture. This commonly rises in thin or middling strata; appearing at the edges of a section, when broken or cut, to be formed of thin lamina or layers of sand, equally laid on the whole breadth of the stone, and well cemented together. A great deal of both red and white free-stone rise in layers of five or six inches, and so upwards, with regular streaks of a fifth or sixth part of an inch appearing the whole length of the stone, when the edge of a slab is polished, as if so many gentle waves of water had formed the layer. The regularity of the structure of this stone corresponds exactly with the regularity of its layers; and our author is of opinion, that the flaggy grey-strata of free stone, with many of the black and grey-strata of coal metals, the grey slate, as well as many other thin strata of the coal metals, may be ranked with this free stone for perfect and regular stratification.

Along with these he classes some of the thin argillaceous strata. "Many of the grey regularly stratified mountain limestones (says he) are also streaked or striped; and the streaks in these appear more conspicuous when broken than the streaked free stones. Some of the hard regularly stratified mountain rocks are also stratified; and in all these three kinds of stones, the streaks are regularly and exactly parallel to the bed of the stone."

Another remarkable instance of regularity of strata is met with in the grey flaggy strata of Caithness.—Throughout all the low country of Caithness, a square of about 10 or 15 miles, there are bluish argillaceous strata, with generally a small quantity of lime in the composition of the stone, which is indurated to a greater degree than is common to such thin strata, The stone is strong and tough, every where disposed in thin broad-beded, regular strata; and in several parts of the country the flags are so thin and regular, and are raised so light and broad, that they are used for covering houses; and three or four of them will cover the side of a small one. Our author mentions a gentleman who has an estate on the south side of the Pentland frith, and who in a bay there raises flags of any size and thickness he pleases; "so truly flat and smooth, that he has only to square the edges to make of them good loft-floors, partitions, chests, mangers, roofs of houses; in short, he does every thing with them. The face of these flags are as smooth and true a plane, as if artificially finished by the best workman."

In most coal fields there are a great variety of strata of different kinds accompanying and lying between the seams of coal, of all sorts of colours, consistencies, and dimensions; all of them blended together without any certain order or regularity; so that if there be 20 seams of coal, it is possible that there may be as many different roofs; that is, the stratum which is the immediate roof of one seam of coal, shall differ from that of another seam in quality, thickness, and colour, so that perhaps no two of the twenty shall be in any respect alike.

The various kinds of coal-roofs (*a*) commonly met with are the following.

1. *Ba-*

(*a*) The stratum which is placed immediately above a seam of coal, is called the *roof* of the coal, and that which is placed immediately below the seam, is called the *pavement* of the coal: which three, viz. the stratum of coal, and its roof and pavement, with the other concomitant strata lying above and below them, always preserve their stations and parallelism; that is, are all stretched out and spread one above another upon the same inclining plane, and have the same line of bearing and of declivity.

Inflammables.

X. The mineral phlogiſton or bitumen, united with the vitriolic acid: ſulphur or brimſtone. See the article SULPHUR.

This is very common in the earth, and diſcovers itſelf in many and various forms. It is found,

A. Native. *Sulphur nativum.*

In this the two conſtituent parts are mixed in due proportion in regard to each other, according to the rules of that atttraction which is between them. It is eaſily known,

1. By its inflammability, and by its flame.
2. By its ſmell when burnt; and,

Inflammables.

3. By

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1. *Baſaltes.* This is very common in Scotland, where it is frequently called *whin* ſtone; and at Borrowſtounneſs there are ſeveral thick beds of it between the ſeams of coal. One of them being the immediate roof of a ſeam of coal there at Hillhouſe lime quarry, there is a thin ſeam of coal beneath a beautiful bed of columnar baſaltes. In the Bathgate hills to the ſouthward of Linlithgow, alſo, there are ſeveral ſtrata of coal blended with thoſe of baſaltes. Theſe baſaltine ſtrata are always very hard, frequently very thick, and generally of a black or blackiſh grey colour. "There are but few people (ſays Mr Williams) ſufficiently verſed in natural hiſtory, to know that they are baſaltes, as this kind of rock, both in England and Scotland, goes by the name of *whin rock.* In the north of Scotland it is called *ſkurdy*; and among the miners in Cornwall it has the name of *cockle* (*b*)."—

2. Strata of *limeſtone* of various thickneſſes are met with in different coal-fields. Sometimes the lime is the immediate roof; but ſometimes there is an argillaceous ſtratum of about the thickneſs of a foot between the coal ſtratum and that of lime. In the coal-fields at Gilmerton, near Edinburgh, are ſeveral beds of limeſtone, ſome of them very good, and of conſiderable thickneſs. At Blackburn in Weſt Lothian, alſo, there is a ſtratum of limeſtone ſix or ſeven feet thick, which is the immediate roof of a ſeam of coal about five or ſix feet thick. At Carlops and Spittlehaugh in Tweedale, they have a ſeam of coal immediately below their lime quarries, which they work for burning their lime.

3. *Poſt-ſtone*, a kind of thick and ſolid ſtratum of free ſtone, is one of the roofs of coal, generally without the intervention of any argillaceous ſtratum, though ſometimes a ſtratum of this kind is interpoſed. Frequently this kind of ſtone is rendered very hard by a mixture of iron or pyrites. In moſt coal fields, thinner ſtrata of free ſtone are met with as the roofs of coal ſeams.

4. *Dogger-band*, as it is called by the Scots colliers, is frequently met with as the roof of coal ſeams. This name is applied to various ſubſtances. Sometimes they call ſtrata of iron-ſtone *dogger bands*; ſometimes the name is reſtricted to the ball iron-ſtone; ſometimes to pyrites; and ſometimes the dogger band is a kind of imperfect ſtone, compoſed of ſeveral heterogeneous mixtures, among which pyrites bears a conſiderable proportion, and by which the whole is ſo ſtrongly bound together, that it is frequently very difficult to break through it.

5. *Whin-ſtone*, properly ſo called, not of a baſaltic nature. Theſe roofs are always very hard, and of various colours, as black, blackiſh grey, brown, red, &c. ſometimes not above two or three feet in thickneſs, but ſometimes much more.

6. *Poſt-ſtone*, of a ſofter nature than that already mentioned. This has no mixture of ferruginous matter.

7. *Regular ſtrata of free-ſtone*, of various colours, textures, and thickneſſes, but not ſufficiently thick to deſerve the name of *poſt-ſtone*, which our author thinks they do not, unleſs they are above three or four feet. Theſe thin ſtrata of free ſtone are very numerous in coal fields, and very frequently form the roofs of coal-ſeams. Some of them are three or four feet thick, while others do not exceed three or four inches. They make good roofs, eaſily cut through, and may be readily quarried out for other purpoſes.

8. *Grey-bands*, or grey-coloured free-ſtone, frequently form the roofs of coal ſeams. A great number of them are generally arranged in one place, lying immediately above one another; and they are frequently found of all degrees of thickneſs from one to twenty inches, though the moſt common dimenſions are from two to ſix. By the Scots colliers theſe are called *grey ſekes* as well as grey bands. Frequently they are found of moderate hardneſs, and ſufficiently ſtrong to make good flags and covers for ſewers. Theſe roofs are ſtrong and ſafe when the ſtone partakes of the nature of the coal, and has a black or blackiſh grey colour; but when they have a mixture of tilly or argillaceous matter, they are more friable.

9. *Blaes*, when hard, ſtrong, and well ſtratified, are reckoned tolerably good coal-roofs. Theſe are always of a bluiſh-black or black-grey colour, and are of great variety in reſpect to hardneſs and ſtrength. Some of the ſtrongeſt and hardeſt are either entirely black or greyiſh black; while ſome of the different ſhades of black are pretty thick, and others are but thin. The thickeſt, however, are not above 18 inches, and the thinneſt two or three inches or leſs. The medium thickneſs is from one foot to three or four inches. Some of them are ſufficiently hard to make a good and ſafe coal-roof; but they ſeldom acquire ſuch a degree of hardneſs as to give any conſiderable obſtruction in ſucking. All of them ſeem to have a conſiderable quantity of black argillaceous matter in their compoſition; and the ſtrong blaes have alſo a conſiderable quantity of ſand; often alſo containing a large portion of empyreumatic oil, and ſometimes have a conſiderable mixture of coaly matter. There is a great variety both in the thickneſs and quantity of theſe blaes found above ſeams of coal. In ſome places the thinneſt ſtrata make the immediate roof; in others, the thickeſt. Sometimes we find only five or ſix inches of blaes upon the coal; in others as many fathoms, or even much more; and it is common to find them of all the intermediate thickneſſes.

10. *Whitiſh*

(*b*) We muſt obſerve, however, that according to Bergman and other eminent mineralogiſts, the *cockles* or *ſhirls* ought not to be confounded with *baſaltes*; which laſt name does not at all fit thoſe ſubſtances. See *Volcanic Products* in the Appendix to this article.

Inflammables.

3. By its producing a liver of ſulphur, when mixed with a fixed alkali, like that made from artificial ſulphur. It is found,
   a. Pellucid, of a deep yellow colour.
   b. Opaque, white, and greyiſh.
   Theſe are found in Siberia, at Bevieux in Swiſſerland, and at Salfatara near Naples.
   c. Cryſtalliſed in octoedral priſms, with blunted points.
   d. Tranſparent. Mr Davila had been informed that this was brought from Normandy in France. (*Brun.*)

I. Inflammables.

1. Native ſulphur is found in different forms, *viz.* either in ſolid pieces of indeterminate figure, running in veins through rocks; or in ſmall lumps, in gypſum and limeſtones; in conſiderable quantities at Solfatara, and in the neighbourhood of volcanoes; or cryſtalliſed in pale, tranſparent, or ſemitranſparent, octogonal, or rhomboidal cryſtals, in the cavities of quartz; and particularly in the matrices of ores; or in the form of ſmall needles over hot ſprings, or near volcanoes (*Kirwan*).

Some-

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10. *Whitiſh and aſh-coloured argillaceous ſtrata*, of middling ſtrength, are frequently found to be the immediate roofs of coal. Some of theſe are of middling thickneſs, others thin. They are commonly found from two inches to two feet in thickneſs. A great many of theſe roofs are very dangerous on account of their fragility; while others are quite ſafe, owing to the more perfect formation of their ſtrata, or to ſome ingredient in their compoſition.

11. *Streaked roofs*. Theſe are of two ſorts: 1. Such as are compoſed chiefly of ſand, with a very ſmall mixture of clay and blaes; and, 2. Thoſe compoſed principally of clay or blaes with a ſmall quantity of ſand. Some of theſe have large, others ſmall, ſtreaks or ribs. Mr Williams ſays that he has ſeen them ſo beautifully ſtreaked as to reſemble the fineſt ſtriped cotton ſtuffs. Theſe ſtripes or ſtreaks always lie exactly parallel to one another, as well as to the bed of the ſtone, and are always ſpread out the whole breadth of the ſtratum. Their colours are various in different ſtrata, ſome of the ſtripes being nearly black and white, others white and red, and others yellow and red. In ſome the ſtripes appear of a lighter and darker grey colour. Some of the finely ſtriped ſtones have their ſtreaks about a quarter of an inch in diameter; ſometimes leſs: and it is common to ſee ſtripes from a quarter to three quarters of an inch broad; but in the finely ſtriped ſtones it is rare to find them a full inch thick without ſome different ſhade on one ſide or other of the ſtripe. The ſecond kind of theſe ſtreaked roofs, viz. ſuch as are compoſed of blaes, with a ſmaller mixture of ſand, differ but little from the former; only the colours are not always ſo bright, nor the ſtripes ſo fine; neither is the roof quite ſo hard.

12. *The ſoft blae roofs* ſometimes conſiſt of pretty thick ſtrata; others of ſuch as are thin or of middling thickneſs. There are likewiſe arrangements or claſſes of regularly ſtratified blaes, found immediately above ſeams of coal, from three or four inches to ſeveral fathoms in thickneſs, though ſome are even met with little exceeding one inch in thickneſs; though in the ſame place there might be a conſiderable thickneſs of blaes above the coal, taking in all the different ſtrata, thick and thin, which lay above it. Some of theſe roofs have an oily appearance on the outſide, and through all the fiſſures and joints of the ſtrata; that is, they appear ſmooth and gloſſy, and are very ſlippery to the touch. Others have no appearance of this kind; but all of them are tender, weak, and fragile, ſo that they make a very indifferent and dangerous roof.

13. Another kind of coal-roof conſiſts likewiſe of *blaes*, but ſuch as are *imperfectly ſtratified*. It is altogether the ſame in quality and colour as the laſt, the only difference that can be diſtinguiſhed being in the different degrees of ſtratification. The beds of this kind are not perfect, but unequal; whence it is a bad and dangerous roof, as great pieces of it are frequently apt to fall down by reaſon of the inequality and different joints of the ſtrata. Some of theſe blaes appear in thick, and others in thin or middling thick beds; while ſome have an oily ſmoothneſs, called by the Scots colliers *creeſhy* (greaſy) *blaes*. It is owing to this oilineſs particularly that theſe kinds of roofs are ſo dangerous; for the oil pervades the joints, and, rendering them ſlippery, makes the pieces more apt to fall out as ſoon as the coal is worked away from below them. Some of theſe have ſuch a quantity of natural oil, that they will flame a little in the fire; and in ſome places there are hard blaes which will burn when fire is ſet to them, though they will not conſume. At Pitſirran in Fifeſhire there is a ſpecies of this blaes ſo inflammable, that when fire is ſet to one corner of a hillock it will burn throughout the whole; nevertheleſs it is not reduced in bulk by this combuſtion, nor does it produce any aſhes. Inſtead of this it becomes conſiderably harder than before, and acquires a pale red colour. By reaſon of its hardneſs, it is proper for being laid upon horſe and foot paths, but is not ſo for roads over which heavy wheel-carriages paſs.

14. *Soft blaes not ſtratified at all.* Of theſe there is no more than one bed from two or three inches to ſeveral fathoms in thickneſs, without any others either above or below it. They are as common as any above the coal ſeams; but their ſubſtance is not always uniform throughout the whole ſtratum. Some of them are found divided into ſmall angular maſſes, and others into larger ones; but whether theſe are uniform or not, they always make a bad and dangerous roof. Theſe argillaceous ſtrata are ſometimes called *beds of till*; the uniform ſort are called *dauk*, and the glebous kind *lipey* blaes, by the Scots colliers. Both the uniform and glebous ſoft blaes frequently contain a quantity of ball iron-ſtone, though ſome of it contains none at all. The regular continuous ſtrata of iron-ſtone are commonly found in ſtratified ſoft blaes. There is a variety of ſoft coal-roofs of a grey colour, and of which ſome are regularly ſtratified, and ſome not.

15. *Re-*

Inflammables.

Sometimes it is formed in old privies: of this Mr Magellan ſaw ſome lumps that were found in a very old one at Paris.

2. United with clay in the aluminous ore of La Tolfa, and alſo at Tarnowitz in Sileſia. This laſt reſembles a light grey earth: when dry, burſts or cracks in the water like marl; and poſſeſſes a ſtrong peculiar ſmell like camphor. If diſtilled, the ſulphur ſublimes. One hundred parts of this earth afford eight of ſulphur, beſides gypſum and a quantity of iron.

3. Mixed with clay, iron, and ſelenite. This compound is of a grey, brown, or black colour, found near Rome, Auvergne, Spain, and Iceland.

4. With limeſtone in the form of a calcareous hepar. This is found at Tivoli, near Rome, and elſewhere in Italy. It is ſometimes diſſolved in mineral waters, three pounds of which contain as much as 25 grains of ſulphur. It often forms incruſtations on the brinks of theſe ſprings.

5. In the form of an alkaline hepar. This is ſaid to be found in ſome waters in Ruſſia; as will be hereafter noticed.

6. United to iron and clay of pyrites, &c. of which hereafter.

7. United to metallic ſubſtances, as hereafter ſpecified.

B. Saturated with metals (F).

1. With iron. Pyrites, or copperas-ſtone; *Pyrites.*

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15. *Regularly ſoft grey coal-roofs.*—Of theſe there are ſeveral ſorts. Some have a conſiderable quantity of ſand in the compoſition of the ſtrata; and many of theſe are as regularly ſtratified as any coal-metals whatever. Numbers are found very thin, and others of middling thickneſs; though in all caſes they are ſo tender and friable, that they make very bad and dangerous roofs. Some of them indeed look pretty well at firſt but they ſoon crumble and come down, eſpecially when they have been expoſed to the air. This, in the opinion of Mr Williams, is owing partly to their having too much clay in their compoſition, and partly to the want of a ſufficient quantity of natural cement to connect the ſeveral particles of the ſtone together.

16. *Soft grey regular ſtrata*, or grey bands of an argillaceous kind; and of theſe there is likewiſe a conſiderable variety. Some are of a dark, others of a lighter grey; ſome thick, others thin: they are very numerous in coal-fields, and are frequently to be found as the immediate roofs of coal. Theſe, as well as the black kinds, are found in all quantities or degrees of thickneſs above different coals, from a few inches up to ſeveral fathoms; but whether they be in great or ſmall quantity, the roof they compoſe is generally very frail and tender.

17. *Soft grey argillaceous bands, imperfectly ſtratified.* Theſe differ little or nothing in ſubſtance from the former; the only difference is in the ſtratification. Many of the ſtrata of the former are of a middling thickneſs, or rather thin, finely and regularly ſpread out, and every part of each ſtratum of an equal thickneſs. But this ſort, though it has the appearance of ſtrata, is clumſy and irregular; that is, the ſeveral beds are unequal, and divided by many irregular joints into unequal miſhapen maſſes, which makes this a very bad roof; the maſſes being apt to ſeparate at the joints, and to fall down when the coal is worked out from below them.

18. *Soft grey argillaceous beds* of metal or coal roofs *not ſtratified at all.* Theſe are of two kinds, *viz.* 1. ſuch as are found broken or formed in the ſtratum into glebes or maſſes; and, 2. ſuch as are found in one uniform maſs throughout the whole bed, without any diviſion into maſſes or ſtrata. Theſe grey ſoft roofs are of all degrees of thickneſs, from a few inches up to many fathoms, as well as the black; and there is but very little difference between them in any reſpect excepting the colour. But in this, as well as in the black unſtratified blaes, and that both in the glebous and uniform beds, ball or glebous iron-ſtone is frequently found; and ſtrata of iron-ſtone are alſo found in the ſtratified ſoft grey blaes.

19. *White and aſh-coloured ſoft argillaceous coal-roofs;* and of theſe there is alſo a great variety. Some of this kind are regularly ſtratified, others imperfectly, and ſome not at all. Some of the whitiſh argillaceous roofs are compounded of gritty ſand and clay; others appear to be chiefly compoſed of pure clay; and ſome of a loamy clay. Thoſe which are regularly ſtratified and mixed with ſand, either coarſe or fine, are of great variety with regard to thickneſs and the arrangements of the ſtrata; but all of them are tender and fragile, and thus make very troubleſome and dangerous roofs.

20. *Whitiſh argillaceous roofs, ſtratified,* and of a homogeneous quality, or not mixed with ſand. Some of theſe are finely and perfectly ſtratified, and are of different degrees of hardneſs; but in general, make but a weak roof. Some of them are found in irregular ſtrata, with all the other varieties and imperfections already mentioned.

21. *White and aſh-coloured argillaceous coal-roofs,* not *ſtratified at all.* Sometimes theſe are found in very thick beds in the coal-fields; and ſome of theſe, as well as of the black ſoft roofs, riſe in glebes and maſſes of different ſizes; while others are homogeneous throughout the whole bed, however thick, from two or three inches to ſeveral fathoms. Some of theſe beds of white argillaceous marle-like matter are found to be a ſandy or loamy clay; others a pure homogeneous clay, which does not feel gritty between the fingers nor in the mouth. The ſhades and varieties of this kind are as numerous as thoſe of any of the foregoing; and all of them, by the Scots colliers, are called *dauk*, whatever be their coour. Mr Williams informs us, that he has frequently taken ſome of theſe fine white clays to waſh his hands, and has found them anſwer almoſt as well as ſoap.

(F) Sulphur is the moſt common mineraliſer of metals; and therefore moſt of its combinations with thoſe ſubſtances fall to be ranked hereafter among the metallic ores.

Inflammables.

rites. This is the ſubſtance from which moſt ſulphur is prepared, and is therefore ranked here with all its varieties. It is hard, and of a metallic ſhining colour.

A. Pale yellow pyrites; *Pyrites ſubflavus.* Marcaſite. This is very common, and contains a proportionable quantity of ſulphur with reſpect to the iron; when once thoroughly inflamed, it burns by itſelf.

a. Of a compact texture; *Polita piedra del ynca, Hiſpanorum.*

b. Steel-grained.

c. Coarſe-grained.

d. Cryſtalliſed. It ſhoots moſtly into cubical and octoedral figures, though it alſo cryſtalliſes into innumerable other forms.

B. Liver-coloured marcaſite. Its colour cannot be deſcribed, being betwixt that of the preceding marcaſite and the azure copper ore. The iron prevails in this kind; it is therefore leſs fit to have ſulphur extracted from it, and alſo for the ſmelting of copper ores. It is found,

a. Of a compact texture.

b. Steel-grained.

c. Coarſe-grained.

C. Variouſly combined with iron and other metallic ſubſtances.

1. With iron and copper; forming yellow or marcaſitical copper ore.
2. With iron, ſilver, and lead; potters lead ore.
3. With iron and zinc; mock lead, black jack or blende.
4. With iron and arſenic; arſenical pyrites.
5. With iron and cobalt.
6. With iron and biſmuth.
7. With iron and nickel.
8. With iron and gold; pyritical gold ore.
9. With ſilver; glaſs ſilver ore.
10. With copper; grey or vitreous copper ore.
11. With lead; potters lead ore.
12. With biſmuth.
13. With quickſilver; cinnabar.
14. With arſenic; orpiment, realgar.

XI. Mineral phlogiſton mixed with metallic earths.

This is not found in any great quantity: in regard to its external appearance, it reſembles pit-coal; and the fat ſubſtance contained in it, at times, partly burns to coal, and partly volatiliſes in a calcining heat.

The only known varieties of this kind are,

A. Minera cupri phlogiſtica.

When it has been inflamed, it retains the fire, and at laſt burns to aſhes, out of which pure copper can be ſmelted.

B. Minera ferri phlogiſtica.

This is not very different in its appearance from the pit-coal or foſſile pitch, but it is ſomewhat harder to the touch. There are two varieties of this ſpecies: Metals.

1. Fixt in the fire; *Minera ferri phlogiſtica fixa.*

Expoſed to a calcining heat, it burns with a very languid though quick flame; it preſerves its bulk, and loſes only a little of its weight. It yields above 30 per cent. of iron.

a. Solid, which reſembles black ſealing-wax.

b. Cracked, and friable.

2. Volatile in the fire.

This is unalterable in an open fire, either of charcoal, or even upon a piece of charcoal before the flame of the blow-pipe; but under a muffle the greateſt part of it volataliſes, ſo that only a ſmall quantity of calx of iron remains. It is found,

a. Solid.

b. Cracked.

This laſt kind leaves more aſhes: theſe aſhes, when farther expoſed to the fire, become firſt yelloviſh-green, and afterwards reddiſh-brown; when, beſides iron, they then alſo diſcover ſome marks of copper: it has, however, not been poſſible to extract any metallic ſubſtance from them, the effects of the loadſtone, and the colour communicated to the glaſs of borax, having only given occaſion to this ſuſpicion.

Class IV. METALLIC SUBSTANCES.

Metals are thoſe minerals which, with reſpect to their volume, are the heavieſt of all known bodies. Some of them are malleable; and ſome may be decompounded; and, in a melting heat (G), be brought back again to their former ſtate by the addition of the phlogiſton they had loſt in their decompoſition. See Metallurgy, Part I. Sect. i. and Chemistry-*Index* at *Metallic Calces* and *Metals.*

All the metallic ſubſtances contain phlogiſton; and when, to a certain degree, deprived of it, fall into a powder like an earth; but their attractions for phlogiſton are different.

Moſt of them, when melted in a common way, and expoſed to the air, have an earthy cruſt formed upon the ſurface, which cannot again be reduced to metal without the addition of ſome inflammable matter. The baſe metals have this property.

But the noble metals, *viz.* platina, gold, and ſilver, are ſo firmly united to the phlogiſton, that they never calcine under fuſion, however long continued; and, after being changed into a calx in the liquid way, when melted in the fire, they reaſſume their metallic form without any other phlogiſton than what is contained in the matter of heat.

Quick-

(G) The various degrees of heat required to reduce metals to a fluid ſtate, are ſeen in the following table, which was extracted, for the moſt part, by Dr Withering, from the printed treatiſes of the late celebrated Profeſſor Bergman. It exhibits, in a ſimple view, 1. The ſpecific gravity of each metal; 2. The degree of heat by Fahrenheit's ſcale, in which it melts; 3. The quantity of phlogiſton it requires for its ſaturation; and,

METALS. Quickſilver holds a kind of middle place: for, like the baſe metals, it may be calcined, though not readily; and, like the noble ones, it may be reduced by heat alone.

We may therefore reckon four noble or perfect metals; *viz.* gold, platina, ſilver, and mercury; becauſe, when calcined, they recover their phlogiſton without the addition of any phlogiſtic ſubſtance.

But as tin, lead, copper, and iron, cannot be reduced without ſuch addition, theſe are called *ignoble* and *imperfect* or *baſe metals*. *Kirwan's Mineralogy*.

However, all thoſe eight metals (even mercury, when ſolid) are malleable to a conſiderable degree, and are called *entire metals*. But METALS.

Biſmuth, zinc, antimony, arſenic, cobalt, nickel, manganeſe, molybdena, and wolfram, are ſcarce at all malleable, and hence they are called *ſemimetals*. Nevertheleſs, zinc and purified nickel are more malleable than any of the other ſemimetals; ſo that we have four perfect or noble metals, four imperfect or baſe, eight entire, and nine ſemimetals (H).

Order

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4. Its attraction to the ſame ſaturating phlogiſton. We muſt, however, obſerve, that if the ſecond column be compared with that of Wedgwood's thermometer, their great diſagreements betray ſome fundamental error in the aſſumed data: for the degrees of heat aſſigned by Mr Wedgwood for melting gold, ſilver, and copper, are more than quadruple of thoſe aſſigned by Bergman, and that for melting iron is more than eleven times greater; although they both nearly agree in the red heat of iron, which Bergman ſays to be 1050 degrees, and Wedgwood 1077. Mr Magellan is of opinion, that the fault lies in Mortimer's thermometer, which Bergman quotes with ſome diffidence (Sect. 197. of his *Sciagraphia*); and thinks it probable, that the changes cauſed by heat, on this metallic thermometer, are in a much leſs increaſing proportion by intenſe fire, than thoſe indicated by the contraction of the pure clay, happily employed by Wedgwood in his thermometer. He therefore added another column to this table, marked *Wedgw.* with the degrees of the melting heats already aſcertained by this laſt thermometer, as being the neareſt to truth.

Metals.	Specific Gravity.	Melting Heat. *Berg*	Melting Heat. *Wedgw.*	Saturating Phlogiſton.	Attraction to ſaturating Phlogiſton.
Gold	19,640	1301	5237	394	1 or 2
Platina	21,000			756	1 or 2
Silver	10,552	1000	4717	100	3
Quickſilver	14,110	—40	—40	74	4
Lead	11,352	595		43	10
Copper	8,876	1450	4587	312	8
Iron	7,800	1601	17977	342	11
Tin	7,264	415		114	9
Biſmuth	9,670	494		57	7
Nickel common	7,000	1301		156	11
Nickel pure	9,000	1601		109	5
Arſenic	8,308				
Cobalt common	7,700	1450			
Cobalt pure		1601			
Zinc	6,862	699		182	11
Antimony	6,860	809		120	6
Manganeſe	6,850	Very great		227	11

N. B. By ſaturating phlogiſton, Profeſſor Bergman means to expreſs the proportionate quantities taken away from each metallic ſubſtance, when diſſolved by means of acids, and of courſe reduced to a calciform ſtate. The laſt column only expreſſes their attraction to this part of their phlogiſton, not to that which ſtill remains united to them in a calciform ſtate. *Withering*.

(H) Mr Mongez remarks, that the following are the general properties of metals, when conſidered as phyſical bodies; *viz.* their opacity, great ſpecific gravity, ductility, tenacity, cryſtallization, flavour, and even ſmell, at leaſt in ſome of them.

It is from their denſity that their gravity and opacity proceed; this laſt being ſuch, that, even reduced to the thinneſt plates, no rays of light can paſs through their particles, unleſs there remains an interſtice or pore quite free from the metallic ſubſtance. Gold leaf muſt, however, be excepted, which exhibits a fine green by tranſmitted light.

As to their cryſtallization, it has been found to take place whenever they are pure, and left to cool very ſlowly by themſelves, after having been perfectly fuſed. (See *Journal de Phyſique* for July 1781, p. 74.) The flavour and ſmell above mentioned are very perceptible in the reguline ſubſtances of arſenic and antimony, as well as in lead, copper, and iron.

All metals are conductors of electricity; and more perfectly ſo than any other bodies during their union with phlogiſton.

They

Metals. *Gold.*

Order I. Noble or Perfect Metals.

I. Gold; *Aurum fol chymicorum.* See the articles Gold; alſo Chemistry-*Index*; and Metallurgy, Part II. ſect. 1.

This is eſteemed the principal and firſt among the metals; and that partly for its ſcarcity, but chiefly for the following qualities:

1. It is of a yellow ſhining colour.
2. It is the heavieſt of all known bodies, its ſpecific gravity to water being as 19,640 to 1000.
3. It is the moſt tough and ductile of all metals; becauſe one grain of it may be ſtretched out ſo as to cover a ſilver wire of the length of 98 yards, by which means $\frac{1}{105600}$ of a grain becomes viſible to the naked eye.
4. Its ſoftneſs comes neareſt to that of lead, and conſequently it is but very little elaſtic.
5. It is fixed and unalterable in air and water, and is indeſtructible by the common action of fire.
6. When melted, it reflects a bluiſh-green colour from its ſurface.
7. It diſſolves in aqua-regia, in the dephlogiſticated marine acid, and alſo (according to Crell ‡) in an acid obtained by diſtilling vitriolic acid from off manganeſe.
8. When mixed with a volatile alkali and a little of the acid of nitre, by means of precipitation out of aqua-regia, it burns off quickly, in the leaſt degree of heat, with a ſtrong fulmination.
9. It is diſſolved, *in forma ſicca*, by the liver of ſulphur, and alſo ſomewhat by the glaſs of biſmuth (1).
10. It is not carried away by the antimony during the volatiliſation of that ſemi-metal, and is therefore conveniently ſeparated from other metals by the help of crude antimony; in which proceſs the other metals are partly made volatile, and fly off with the antimony, and partly unite with the ſulphur, to which the gold has no attraction, unleſs by means of ſome uniting body, or by a long digeſtion (κ).

Metals. *Gold.*

‡ *Journal de Phyſique*, Oct. 1785. p. 295.

11. The

They are ſoluble either in nitrous acid and in dephlogiſticated marine acid, or in aqua regia; and are precipitable in ſome degree by cauſtic alkalies; and except platina by the Pruſſian alkali.

When dephlogiſticated, they communicate a tinge to borax and to microcoſmic ſalt, or at leaſt render them opaque.

They aſſume a convex ſurface when melted, and even a globular form, if in a ſmall quantity; and though they mix for the moſt part with one another whilſt fuſed, yet they refuſe to unite with unmetallic ſubſtances, even their own calces, iron only excepted, which does to its own calx ſlightly dephlogiſticated and to plumbago. Nickel alſo, and ſome others, may contain ſulphur in their reguline ſtate.

Metals, when calcined, are capable of uniting with other calces and ſalts.

Three of the metallic calces have been found to be of an acid nature; *viz.* the arſenical, molybdenic, and tungſtenic; from which, by analogy, the nature of other calces may be conjectured.

The phlogiſton contained in metals is in a pure ſtate; *viz.* without water and aerial acid, with which it is invariably accompanied in all other compounds except acid airs and ſulphur.

When metallic ſubſtances are naturally found in the earth united to their full ſhare of phlogiſton, and conſequently poſſeſſing their peculiar properties, they are called *native*.

But when they are found more or leſs deprived of their phlogiſton and of their properties, combined with other ſubſtances, they are then called *mineraliſed*. This is the moſt common ſtate of the mineral kingdom. The ſubſtance ſo combined with them is called the *mineraliſer*, and the whole is called *ore*; by which name are alſo diſtinguiſhed theſe earths and ſtones in which metallic ſubſtances are contained.

But if both metallic ſubſtances are mixed together in their metallic or reguline form, without the loſs of phlogiſton, they are then ſaid to be alloyed.

When the mineraliſer is of a ſaline nature, and renders the metallic combination ſoluble in leſs than 20 times its weight of water, the compound is ranged among ſalts. Thus the vitriols of iron, copper, and zinc, are rather claſſed with ſalts than with ores.

The moſt common mineraliſers are, ſulphur, arſenic, and fixed air or aerial acid. The leaſt common are the vitriolic and the marine acids. The phoſphoric has been found only in two inſtances; *viz.* united to lead, diſcovered by Gahn; and to iron, in the ſiderite, as Mr Meyer believes.

Thoſe metallic ſubſtances, mineraliſed by aerial acid, are called *calciform ores*.

M. Magellan obſerves, that if the new doctrine of the French chemiſts, who aſſert, that calces of metals are a compound of dephlogiſticated or vital air with the metallic ſubſtance, were juſt, all calciform ores ſhould produce this vital air inſtead of aerial acid, when they are reduced to their metallic form; which is not the caſe: neither ſhould all the baſe metals and ſemimetals abſolutely require the mixture of ſome phlogiſtic ſubſtance in order to their being reduced from the ſtate of calces to their metallic form, which otherwiſe would be quite uſeleſs, if their reduction ſimply conſiſted in their ſeparation from the vital or dephlogiſticated air.

(1) Neither ſulphur nor fixed alkali has any action on gold; but the liver of ſulphur, which is a compound of both, can diſſolve it in the dry way; ſo that if a proper quantity of gold-leaves be put in a crucible together with liver of ſulphur, and it be melted in a briſk fire, the gold is thoroughly diſſolved; and if the whole be diluted in water, the gold will be kept in the ſolution, and even paſs through the filtre along with it.

(κ) Antimony is uſed alſo to refine gold from its alloy, as it attenuates and carries off all other metallic

ſubſtances

Perfect Metals. Gold.

11. The phoſphorus is ſaid to have ingreſs into gold (L).
12. If mixed with a leſs portion of ſilver, platina, copper, iron, and zinc, it preſerves tolerably well its ductility. But,
13. When mixed with tin, it becomes very brittle; and it attracts likewiſe the ſmoke of that metal, ſo as to be ſpoiled if melted in an hearth where tin has been lately melted (M).
14. It requires a ſtrong heat before it melts, nearly as much or a little more than copper.
15. It mixes or amalgamates readily with quickſilver. See METALLURGY, Part II. ſect. i. (N).
16. It is not diſſolved by the glaſs of lead, and therefore remains on the cupel.

A. Native gold. With reſpect to the figure or the quantity in which gold is found in one place, it is by miners divided into,
1. Thin ſuperficial plated or leaved gold; which conſiſts of very thin plates or leaves, like paper.
2. Solid or maſſive, is found in form of thick pieces.
3. Cryſtalliſed, conſiſts of an angular figure.
4. Waſh gold, or gold duſt, is waſhed out of ſands, wherein it lies in form of looſe grains and lumps (O). See other diſtinctions of form under the article GOLD.

B. Mineraliſed gold. This is an ore in which the gold is ſo far mineraliſed, or ſo entangled in other bodies, as not to be diſſolved by the aqua-regia.
1. Mineraliſed with ſulphur by means of iron. Marcaſitical gold-ore; *Pyrites aureus*.
2. By means of quickſilver. It is found in Hungary.
3. By means of zinc and iron, or ſilver. The Schemnitz blende.

See other varieties of mineraliſed gold ores under the detached article GOLD, already referred to.

Perfect Metals. Silver.

II. Silver: *Argentum*, *Luna*. See the article SILVER. See alſo CHEMISTRY-*Index*; and METALLURGY, Part II. ſect. iii. and Part III. ſect. iii.

This metal is,
a. Of a white ſhining colour.
b. Its ſpecific gravity to water is, according to Cronſtedt, as 11,091 to 1000; according to Bergman, = 10,552; and according to Kirwan, 11,095.
c. It is very tough or ductile, ſo that a grain of it may be ſtretched out to three yards in length and two inches in breadth.
d. It is unalterable in air, water, and fire.
e. It diſſolves in the acid of nitre, and alſo by boiling in the acid of vitriol.
f. If precipitated out of the acid nitre with the common ſalt, or with its acid, it unites ſo ſtrongly with this laſt acid, that it does not part from it, even in the fire itſelf, but melts with it into a maſs like glaſs, which is called *luna cornea* (P).

ſubſtances mixed with it, without excepting the ſilver; whilſt lead leaves this laſt behind, and even adds ſome of its own to the gold. *Paulon*, p. 659.

(L) Gold, reduced into thin leaves, is not acted upon by the phoſphoric acid in the humid way, though the fire be urged till luminous decrepitations take place; but when it paſſes that point which ſeparates the humid from the dry way, Mr Margraaf obſerved that ſome purple ſcoria were formed, which is an indication that this concrete acid had partly calcined the gold during its fuſion. *Elements de Chymie de Dijon*, Vol. III. p. 131.

Beſides this, a drop of the phoſphoric acid on the ſolution of gold by aqua-regia precipitates the metal in its revived ſtate, as aſſerted by the academicians of Dijon. *Magellan.*

(M) The fumes of a ſingle grain of tin are capable of rendering hard eight ounces of gold; but it eaſily recovers its malleability by being melted on the fire. (*Wallerius* and *Bomare's* Mineralogy.) But when gold is mixed with arſenic, cobalt, nickle, biſmuth, or with the regulus of antimony, it only loſes great part of its malleability; and when in a certain proportion, it may be calcined and vitrified with them.—(*Fabroni.*)

(N) Bergman doubts if ever gold has been found perfectly pure; and Mr Kirwan ſays that it is very ſeldom found ſo, being generally alloyed with ſilver, copper, or iron, or all three. As to the gold commonly uſed in toys and other objects of luxury, every one knows that it is purpoſely debaſed by the artiſts with copper or other metals; and of late it has been employed in various pieces of jewellery, to form ornaments of various colours: thus a great alloy of ſilver (viz. one-third part), gives it a ſhade of a green colour; a ſimilar quantity of copper, a reddiſh one; a mixture of arſenic, or filings of ſteel, in the proportion of one-fourth part, gives it a bluiſh caſt; ſo that having the yellow naturally in the pure gold, and the white in pure ſilver, the jewellers have almoſt all the colours to diverſify their work. Even in the currency of money, there is none coined out of pure gold, which, by common agreement, is called *gold of* 24 *carats*. The gold coin of England, France, and Portugal, only contains 22 parts of pure gold, and two of alloy, viz. it is only 22 carats, in the common ſaying: that of Spain is but of $21\frac{1}{12}$ carats: but the ducat of Holland is of $23\frac{3}{4}\frac{4}{4}$ carats; and the zecchino of Venice, of $23\frac{1}{2}\frac{8}{4}$ carats: which laſt therefore, it would ſeem, is the pureſt gold coin of Europe. (*Paulon's Metrologie.*)

(O) M. Daubenton, in his Methodical Tables of Minerals, enumerates eight ſorts of native gold, viz. 1. In powder; 2. In grains; 3. In ſmall ſpangles; 4. In maſſes of lumps; 5. In filaments; 6. In branches like vegetables; 7. In lamella; and 8. In octoedral cryſtals.—He obſerves alſo, that gold, in its reguline ſtate, is formed, either, 1. Into angular cryſtals, compoſed of yellow octoedres; or, 2. Into irregular yellow maſſes, which, being broken, ſhow a granular ſubſtance.

(P) The marine acid attracts the calx of ſilver, but cannot remove its phlogiſton; and therefore cannot diſſolve

g. It does not unite with the ſemi-metal nickel during the fuſion.
h. It amalgamates eaſily with quickſilver.
i. It is in the dry way diſſolved by the liver of ſulphur.
k. It has a ſtrong attraction to ſulphur, ſo as readily to take a reddiſh yellow or black colour when it is expoſed to liver vapours.
l. It has no attraction to arſenic; whence, when the red arſenical ſilver ore, or *rothgulden ertz* of the Germans, is put into the fire, the arſenic flies off, and leaves the ſulphur (which in this compound was the *medium uniens*, behind, united with the ſilver in form of the glaſs ſilver ore, or glaſs ertz.
m. It is not diſſolved by the glaſs of lead, and conſequently it remains on the cupel.
n. It is exhaled or carried off by volatile metals and acids; as by the vapours of antimony, zinc, and the acid of common ſalt.
o. According to Cronſtedt, it melts more eaſily than copper; and this was a general opinion. But the contrary, as Mr Magellan remarks, has been proved by means of the nice thermometer lately invented by Wedgewood.—See THERMOMETER.

Silver is found,

A. Native or pure; which moſt generally is nearly of 16 carats ſtandard (Q.)
1. Thin, ſuperficial, plated or leaved.
2. In form,
   a. Of ſnaggs, and coarſe fibres.
   b. Of fine fibres. Capillary ſilver.
   c. Arboreſcent.
   d. Cryſtalline or figured. This is very rare: it has diſtinct fibres, with ſhining ſurfaces.

B. Mixed or alloyed with other metals.

The following are the known inſtances of theſe mixtures:
1. United to gold, (*Bergman's Sciagraphia*, § 154.)
2. Mixed with copper; (*Berg. Sc* § 155.)
3. United to gold and copper; (*Berg. Sc.* § 156.)
4. Amalgamated with mercury, found in the mines of Salberg; (*Foſter's notes to Brunnich.*)
5. United to iron; (*Berg. Sc.* § 157.)
6. United to lead, ſometimes in ſuch quantities as to be worth the expences attending the ſeparation.
7. United to arſenic; (*Journal de phyſique*, 1778, p. 50.)
8. United to antimony; (*Berg. Sc.* § 159.)
9. Joined to the regulus of arſenic and iron; (*Berg. Sc.* § 160.)
10. Mixed with the alkaline limeſtone from Annaberg, deſcribed by Mr Juſti; (*Brunnich.*)
11. Sandy ſilver-ore, without any metallic ſhining.
12. Silver-ore in a red-brown ſchiſtus, deſcribed by Lehman: it is compoſed of argillaceous earth, micaceous hematites, ſulphur, calcareous ſpar, fluor mineralis, lead, and ſilver.—It contains about ſeven or eight ounces of ſilver on the hundred weight.
13. Soft ſilver-ore. It is found among the marles and argillaceous earths; and is of various colours, either ſingly or mixed.

C. Diſſolved and mineraliſed.

(1.) With ſulphur alone. Glaſs ſilver-ore.

This is ductile, and of the ſame colour as lead; but, however, becomes blacker in the air. It has therefore, though very impoperly, got the name of *glaſs-ore*; for that name rather belongs to the *minera argenti cornea*, or horn ſilver ore, if indeed any ſilver ore can be conſidered as glaſſy.

It is found,
1. In cruſts, plates, or leaves.
2. Grown into
   a. Snaggs, and
   b. Cryſtalline figures.
   It is generally either of a lamellar or a grained texture.

The glaſs ſilver ore is the richeſt of all ſilver ores; ſince the ſulphur, which is united with the ſilver in this ore, makes but a very ſmall quantity of its weight.

(2.) Arſenico-martial ſilver ore, (*Weill ertz*, Germ.)

This ore contains ſilver and iron mineraliſed by arſenic; the arſenic in a larger proportion than the iron. This is the *Pyrites argenteus* of Henckel.
1. It is a hard ſubſtance, of a white ſhining appearance, and of a compact, lamellar, or fibrous texture. (*Kirwan*, ſp. 7.)
2. Of a yellowiſh white colour, and of a ſtriated ſtructure, reſembling biſmuth, but much harder. (*Kirwan*, ſp. 3.)—It is found near Guadanal canal in Spain.
3. Near the ſame place is found alſo another ore of the ſame kind, which is very ſoft and eaſily cut; and when cut, has a brilliant metallic appearance. It conſiſts of conchoidal laminæ. The quintal contains only from four to ſix ounces of ſilver; but it is eaſily reduced by evaporating the arſenic, which then leaves the ſilver ſlightly contaminated with iron. (*Kirwan*, ſp. 4.)

(3.) With

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diſſolve it in its metallic ſtate, (*Bergman.*) However, the marine acid, if well concentrated, or rather reduced into an aerial form, diſſolves ſilver in its metallic ſtate, (*Fabroni.*)

Mr Scheele, and after him Mr Bertholet, aſſert poſitively, that the marine acid, being dephlogiſticated by its diſtillation over maganeſe in the form of a yellow air or gas, diſſolves all the metals, without excepting gold, ſilver, or mercury. See Scheele's Eſſay 5. § 25. H.

The vitriolic acid being diſtilled alſo over the maganeſe, diſſolves ſilver, gold, and mercury, as Dr Crell aſſerts, (*Journal de Phyſique*, Oct. 1785, p. 297.)

Silver is precipitated from the vitriolic and nitrous acids by the marine; and from the nitrous, in great meaſure, by the vitriolic, (*Kirwan.*)

(Q) Wallerius diſtinguiſhes ſeven ſpecies of ſilver: (ſee the article SILVER). Daubenton reckons eight varieties of *native white ſilver*, ariſing from their peculiar forms.

Perfect Metals. Silver.

(3.) With ſulphur and arſenic. The red or ruby-like ſilver ore. The *rothgulden* of the Germans.

The colour of this ore varies as the proportion of the ingredients varies in the mixture, viz. from dark grey to deep red; but when it is rubbed or pounded, it always gives a red colour.

a. Grey arſenical ſilver ore.
1. Plated, cruſted, or leaved.
2. Solid.

b. The red arſenical ſilver ore:
1. Plated, cruſted, or leaved;
2. Solid or ſcaly.
3. Cryſtalliſed (R.)

In this laſt form it ſhows the moſt beautiful red colour, and is often ſemi-tranſparent. It contains about 60 *per cent.* in ſilver.

(4.) With ſulphur, little arſenic, and iron.—(*Schwartz ertz, Schwartz gulden, Silber mulm.* Germ.)

This is a friable, weathered, decayed ore.

a. Of a black or ſooty colour; and is therefore called by the Germans *ſilberſchwartz*, or *ruſſigtes-ertz.*

(5.) With ſulphurated arſenic and copper. The *weiſſgulden* of the Germans.

This, in its ſolid form, is of a light grey colour, and of a dull and ſteel-grained texture. Its proportion of ſilver is from 10 to 30 *per cent.*

(6.) With ſulphurated arſenic and iron. The *weiſertz*, or white ſilver ore of the Germans.

This is an arſenical pyrites, which contains ſilver; it occurs in the Saxon mines, and ſo exactly reſembles the common arſenical pyrites, as not to be diſtinguiſhed from it by ſight alone, or without other means.

(7.) With ſulphurated antimony.

a. Of a dark grey and ſomewhat browniſh colour; the *laberetz* of the Germans.

b. Of a blackiſh blue colour.
1. In form of capillary cryſtals. *Federertz*, or plumoſe ſilver ore.

(8.) With iron, arſenic, and cobalt, mineraliſed by ſulphur.

This ore looks like the *weiſſgulden* deſcribed above; but is diſtinguiſhed by the roſe coloured particles of cobalt, diſperſed through dark brown, blackiſh, or grey, and ſometimes ſhining ſolid maſs. It is to this ſpecies of ores that the ſilver gooſe dung ore belongs.

(9.) With ſulphurated copper and antimony.—The Dal *fahlertz.*

This reſembles both in colour and texture the dark-coloured weiſſgulden. When rubbed, it gives a red powder.

a. Solid.

b. Cryſtalliſed.

(10.) With ſulphurated zinc. The *pechblende* of the Germans.

This is a zinc ore, mock lead, or blende, which contains ſilver, and is found among rich ſilver and gold ores.

a. Of a metallic changeable colour.
1. Solid, and with fine ſcales.
2. In form of balls. The *kugel-ertz*, or ball ore.

b. Black mock lead, or blende, found in Saxony. This is alſo found,
1. Solid, and with fine ſcales;
2. And in form of balls.

(11.) With ſulphurated lead; potters ore. *Galena; bleyglanz.*

(12.) With ſulphurated lead and antimony, called *ſtriperz.*

(13.) With ſulphurated iron. *Silberhalitgier kies;* marcaſite holding ſilver.

(14.) With ſulphurated and arſenical cobalt; dendrites being ſometimes found in the ſtone.

Theſe kinds keep well in water; but generally wither in the air, and loſe the ſilver they contain.

(15.) Mineralized by ſulphur, with regulus of antimony and barytes. The butter-milk ore.

This is found in the form of thin particles, on granular ſpar, (*Kirwan*, ſp. 13.)

(16.) Combuſtible ſilver ore.

This is a black and brittle ſubſtance, and leave about 6 per cent. of ſilver in its aſhes. It is in fact a coal in which ſilver is found. (*Kirwan*, ſp. 14.)

(17.) With the acid of common ſalt. *Minera argenti cornea. Hornetz*, or horn-ſilver ore.

This is the ſcarceſt ſilver ore; it is of a white or pearl colour, changeable or varying on the ſurface, ſemi-tranſparent, and ſomewhat ductile both when crude and when melted. It cannot be decompoſed without ſome admixture of ſuch ſubſtances as attract the acid of ſea-ſalt.

Perfect Metals. Platina.

III. Platina del Pinto; *Juan blanca.*

This metal is a recent diſcovery of our times; and is deſcribed with great accuracy by Scheffer, in the Acts of the Royal Academy of Sciences at Stockholm for the year 1752; as alſo by Dr Lewis, in the Philoſophical Tranſactions for the year 1754, vol. xlviii. and by many other writers. By theſe deſcriptions we are convinced of the reſemblance this metal bears to gold; and therefore we muſt allow it to be called *white gold.* It has, however, a variety of diſtinguiſhing qua-

(R) Wallerius mentions the ſix following varieties of this notable ore in his *Species* 388, viz. 1. The red opaque, like cinnabar, from Andreaſberg in the Hartz, and from Salberg in Weſtmannia: 2. The bluiſh, from Freiberg and Annaberg: 3. The grey, from Freiberg and Andreaſberg: 4. The red tranſparent amorphous, of the garnet colour, from Potoſi and Ioachimſtal: 5. The red tranſparent, cryſtalliſed into priſmatic decaedres, or dodecaedres, from Hungary, Alſace, and the Duchy of Deuxponts: 6. The only ſuperficially red ore, from Salberg and Ehrenfriederichſdorf.

Perfect Metals. Quickſilver.

lities beſides its colour, which aſcertain its peculiar nature: All which, with its hiſtory, uſes, &c. are particularly deſcribed under the detached article PLATINA. See alſo CHEMISTRY-*Index*; and METALLURGY, Part II. ſect. ii.

1. It is of a white colour.
2. It is ſo refractory in the fire, that there is no degree of heat yet found by which it can be brought into fuſion by itſelf, the burning-glaſs excepted. But, when mixed with other metals and ſemimetals, it melts very eaſily, and eſpecially with arſenic, both in its metallic form and in form of a calx or glaſs.

IV. Quickſilver, mercury. *Hydrargyrum*, *Argentum vivum*, *Mercurius*. See the article QUICKSILVER; CHEMISTRY-*Index*, at *Mercury*; and METALLURGY, Part II. ſect. viii.

Mercury diſtinguiſhes itſelf from all metals by the following qualities (s.)

a. Its colour is white and ſhining, a little darker than that of ſilver.

b. It is fluid in the cold, and diviſible by the leaſt force; but, as it only ſticks to a few bodies to which it has an attraction, it is ſaid that it does not wet.

Perfect Metals. Quickſilver.

c. It is volatile in the fire.

d. It attracts the other ſemimetals and metals; and unites with them all except cobalt and nickel, with which it cannot by any means yet known be made to mix. This union is called *amalgamation*. This amalgamation, or mixtion of metallic bodies, according to the readineſs with which they unite or mix, is in the following progreſſion, viz. gold, ſilver, lead, tin, zink, biſmuth, copper, iron, and the regulus of antimony; the three latter, however, do not very readily amalgamate. The iron requires a ſolution of the vitriol of iron, as a medium to promote the union.

e. It diſſolves in ſpirit of nitre, out of which it is precipitated by a volatile alkali, and common ſalt, in form of a white powder; but if a fixed alkali is uſed, a yellow powder or calx is obtained (T).

f. But

(s) It were almoſt ſuperfluous, ſays Mr Kirwan, to mention any other character of quickſilver than its liquidity, to diſtinguiſh it from other metals. In regard to this property, Bergman obſerves, that mercury conſtitutes one extreme among the metals, and platina the other; ſince it requires to be melted only ſuch a degree of heat as is rarely wanting in our atmoſphere, and boils at the 6000 degrees nearly after lead melts. See the table at p. 111. *Note*. But when the cold is increaſed to the temperature denoted by 40 degrees below ⊙ both of Fahrenheit's and of the Swediſh thermometer, which both coincide in that point (ſince 212—32, or 180: 100 :: 32+40, or 72 : 40), this metal concretes like any other metal, and becomes quite ſolid; (ſee Philoſophical Tranſactions for 1783, p. 303.) Mercury in its common ſtate, therefore, according to Bergman (Treatiſe of *Elect. Attract.*), is to be conſidered as a metal in fuſion: and ſince in its ſolid ſtate it is nearly as malleable as lead, it by no means ought to be placed among the ſemimetals, otherwiſe every other entire metal ſhould be conſidered as brittle, for none is malleable when in fuſion.

(T) 1. Mercury is diſſolved with great rapidity by nitrous acid: the liquor is of a greeniſh-blue colour, but loſes it afterwards and becomes limpid. This ſolution, when made without heat, is uſed as a teſt for the analyſis of mineral waters, and has different properties from that made with the help of heat. In the firſt caſe, ſays Bergman, very little phlogiſton is loſt, and the ſalt eaſily cryſtalliſes, being white, and ſcarcely acrid. It is not precipitated by diſtilled water; but by cauſtic vegetable alkali, it is precipitated of a yellowiſh colour; by mild alkali, the precipitation is white; by mineral alkali, it is yellow, but it ſoon grows alſo white; by volatile alkali, it turns to a greyiſh-black colour; by Glauber's ſalt, or by pure vitriolic acid, the precipitation is white, granulated, and in a ſmall quantity; nor, if this precipitant has been ſparingly uſed, does this colour appear in leſs than an hour: by muriatic acid, or common ſalt, the precipitation is alſo white, but in a large quantity, and in curdles.

2. But if the mercurial ſolution be put over a ſand-heat, it may be charged with a quantity of mercury equal almoſt to its weight. According to the chemiſts of Dijon, 10 ounces of nitrous acid may diſſolve eight of mercury. The action of the ſolvent becomes ſtronger with the heat; emits great quantity of vapours; and if not taken from the fire, will be too far evaporated. Diſtilled water will precipitate from this ſolution a white calx, becauſe it is more dephlogiſticated, and the ſolvent is overcharged with it; and the water changing the denſity of the liquor, diminiſhes the adheſion of the calx, as Fourcroy remarks. This white calx will turn yellow, if boiling water be poured on it. The vegetable alkali precipitates it of a browniſh yellow, which by degrees aſſumes a pale-yellow tinge: the mild vegetable, and the mineral alkalies, produce nearly the ſame colour; though when this laſt is employed, the colour turns afterwards to white. The precipitation by volatile alkali is quite white alſo; that by the vitriolic acid is yellow; and, finally, a copious white mucilaginous matter is the precipitate by the marine acid.

3. This ſolution by nitrous acid is very cauſtic; corrodes and deſtroys animal ſubſtances; when it falls on the ſkin, ſtains it it of a deep purple brown colour, which appears black: the ſtains do not go off before the ſeparation of the epidermis, which falls away in ſcales or kind of ſcars. It is uſed in ſurgery as a powerful eſcharotic, and is called *mercurial water*.

4. The ſame ſolution, by cooling, is ſuſceptible of forming cryſtals, which vary from one another according to circumſtances: for the moſt part they are like needles; are very cauſtic; redden the ſkin; and detonate when put on burning coals, provided they be dry. They are called *mercurial nitre*, which fuſes when heated in a crucible; exhales reddiſh fumes; aſſumes a deep yellow colour, which afterwards turns to orange,

and

Perfect Metals. Quickſilver.

f. But it requires a boiling heat to diſſolve it in oil of vitriol (u).

g. It is not affected by the acid of common ſalt, unleſs it be previouſly diſſolved by other acids (v); in which caſe only they both unite with one another, and may be ſublimed together; this ſublimate is a ſtrong poiſon.

h. It unites with ſulphur by grinding; and then produces a black powder called *æthiops mineralis* (w), which ſublimes into a red ſtriated body called *factitious cinnabar*.

i. The ſulphur is again ſeparated from the quickſilver, by adding iron or lime, to which the ſulphur attaches itſelf, leaving the quickſilver to be diſtilled over in a metallic form; but if a fixed alkali be uſed, ſome part of the quickſilver will remain diſſolved in the reſiduum, which is a liver of ſulphur.

Quickſilver is found,

A. Native, or in a metallic ſtate. *Mercurius nativus*, or *virgineous*.

This found in the quickſilver mines at Idra in Friuli, or the Lower Auſtria, in clay, or in a black ſlaty *lapis ollaris*, out of which it runs, either ſpontaneouſly, or by being warmed even in the hands.

B. United to gold or ſilver. *Hydrargyrum argento vel auro adunatum*.

Mr Kirwan aſſerts, on the authorities of Monet and Lin. Von Gmelin, that in Sweden and Germany mercury has been found united to ſilver in the form of a ſomewhat hard and brittle amalgam.

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Romé de l'Iſle had a ſpecimen of this natural amalgam from Germany, which is imbedded in a quartzoſe maſs, and mixed with cinnabar, as Mr Mongez aſſerts; and he adds, that in the royal cabinet, at the king's garden at Paris, is depoſited another fine ſpecimen of this mercurial ore, which was found cryſtalliſed in the mine called *Carolina* at Muchel-lanſberg in the duchy of Deux Ponts. M. de l'Iſle ſpeaks alſo very poſitively of a ſpecimen of native gold from Hungary, which ſeems to be a natural amalgam of gold and mercury. It is compoſed of quadrangular priſms, of a greyiſh yellow colour, and of a brittle texture. This ſpecimen is alſo in the king's cabinet at the royal garden at Paris.

Mr Kirwan, ſpeaking of the method of examining the purity of gold by the moiſt way, ſuppoſes, with Sir Torbern Bergman, that there are natural amalgamations of mercury with gold and ſilver: and Neumann obſerves, that ſometimes a mineral, containing gold or ſilver, is met with among mercurial ores, although this is a great rarity.

It is evident, therefore, that there naturally exiſt

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and at laſt to a brilliant red: in this ſtate it is called *red precipitate*, or *arcanum corallinum*. It muſt be made in a matraſs with a gentle heat if it is deſigned to be corroſive for chirurgical purpoſes.

(u) 1. The vitriolic acid, concentrated and boiling hot, ſeizes on mercury, and preſently reduces it if urged by heat to a kind of white powder, which turns yellow by the affuſion of hot water, but does not diſſolve in it; this is called *turbith mineral*: but if cold water, inſtead of hot, was poured in the white maſs, the powder would not change its white colour into yellow as was ſaid above about the nitrous ſolution.

2. If Mercury be rarefied by heat into vapours, and theſe meet with thoſe of marine acid in the ſame ſtate, a corroſive ſublimate will be formed. This metallic ſalt ſhoots into cryſtals pointed like daggers, which are the ſtrongeſt of all poiſons. But there are various other proceſſes found in chemical authors to make this ſalt with more or leſs trouble. See Chemistry, n° 814—818.

3. If corroſive ſublimate be mixed with tin and diſtilled, a very ſmoking liquor is produced, called by the name of its inventor the *ſmoking liquor of Libavius*. See Chemistry, n° 810.

The muriatic acid in the ſublimate is not ſaturated, and from hence proceeds its great corroſive power; for if a freſh quantity of mercury be added to it, and ſublimed a ſecond or third time, a ſweet, or mixed ſublimate, called *mercurius dulcis*, is produced, which is not poiſonous, and is given internally as a purgative, or an emetic, according to the doſe. See Chemistry, n° 819.

(v) Muriatic acid does not act upon quickſilver unleſs this laſt be previouſly deprived of as much phlogiſton, as $\frac{24}{1000}$ of the quantity contained in the hundred of ſilver, or of $\frac{80}{1881}$ in the hundred of zinc. (See Bergman's *Sciagraphia*, and his treatiſe *De Phlogiſti quantitate.)*

(w) The academicians of Dijon ſay, that the true proportion to make this æthiops, is that of one part of brimſtone with four of mercury. Fourcroy directs only one of mercury, with three of flowers of ſulphur, to be triturated, till the mercury is extinguiſhed. A black powder is then produced, which is the æthiops mineral. The combination is better effected when the mercury is mixed with the fuſed ſulphur: by agitating this mixture, it becomes black, and eaſily takes fire; it ſhould be then taken from the fire, and the flame ſhould be extinguiſhed a little after, ſtirring the maſs till it becomes into ſolid clots. If this ſubſtance be expoſed to a great degree of heat, it takes fire, the ſulphur is conſumed, and a ſubſtance remains which is of a violet colour when pulveriſed. This powder being put into matraſſes, till their bottom become red by the force of fire, is ſublimed after ſome hours, and artificial cinnabar is found in the top of the veſſels cryſtalliſed into brown red needles.

Mercury, divided by means of a rapid and continual motion, as that of a mill-wheel, gradually changes itſelf into a very fine black powder, which is called *æthiops per ſe*, on account of its colour, in order to diſtinguiſh it from this *æthiops mineralis* mentioned in the text.

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iſt various ores of quickſilver, amalgamated with ſilver, gold, and other minerals, although they be but ſeldom met with.

C. Mineraliſed,

[1.] With ſulphur.

A. Pure cinnabar, *Cinnabaris nativa.*

a. Looſe or friable cinnabar like red ochre.

b. Indurated or ſolid cinnabar. It is of a deep red colour; and, with reſpect to its texture, is either,

1. Steel-grained;
2. Radiated;
3. Compoſed of ſmall cubes, or ſcaly; or
4. Cryſtalliſed, in a cubical form; it is tranſparent, and deep red like a ruby.

B. Impure cinnabars.

1.) A mercurial ore is found in Idria, ſays Gellert, where the mercury lies in an earth or ſtone, as if it were in a dead form; and has the appearance of a red-brown iron-ſtone; but it is much heavier than that. It contains from three quarters to ſeven eighths of the pureſt mercury; leaves, after diſtillation, a very black ſtrong earth behind; and gives ſome marks of cinnabar.

2.) Liver ore, which is moſt common in Idria, and has its name from its colour.—Outwardly it reſembles an indurated iron-clay; but its weight diſcovers that its contents are metallic. It yields ſometimes 80 pounds of quickſilver per hundred weight.

3.) Burning ore; *brand-erz* in German. This ore may be lighted at the candle; and yields from nine to 50 pounds of quickſilver per hundred weight. *Brunnich.*

[2.] With iron by ſulphur. Pyritous cinnabar. Sir Torbern Bergman inſerted this ore in the 177th ſection of his *Sciagraphia*, and ſeems doubtful whether this be a diſtinct ſpecies from the cinnabar; as the iron is perhaps, ſays he, only mechanically diffuſed therein. Mr Mongez remarks, that there are but a few inſtances of cinnabar in which iron is not found in its calcined form; though, in the act of the ore being reduced, it paſſes to its metallic ſtate, and becomes capable of being acted on by the loadſtone.

Another pyritous ore of cinnabar was found at Menidot, near St Lo in Lower Normandy. It conſiſted in grains of different ſizes, of a red brown colour: they had a vitriolic taſte and ſulphureous ſmell. Found alſo at Almaden in Spain, and at Stahlberg in the Palatinate; though at this laſt place they are of a dodecaedral form.

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[3.] With ſilver by the aerial acid, and ſulphur.

This ſeems to be a native precipitate *per ſe*, or calx of mercury. It is ſaid to have been lately found in Idria, in hard compact maſſes of a browniſh-red colour; ſee *Journal de Phyſique* for January 1784, p. 61. If this account can be relied upon, it will prove, that quickſilver, even in a calciform ſtate, is naturally found mineraliſed with ſilver by means of ſulphur.

[4.] With ſulphur and copper.

This ore is blackiſh grey, of a glaſſy texture, and brittle; crackles and ſplits exceſſively in the fire; and when the quickſilver and ſulphur are evaporated, the copper is diſcovered by its common opaque red colour in the glaſs of borax, which, when farther forced in the fire, or diluted, becomes green and tranſparent. It is found at Muſchlanſberg in the duchy of Deux Ponts.

[5.] Mineraliſed by the marine and vitriolic acids.

Mineralogy owes the diſcovery of this ore to Mr Woulfe, who publiſhed an account of it in the Philoſophical Tranſactions for 1776. It was found in the duchy of Deux Ponts, at the mine diſtinguiſhed by the name of *Obermoſchal*. It had a ſpar-like appearance. This ore is either bright and white, or yellow or black. It was mixed with cinnabar in a ſtony matrix: and being well mixed with one-third of its weight of vegetable alkali, afforded cubic and octagonal cryſtals; that is, ſalt of Sylvius and vitriolated tartar.

The marine ſalt of this mercury is in the ſtate of ſublimate corroſive.

Order II. Imperfect or base Metals.

I. Tin. *Stannum; Jupiter.* (See the detached article Tin: Alſo Chemistry-*Index;* and Metallurgy, Part II. ſect. vi. and Part III. ſect. vi.)

This is diſtinguiſhed from the other metals by the following characters and qualities. It is,

a. Of a white colour, which verges more to the blue than that of ſilver.

b. It is the moſt fuſible of all metals; and,

c. The leaſt ductile; that is, it cannot be extended or hammered out ſo much as the others (x).

d. In

(x) Tin is ſufficiently ductile to be beaten into very thin leaves. But ductility and extenſibility are two different properties, leſs connected with one another than is generally imagined. Iron and ſteel are drawn into exquiſite fine wire, but cannot be beat into very thin leaves. Tin, on the other hand, is beat into fine leaves, and may be exended between rollers to a conſiderable ſurface. The tin-ſheet uſed in various arts, is commonly about $\frac{1}{600}$th part of an inch; but may be extended twice as much in its dimenſions without difficulty. Notwithſtanding this extenſibility, tin cannot be drawn into wire, on account of the weak cohesion of its particles. A tin wire, however, of one-tenth of an inch diameter, is able to ſupport a weight of 49½ pounds, according to Fourcroy. Gold and ſilver poſſeſs both properties of ductility and extenſibility the moſt eminently of all metallic bodies; whilſt lead, notwithſtanding its flexibility and ſoftneſs, cannot be made either into leaves or wire of any fineneſs.

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d. In breaking or bending, it makes a crackling noiſe.

e. It has a ſmell particular to itſelf, and which cannot be deſcribed.

f. In the fire it is eaſily calcined to white aſhes, which are 25 per cent. heavier than the metal itſelf. During this operation, the phlogiſton is ſeen to burn off in form of ſmall ſparkles among the aſhes or calx.

g. This calx is very refractory; but may, however, with a very ſtrong degree of heat be brought to a glaſs of the colour of colophony. But this calx is eaſily mixed in glaſs compoſitions, and makes with them the white enamel.

h. It unites with all metals and ſemimetals; but renders moſt of them very brittle, except lead, biſmuth, and zinc.

i. It amalgamates eaſily with quickſilver.

k. It diſſolves in aqua-regia, the ſpirit of ſea-ſalt, and the vitriolic acid; but is only corroded into a white powder by the ſpirit of nitre. The vegetable acid, ſoaps, and pure alkaline ſalts, alſo corrode this metal by degrees.

l. Its ſpecific gravity to water is as 7400 to 1000, or as 7321 to 1000.

m. Diſſolved in aqua-regia, which for this purpoſe ought to conſiſt of equal parts of the ſpirit of nitre and ſea-ſalt, it heightens the colour of the cochineal, and makes it deeper; for otherwiſe that dye would be violet.

(1.) Native Tin.

The exiſtence of native tin has long been queſtioned: but it has undoubtedly been found ſome years ago in Cornwall, as Mr Kirwan remarks.

1. Malleable tin, in a granular form, and alſo in a foliaceous ſhape, iſſuing out of a white hard matter like quartz: but which, after being properly aſſayed, proved to be arſenical cryſtals; a circumſtance that evinces its being native tin, ſince the arſenic could not remain in this form if the tin had been melted. It appeared like a thick, jagged, or ſcolloped lace or edging; and was found near St Auſtle in Cornwall.

2. In the form of cryſtalline metallic laminæ, or laminated cryſtals, riſing ſide by ſide out of an edging, which ſhone like melted tin: they were almoſt as thin as flakes or ſcales of talc, interſecting each other in various directions, with ſome cavities between them, within which appeared many ſpecks and granules of tin, that could be eaſily cut with a knife: this was alſo found in Cornwall.

3. In a maſſy form, more than one inch thick in ſome places, and incloſed in a kind of quartzous ſtone; or rather in an hard cruſt of cryſtalliſed arſenic.

(2.) Calciform Ores of Tin.

A. In form of a calx, *Stannum calciforme.*

A. Indurated, or vitrified.

1. Mixed with a ſmall portion of the calx of arſenic.

a. Solid tin ore, without any determinate figure. Tin-ſtone.

It reſembles a garnet of a blackiſh brown colour, but is much heavier; and has been conſidered at the Engliſh tin-mines as a ſtone containing no metal, until ſome years ago it began to be ſmelted to great advantage.

B. Cryſtalliſed.

a. Tin ſpar, or white tin ore. This is generally of a whitiſh or grey colour; ſometimes it is yellowiſh, ſemi-tranſparent, and cryſtalliſed, either of a pyramidical form, or irregularly.

b. Tin-grains. This ore, like the garnets, is of a ſpherical polygonal figure; but ſeems more unctuous on its ſurface.

1. In large grains.

2. In ſmall grains.

B. Mixed with metals.

1. With the calx of iron, as in the garnet.

2. With manganeſe. See the *Semimetals*.

C. Mineraliſed.

1. With ſulphur and iron.

2. With ſulphur. *Aurum muſivum.*

This was diſcovered by Profeſſor Bergman, among ſome minerals which he received from Siberia. He obſerved two ſorts of it, analogous to the two artificial combinations of tin with ſulphur.

1. One nearly of the colour of zinc, and of a fibrous texture, which contained about 20 *per cent.* of ſulphur, and the remainder tin.

2. The other enveloped the former like a cruſt; reſembled aurum muſivum; and contained about 40 *per cent* of ſulphur, a ſmall proportion of copper, and the remainder tin. *Mem. Stockh.* for 1721, p. 328.

At Huel Rock, in St Agnes in Cornwall, there has been found a metallic vein, nine feet wide, at 20 yards beneath the ſurface. Mr Raſpe was the firſt who diſcovered this to be a ſulphurated tin-ore: it is very compact, of a bluiſh white colour, approaching to grey ſteel, and ſimilar to the colour of grey copper ore: it is lamellar in its texture, and very brittle. It conſiſts of ſulphur, tin, copper, and ſome iron. Mr Raſpe propoſes to call it *bell-metal ore.*

According to Mr Klaproth's analyſis of this ore, 119 grains contain 30 of pure ſulphur; 41 of tin; 43 of copper; two of iron; and three grains of the ſtony matrix. In another ſpecimen of the ſame ſulphurated tin-ore from Cornwall, there were in the hundred 25 parts of ſulphur, 34 of tin, 36 of copper, three of iron, and two of the ſtony matrix.

II. Lead; *Plumbum, Saturnus.* (See the article LEAD, and CHEMISTRY-*Index*: Alſo METALLURGY, Part II. ſect. v. and Part III. ſect. vii.)

Imperfect Metals. *Lead.*

The properties of lead are as follows.

a. It is of a bluiſh white colour when freſh broke, but ſoon dulls or ſullies in the air.

b. It is very heavy; viz. to water as 11,325 to 1000.

c. It is the ſofteſt metal next to gold; but it has no great tenacity, and is not in the leaſt ſonorous.

d. It is eaſily calcined; and, by a certain art in managing the degrees of the fire, its calx becomes white, yellow, and red.

e. This calx melts eaſier than any other metallic calx to a glaſs, which becomes of a yellow colour, and ſemitranſparent. This glaſs brings other bodies, and the imperfect metals, into fuſion with it.

f. It diſſolves, 1ſt, In the ſpirit of nitre; 2dly, In a dilated oil of vitriol, by way of digeſtion; 3dly, In the vegetable acid; 4thly, In alkaline ſolutions; and 5thly, In expreſſed oils, both in the form of metal and of calx.

g. It gives a ſweet taſte to all ſolutions.

h. It amalgamates with quickſilver.

i. With the ſpirit of ſea-ſalt it has the ſame effect as ſilver, whereby is produced a *ſaturnus corneus*.

k. It does not unite with iron, when it is alone added to it in the fire.

l. It works on the cupel, which ſignifies that its glaſs enters into certain porous bodies, deſtitute of phlogiſton and alkaline ſalts.

m. It melts in the fire before it is made red-hot, almoſt as eaſily as the tin.

n. Its calx or glaſs may be reduced to its metallic ſtate by pot-aſhes.

[1.] Native Lead.

For proofs of lead being naturally found in its metallic ſtate, ſee the article LEAD.—It may be here added, that Henckel likewiſe affirms its exiſtence, in his *Flora Saturniſans*; (ſee Kirwan's *Elements of Mineralogy*, p. 297, 298.) Wallerius aſſerts, that it has been ſo found in Poland, a ſpecimen of which was kept in the collection of Richter; and adds, that a ſimilar one found at Schneberg, was ſeen in the collection of Spener. (*Mineralogy*, vol. ii. p. 301.)

Dr Lawſon, in his Engliſh edition of Cramer's Art of Eſſaying Metals, ſays, that ſome pure native malleable lead had been lately found in New England; (p. 147.) And laſtly, Profeſſor Bergman did not heſitate to inſert, by itſelf alone, the *plumbum nativum*, in Sect. 180. of his *Sciagraphia*.

[2.] Calciform Lead.

Lead is found,

A. In the form of a calx.

A. Pure.

a. Friable lead ochre, native ceruſe.

b. Indurated lead ſpar, or ſpatoſe lead ore.

i. Radiated, or fibrous.

1. White, from Mendip-hills, in England.

ii. Cryſtalliſed in a priſmatic figure.

1. White, from Norrgrufva in Weſtmanland.

2. Yellowiſh green, from Zchopau in Saxony.

B. Mixed,

1. With the calx of arſenic, arſenical lead ſpar.

2. Indurated.

a. White. Mr Cronſtedt has tried ſuch an ore from an unknown place in Germany, and found that no metallic lead could be melted from it by means of the blow-pipe, as can be done out of other lead ſpars; but it muſt be performed in a crucible. (See the article LEAD. par. iii.)

3. With a calcareous earth.

This ore effervеſces with aqua-fortis, and contains 40 *per cent.* of lead; on which account is is placed here rather than among the calcareous earths.

B. Mineraliſed.

1. With ſulphur alone: the *bley-ſchweiff*, or *bley-glanz*, of the Germans.

a. Steel-grained lead-ore.

b. Radiated, or antimoniated lead-ore.

c. Teſſellated, or potter's lead-ore.

At Villach in Auſtria there is ſaid to be found a potter's lead-ore, which contains not the leaſt portion of ſilver.

2. Mineraliſed by the vitriolic acid.

This ore was diſcovered by Mr Monnet. It occurs ſometimes, though rarely, in the form of a white ponderous calx; and ſeems to originate from the ſpontaneous decompoſition of the ſulphurated lead-ores above mentioned.

3. By the acid of phoſphorus.

This ore was lately diſcovered by Gahn; and is of a greeniſh colour, by reaſon of a mixture of iron. See the article LEAD, par. 6.

4. With ſulphurated ſilver. *Galena*; alſo called *bleyglanz* by the Germans. Potter's ore.

a. Steel-grained.

b. With ſmall ſcales.

c. Fine-grained.

d. Of a fine cubical texture; and,

e. Of coarſe cubes. Theſe two varieties are found in all the Swediſh ſilver-mines.

f. Cryſtalliſed.

The ſteel-grained and ſcaly ores are of a dim and dull appearance when they are broken, and their particles have no determined angular figure: they are therefore in Swediſh commonly called *blyſchweif*; in oppoſition to the cubical ores, which are called *blyglanz*. The moſt part of the ores called *blyglanz* contain ſilver, even to 24 ounces *per cent.* of which we have inſtances in the mines of Salberg, where it has been obſerved, that the coarſe cubical lead ores are generally the richeſt in ſilver, contrary to what is commonly taught in books; the reaſon of which may perhaps be, that, in making the eſſays on theſe two ores, the coarſe cubical can be choſen purer or free

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freer from the rock than the fine cubical ores.

5. With ſulphurated iron and ſilver. This is found,
   a. Fine-grained. *b.* Fine cubical. *c.* Coarſe-cubical. When this ore is ſcorified, it yields a black ſlag; whereas the preceding lead-ores yield a yellow one, becauſe they do not contain any iron.
6. With ſulphurated antimony and ſilver; antimoniated or radiated lead-ore. This has the colour of a blyglanz, but is of a radiated texture.
   It is found,
   a. Of fine rays and fibres; and,
   b. Of coarſe rays or fibres. The lead in this ore prevents any uſe being made of the antimony to advantage; and the antimony likewiſe in a great meaſure hinders the extracting of the ſilver.
7. Mineraliſed by arſenic.
   This ore was lately diſcovered in Siberia.—Externally it is of a pale, and internally of a deep red, colour. See the article LEAD, par. 10.

C. Mixed with earth; ſtony, or ſandy lead ores.
These conſiſt either of the calciform or of the galena kind, intimately mixed and diffuſed through ſtones and earth, chiefly of the calcareous or of the barytic genus. See LEAD, par. 11.

Uſes, &c. of Lead. See LEAD, and the other articles above referred to.

III. Copper; *Cuprum, Venus, Æs.* (See the article COPPER: Alſo CHEMISTRY-*Index*; and METALLURGY, Part II. ſect. iv. and Part III. ſect. iv.)
This metal is,
a. Of a red colour.
b. It is pretty ſoft and tough.
c. The calx of copper being diſſolved by acids becomes green, and by alkalies blue.
d. It is eaſily calcined in the fire into a blackiſh blue ſubſtance, which, when rubbed to a fine powder, is red; when melted together with glaſs, it tinges it firſt reddiſh brown, and afterwards of a tranſparent green or ſea-green colour.
e. It diſſolves in all the acids, and likewiſe in alkaline ſolutions. It is eaſier diſſolved when in form of a calx than in a metallic ſtate, eſpecially by the acids of vitriol and ſea-ſalt, and the vegetable acid.
f. Vitriol of copper is of a deep blue colour; but the vegetable acid produces with the copper a green ſalt, which is verdigris.
g. It can be precipitated out of the ſolutions in a metallic ſtate; and this is the origin of the precipitated copper of the mines called *Ziment copper.*
h. It is not eaſily amalgamated with quickſilver; but requires for this purpoſe a very ſtrong trituration, or the admixture of the acid of nitre.
i. It becomes yellow when mixed with zinc, which has a ſtrong attraction to it, and makes braſs, pinchbeck, &c. Imperfect Metals. *Copper.*
k. When this metal is expoſed to the fire, it gives a green colour to the flame in the moment it begins to melt, and continues to do ſo afterwards, without loſing any thing conſiderable of its weight.

[1.] Native copper.
Copper found naturally in a metallic ſtate, is called *virgin* or *native copper.* It is met with,
1. Solid.
2. Friable, in form of ſmall, and ſomewhat coherent grains. Precipitated or ziment copper.

[2.] Calciform.
Copper, in form of a calx, is found,
1.) Pure.
A. Looſe or friable; *Ochra veneris.*
   1. Blue; *Cæruleum montanum.* Very ſeldom found perfectly free from a calcareous ſubſtance.
   2. Green; *Viride montanum.* Both this and the former colour depend on menſtrua, which often are edulcorated or waſhed away.
   3. Red. This is an efflorescence of the glaſs copper ore.

B. Indurated. Glaſs copper-ore.
   a. Red. This is ſometimes as red as ſealing wax, and ſometimes of a more liver-brown colour.
   It is always found along with native copper, and ſeems to have loſt its phlogiſton by way of efflorescence, and to be changed into this form. It is likewiſe found with the ſulphurated copper, improperly called *glaſs copper-ore.*

2.) Mixed.
A. Looſe or friable; *Ochra veneris friabilis impura.*
   1. Mixed with a calcareous ſubſtance; *Cæruleum montanum.* In this ſtate copper-blue is moſtly found. It ferments during the ſolution in aquafortis.
   2. Mixed with iron. Black. It is the decompoſition of the Fahlun copper ore.

B. Indurated.
   1. Mixed with gypſum, or plaſter. Green.
   2. Mixed with quartz. *a.* Red, from Sunnerſkog in the province of Smoland.
   3. Mixed with lime. *a.* Blue. This is the *Lapis Armenus*, according to the accounts given of it by authors.

3.) Cupreous ſtones.
Analogous to the calciform copper ores, are,
1. The *lapis armenus.* } See the detached ar-
2. The turquoiſe. } ticle COPPER, n° 7.

[3.] Diſſolved and mineraliſed; *Cuprum mineraliſatum.*
A. With ſulphur alone. Grey copper-ore; alſo called, improperly, *glaſs copper-ore.*
   a. Solid, without any certain texture, and very ſoft, ſo that it can be cut with a knife almoſt as eaſily as black lead.
   b. Fine cubical. In Smoland this is ſome-

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times found decompoſed or weathered, and changed into a deep mountain blue.

B. With ſulphurated iron. *Minera cupri pyritacea*; yellow copper ore. Marcaſitical copper ore; *Pyrites cupri*. This is various both in regard to colour and in regard to the different proportion of each of the contained metals; for inſtance,

a. Blackiſh grey, inclining a little to yellow; *Pyrites cupri griſeus*. When decayed or weathered, it is of a black colour; is the richeſt of all the varieties of this kind of copper ore, yielding between 50 and 60 *per cent.* and is found in Spain and Germany.

b. Reddiſh yellow, or liver brown, with a blue coat on the ſurface; *Minera cupri lazurea*. This ore yields between 40 and 50 *per cent.* of copper, and is commonly ſaid to be blue, though it is as red, when freſh broken, as a red copper regulus.

c. Yellowiſh green; *Pyrites cupri flavo virideſcens*. This is the moſt common in the north part of Europe: and is, in regard to its texture, found,

1. Solid, and of a ſhining texture.
2. Steel grained, of a dim texture.
3. Coarſe-grained, of an uneven and ſhining texture.
4. Cryſtalliſed marcaſitical copper ore.
   a. Of long octoëdrical cryſtals.

d. Pale yellow. This cannot be deſcribed but as a marcaſite, though an experienced eye will eaſily diſcover ſome difference between them. It yields 22 *per cent.* of copper.

e. Liver-coloured.

C. With ſulphurated ſilver, arſenic, and ſome iron. Fallow copper-ore; which contains only a few ounces of ſilver. This ore is found in Hungary and Germany, where it is called *black copper ore*.

D. With ſulphurated arſenic and iron. White copper ore.

E. Pyritous copper, with arſenic and zinc.

According to Mr Monnet, this ore is found at Catharineberg in Bohemia. It is of a brown colour; of a hard, ſolid, compact, granular texture; and contains from 18 to 30 *per cent.* of copper.

F. Diſſolved by the vitriolic acid; *Vitriolum veneris*. See the article copper, n° xiii.

G. With phlogiſton. Copper coal ore, conſiſting of the calces of copper, mixed with a bituminous earth.

H. Mineraliſed by the muriatic acid. This ore was found in Saxony, and had been generally miſtaken for a micaceous ſubſtance, which in fact it greatly reſembles. It has not yet been found in large maſſes, but only in a ſuperficial form, like a cruſt over other ores. It is moderately hard and friable; of a fine green colour, and ſometimes of a bluiſh green, cryſtalliſed in a cubic form, or with a foliated texture, or in little ſcales reſembling green mica or talc. This ore is eaſily diſſolved by nitrous acid: the ſolution takes a green colour; and the metal may be precipitated on a poliſhed plate of iron. If ſome drops of a nitrous ſolution of ſilver be mixed with it, a white powder of *luna cornea* will be precipitated, which diſcovers the preſence of the muriatic acid in this ore.

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The uſes of copper are very numerous, although not thoroughly known to every one. Several of theſe have been mentioned under the detached article, and in CHEMISTRY. Others of great importance may be here added. Its great ductility, lightneſs, ſtrength, and durability, render it of very extenſive utility. Blocks, or bars of copper, are reduced into flat ſheets of any thickneſs, by being firſt heated by the reverberation of the flame, in a low-vaulted furnace, properly conſtructed for the purpoſe; and then immediately applied between large rollers of ſteel, or rather of caſe-hardened iron, turned by a water-wheel or by the ſtrength of horſes, ſo that the hot metal is there quickly ſqueezed; and the operation is repeated, bringing the rollers every time nearer to one another, till the metallic ſheet acquires the intended thickneſs.

Theſe copper ſheets are very advantageouſly employed in ſheathing the bottoms of men of war and other veſſels, which by this means are prevented from being attacked by the ſea worms, and are kept clean from various marine concretions, ſo as to ſail with conſiderably greater ſwiftneſs. Copper ſheets are alſo employed to cover the tops of buildings inſtead of ſlates or earthen tiles, as is uſed in Sweden; and ſome architects have begun to introduce the uſe of copper covering into Great Britain, which is much lighter, and may be uſed with great advantage, although it muſt be much dearer in the prime coſt.

Sundry preparations of copper are employed in painting, ſtaining, and for colouring glaſs and enamels. See GLASS and ENAMEL.

The ſolution of copper in aqua-fortis ſtains marble and other ſtones of a green colour; when precipitated with chalk or whiting, it yields the green and the blue verditer of the painters. According to Lewis, a ſolution of the ſame metal in volatile ſpirits ſtains ivory and bones: when macerated for ſome time in the liquor, they become of a fine blue colour, which, however, tarniſhes by expoſure to the air, and becomes green afterwards.

The ſame author prepared elegant blue glaſſes, by melting common glaſs, or powdered flint and fixed alkaline ſalt, with blue vitriol, and with an amalgam of copper; fine green ones were made with green verditer, and with blue verditer, as well as with the precipitate of copper made by fixed alkalies, and with a precipitate by zinc; and a reddiſh glaſs was produced by the calx and ſcoria of copper made by fire alone. Even in this vitreous ſtate, it ſeems as if a continuance of fire had the ſame effect in regard to colour, as air has upon copper in other forms; as ſome of the moſt beautiful blue glaſſes, by continued fuſion, have changed

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changed to a green colour. See farther the article BRASS *in the Glaſs-trade.*

Verdegris is a preparation of copper diſſolved by the vegetable acids, which act on this metal, diſſolving it very ſlowly, but in conſiderable quantities. It produces a fine green pigment for painting both in oil and water colours, inclining more or leſs to the bluiſh according to circumſtances.

So great is the tenacity of copper, that a wire of a tenth of an inch in diameter is capable of ſupporting 299.5 pounds weight before it breaks.—Copper may be drawn into very fine wire, and beaten into extremely thin plates. The German artiſts, chiefly thoſe of Nurenberg and Auſburg, are ſaid to poſſeſs the beſt method for giving to theſe thin plates of copper a fine yellow colour like that of gold. See the articles *Brass-Colour* and *Brass-Leaf.*

The parings or ſhreds of theſe very thin leaves of yellow copper being well ground on a marble plate, are reduced to a powder ſimilar to gold, which ſerves to cover, by means of ſome gum-water, or other adheſive fluid, the ſurface of various mouldings or other pieces of curious workmanſhip, giving them the appearance of real bronze, and even of fine gold, at a very trifling expence; becauſe the gold colour of this metallic powder may be eaſily raiſed and improved by ſtirring it on a wide earthen baſon over a ſlow fire.

In ſome of its ſtates, copper is as difficultly extended under the hammer as iron, but proves ſofter to the file, and never can be made hard enough to ſtrike a ſpark with flint or other ſtones; from whence proceeds the uſe that is made of this metal for chiſels, hammers, hoops, &c. in the gun-powder works.

The vitriolic acid does not act on copper unleſs concentrated and boiling: during this ſolution a great quantity of ſulphureous gas flies off; afterwards a brown thickiſh matter is found, which contains the calx of the metal partly combined with the acid. By ſolution and filtration, a blue ſolution is obtained, which being evaporated to a certain degree, produces after cooling long rhomboidal cryſtals of a beautiful blue colour, called vitriol of copper; but if this ſolution be merely expoſed a long time to the air, it affords cryſtals, and a green calx is precipitated, a colour which all calces of this metal aſſume when dried by the air. Blue vitriol, however, is ſeldom formed by diſſolving the metal directly in the vitriolic acid. That ſold in the ſhops is moſtly obtained from copper pyrites. It may alſo be made by ſtratifying copper-plates with ſulphur, and cementing them together for ſome time; becauſe the vitriolic acid of the ſulphur being diſengaged, attacks and corrodes the metal, forming a metallic ſalt, which by affuſion of water yields perfect cryſtals of blue vitriol. See VITRIOL.

The nitrous acid, on the contrary, diſſolves copper when cold with great rapidity; and a great quantity of ſmoaking air or gas flies off, which, on being received in a pneumatic apparatus, and mixed in a glaſs tube with atmoſpheric air, ſhows its good or bad quality for the reſpiration of living animals, according as the common bulk is more or leſs diminiſhed. This is one of the moſt important of Dr Prieſtley's diſcoveries; and various inſtruments known by the name of *eudiometers* have been ſince invented for making theſe experiments with eaſe and ſatisfaction. See EUDIOMETER.

But the moſt common uſe of copper is to make all ſorts of large ſtills, boilers, pots, funnels, and other veſſels employed by diſtillers, dyers, chemiſts, and various other manufacturers, who make uſe of large quantities of hot liquors in their various operations.

Although copper when pure is extremely valuable, on account of its ductility, lightneſs, and ſtrength, it is, however, leſs uſeful on many occaſions from the difficulty of forming large maſſes of work, as it is not an eaſy matter to caſt copper ſolid, ſo as to retain all its properties entire. For if the heat be not ſufficiently great, the metal proves deficient in toughneſs when cold; and if the heat be raiſed too high, or continued for a length of time, the copper bliſters on the ſurface when caſt in the moulds; ſo that the limits of its fuſion are very contracted. And from theſe circumſtances pure copper is rendered leſs applicable to ſeveral purpoſes.

We find, however, that the addition of a certain proportion of zinc removes almoſt all theſe inconveniences, and furniſhes a mixed metal more fuſible than copper, very ductile and tenacious when cold, which does not ſo readily ſcorify in a moderate heat, and which is leſs apt to ruſt from the action of air and moiſture.

Copper is the baſis of ſundry compound metals for a great number of mechanical and œconomical uſes of life, ſuch as braſs (y), prince's-metal, tombac, bell-metal, white copper, &c. See CHEMISTRY, n° 1154, &c.

If the mixture is made of four to ſix parts of copper, with one part of zinc, it is called *Prince's-metal.* If more of the copper is taken, the mixture will be of a deeper yellow, and then goes by the name of *tombac.*

(y) Braſs is frequently made by cementing plates of copper with calamine, where the copper imbibes one-fourth or one-fifth its weight of the zinc which riſes from the calamine. The proceſs conſiſts in mixing three parts of calamine and two of copper with charcoal duſt in a crucible, which is expoſed to a red heat for ſome hours, and then brought to fuſion. The vapours of the calamine penetrate the heated plates of copper, and add thereby to its fuſiblity, It is of great conſequence for the ſucceſs of this proceſs to have the copper cut into ſmall pieces, and intimately blended with the calamine. See CHEMISTRY, n° 1154.

In moſt foreign founderies the copper is broken ſmall by mechanical means with a great deal of labour; but at

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Bell-metal is a mixture of copper and tin, forming a compound extremely hard and ſonorous, and is leſs ſubject to alterations by expoſure to the air than any other cheap metal. On this account it is advantageouſly employed in the fabrication of various utenſils and articles, as cannons, bells, ſtatues, &c. in the compoſition of which, however, other metals are mixed in various proportions, according to the fancy and experience of the artiſt.

White-copper is prepared with arſenic and nitre, as mentioned under CHEMISTRY, n° 1157.

But the principal kind of white-copper is that with which ſpeculums of reflecting teleſcopes are made. See the article SPECULUM.

VII. Iron; *Ferrum, Mars.* This metal is,

a. Of a blackiſh blue ſhining colour.

b. It becomes ductile by repeated heating between coals and hammering.

c. It is attracted by the loadſtone, which is an iron ore; and the metal itſelf may alſo be rendered magnetical.

d. Its ſpecific gravity to water is as 7,645, or 8000 : 1000.

e. It calcines eaſily to a black ſcaly calx, which, when pounded, is of a deep red colour.

f. When this calx is melted in great quantity with glaſs compoſitions, it gives a blackiſh brown colour to the glaſs; but in a ſmall quantity a greeniſh colour, which at laſt vaniſhes if forced by a ſtrong degree of heat.

g. It is diſſolved by all ſalts, by water, and likewiſe by their vapours. The calx of iron is diſſolved by the ſpirit of ſea-ſalt and by aqua-regia. Imperfect Metals. Iron.

h. The calx of the diſſolved metal becomes yellow, or yellowiſh brown: and in a certain degree of heat it turns red.

i. The ſame calx, when precipitated from acids by means of the fixed alkali, is of a greeniſh colour; but it becomes blue when precipitated by means of an alkali united with phlogiſton; in which laſt circumſtance the phlogiſton unites with the iron: theſe two precipitates loſe their colour in the fire, and turn brown.

k. The vitriol of iron is brown.

Iron is found,

[1.] Native. See the detached article IRON.

[2.] In form of calx.

A. Pure.

A. Looſe and friable. Martial ochre; *Minera ochracea.*

1. Powdery; *Ochra ferri.* This is commonly yellow or red, and is iron which has been diſſolved by the vitriolic acid.

2. Concreted. Bog-ore.

a. In form of round porous balls.

b. More ſolid bars.

c. In ſmall flat pieces, like cakes or pieces of money.

d. In ſmall grains.

e. In

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at Briſtol the workmen employ an eaſier method. A pit is dug in the ground of the manufacture about four feet deep, the ſides of which are lined with wood. The bottom is made of copper or braſs, and is moveable by means of a chain. The top is made alſo of braſs with a ſpace near the centre, perforated with ſmall holes, which are luted with clay; through them the melted copper is poured, which runs in a number of ſtreams into the water, and this is perpetually renewed by a freſh ſtream that paſſes through the pit. As the copper falls down it forms itſelf into grains, which collect at the bottom. But great precaution is required to hinder the dangerous exploſions which melted copper produces when thrown into cold water; which end is obtained by pouring ſmall quantities of the metal at once. The granulated copper is completely mixed with powdered calamine, and fuſed afterwards. The proceſs laſts eight or ten hours, and even ſome days, according to the quality of the calamine.

It is a wonderful thing, ſays Cramer, that zinc itſelf, being ſimply melted with copper, robs it of all its malleability; but if it be applied in form of vapour from the calamine, the ſublimates, or the flowers, it does not cauſe the metal to become brittle.

The method mentioned by Cramer to make braſs from copper, by the volatile emanations of zinc, ſeems to be preferable to any other proceſs, as the metal is then preſerved from the heterogeneous parts contained in the zinc itſelf, or in its ore. It conſiſts in mixing the calamine and charcoal with moiſtened clay, and ramming the mixture to the bottom of the melting pot, on which the copper, mixed alſo with charcoal, is to be placed above the rammed matter. When the proper degree of heat is applied, the metallic vapour of the zinc contained in the calamine will tranſpire through the clay, and attach itſelf to the copper, leaving the iron and the lead which were in the calamine retained in the clay, without mixing with the upper metal. Dr Watſon ſays, that a very good metallurgiſt of Briſtol, named John Champion, has obtained a patent for making braſs by combining zinc in the vapourous form with heated copper plates; and that the braſs from this manufacture is reported to be of the fineſt kind: but he knows not whether the method there employed is the ſame with that mentioned by Cramer.

Braſs is ſometimes made in another way, by mixing the two metals directly; but the heat requiſite to melt the copper makes the zinc burn and flame out, by which the copper is defrauded of the due proportion of zinc. If the copper be melted ſeparately, and the melted zinc poured into it, a conſiderable and dangerous exploſion enſues; but if the zinc is only heated and plunged into the copper, it is quickly imbibed and retained. The union, however, of theſe two metals ſucceeds better if the flux compoſed of inflammable ſubſtances be firſt fuſed in the crucible, and the copper and zinc be poured into it. As ſoon as they appear thoroughly melted, they are to be well ſtirred, and expeditiouſly poured out, or elſe the zinc will be inflamed, and leave the red copper behind.

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c. In lumps of an indeterminate figure.

All these are of a blackish brown, or a light brown colour.

B. Indurated. The blood-stone; *Hæmatites*.

(1.) Of an iron colour; *Hæmatites cæruleſcens*. This is of a bluish grey colour; it is not attracted by the loadstone, yields a red powder when rubbed, and is hard.

a. Solid, and of a dim appearance when broken.

b. Cubical, and of a shining appearance when broken.

c. Fibrous, is the most common *torrſten* of Sweden.

d. Scaly: the *eiſenram* of the Germans.

1. Black.
2. Bluish grey. When this is found along with marcasite, it is not only attracted by the loadstone, but is of itself really a loadstone.

e. Crystallised.

1. In octoedrical crystals.
2. In polyedrical crystals.
3. In a cellular form.

These varieties are the most common in Sweden, and are very seldom blended with marcasite or any other heterogeneous substance except their diffeeent beds. It is remarkable, that when these ores are found along with marcasite, those particles which have lain neareſt to the marcasite are attracted by the loadstone, although they yield a red or reddish brown powder, like those which are not attracted by the loadstone: it is likewise worth observation, that they generally contain a little sulphur, if they are imbedded in a limestone rock.

(2.) Blackish brown bloodstone; *Hæmatites nigreſcens*. Kidney ore. This yields a red or brown powder when it is rubbed; it is very hard, and is attracted by the loadstone.

a. Solid, with a glassy texture.

b. Radiated.

c. Crystallised.

1. In form of cones, from Siberia.
2. In form of concentric balls, with a facetted surface. These are very common in Germany, but very scarce in Sweden.

(3.) Red bloodstone; *Hæmatites Ruber*. Red kidney ore.

a. Solid, and dim in its texture.

b. Scaly. The *eiſenran* of the Germans. This is commonly found along with the iron-coloured iron glimmer, and smears the hands.

c. Crystallised, in concentric balls, with a flat or facetted surface.

(4.) Yellow bloodstone; *Hæmatites flavus*.

a. Solid.

b. Fibrous.

The varieties of the colours in the bloodstone are the same with those produced in the calces of iron made by dry or liquid menstrua and afterwards exposed to different degrees of heat.

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B. Mixed with heterogeneous substances.

A. With a calcareous earth. White spathose iron ore. The *ſtahlſtein* of the Germans.

B. With a siliceous earth. The martial jasper of Sinople.

C. With a garnet earth. Garnet and cockle or shirl.

D. With an argillaceous earth. The bole.

E. With a micaceous earth. Mica.

F. With manganese.

G. With an alkali and phlogiston. Blue martial earth. Native Prussian-like blue.

1. Loose or powdery.

H. With an unknown earth, which hardens in water. Tarras; *Cementum*.

1. Loose or granulated; *Terra Puzzolana*. This is of a reddish brown colour, is rich in iron, and is pretty fusible.
2. Indurated; *Cementum induratum*. This is of a whitish yellow colour, contains likewise a great deal of iron, and has the same quality with the former to harden soon in water when mixed with mortar. This quality cannot be owing to the iron alone, but rather to some particular modification of it occasioned by some accidental causes, because these varieties rarely happen at any other places except where volcanoes have been, or are yet, in the neighbourhood.

[3.] Dissolved or mineralised.

A. With sulphur alone.

A. Perfectly saturated; *Ferrum ſulphure ſaturatum*. Marcasite.

B. With very little sulphur. Black iron ore. Iron stone.

This is either attracted by the loadstone, or is a loadstone itself attracting iron; it resembles iron, and yields a black powder when rubbed.

1.) Magnetic iron ore. The loadstone, *Magnes*.

a. Steel-grained, of a dim texture, from Hogberget in the parish of Gagnœf in Dalarne: it is found at that place almost to the day, and is of as great strength as any natural loadstones were ever commonly found.

b. Fine grained, from Saxony.

c. Coarse-grained, from Spetalsgrufvan at Norberg, and Kierrgrufvan, both in the province of Westmanland. This loses very soon its magnetical virtue.

d. With coarse scales, found at Sandswœr in Norway. This yields a red powder when rubbed.

2.) Refractory iron ore. This in its crude state is attracted by the loadstone.

a. Giving a black powder when rubbed; *Tritura atra*. Of this kind are,

1. Steel-grained.
2. Fine grained.

3. Coarse

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3. Coarſe grained.

This kind is found in great quantities in all the Swediſh iron mines, and of this moſt part of the fuſible ores conſiſt, becauſe it is commonly found in ſuch kinds of rocks as are very fuſible; and it is as ſeldom met with in quartz as the hæmatites is met with in limeſtone.

b. Rubbing into a red powder. Theſe are real hæmatites, that are ſo far modified by ſulphur or lime as to be attracted by the loadſtone.

1. Steel-grained.
2. Fine-grained. Emery. This is imported from the Levant: it is mixed with mica, is ſtrongly attracted by the loadſtone, and ſmells of ſulphur when put to the fire.
3. Of large ſhining cubes.
4. Coarſe, ſcaly. The *eiſenglimmer* or *eiſenran.*

[4.] Mixed with various foſſile ſubſtances.

1. With ſulphur and clay; Pyrites.
2. With arſenic; called *miſpickel* by the Germans, and *plate mundic* in Cornwall.
3. With ſulphurated arſenic. Arſenical pyrites.
4. With vitriolic acid. Martial vitriol.
5. With phlogiſton. Martial coal ore.
6. With other ſulphurated and arſenicated metals. See theſe in their reſpective arrangements.

Uſes and Properties of Iron. Iron is the moſt common metal in nature, and at the ſame time the moſt uſeful in common life; notwithſtanding which, its qualities are perhaps very little known.

Iron has a particular and very ſenſible ſmell when ſtrongly rubbed or heated; and a ſtyptic taſte, which it communicates to the water in which it is extinguiſhed after ignition. Its tenacity, ductility, and malleability, are very great. It exceeds every other metal in elaſticity and hardneſs, when properly tempered. An iron wire of one-tenth of an inch thick is able to ſupport 450 pounds weight without breaking, as Wallerius aſſerts.

Iron drawn into wire as ſlender as the fineſt hairs. It is more eaſily malleable when ignited than when cold; whereas other metals, though ductile when cold, become quite brittle by heat.

It grows red-hot ſooner than other metals: nevertheleſs it melts the moſt difficultly of all, platina and manganeſe excepted. It does not tinge the flame of burning matters into bluiſh or greeniſh colours, like other imperfect metals, but brightens and whitens it; hence the filings of iron are uſed in compoſitions of fire-works, to produce what is called *white-fire.*

Iron, or rather ſteel, expands the leaſt of all hard metals by the action of heat; but braſs expands the moſt: and on this account theſe two metals are employed in the conſtruction of compound pendulums for the beſt ſort of regulating clocks for aſtronomical purpoſes.

Iron, in the act of fuſion, inſtead of continuing to expand, like the other metals, ſhrinks, as Dr Lewis obſerves; and thus becomes ſo much more denſe as to throw up ſuch part as is unmelted to the ſurface; whilſt pieces of gold, ſilver, copper, lead, and tin, put in the reſpective metals in fuſion, ſink quickly to the bottom. But in its return to a conſiſtent ſtate, inſtead of ſhrinking, like other metals, it expands; ſenſibly riſing in the veſſel, and aſſuming a convex ſurface, whilſt the others ſubſide, and appear concave. This property of iron was firſt taken notice of by Reamur, and excellently fits it for receiving impreſſions from the moulds into which it is caſt, being forced into their minuteſt cavities. Even when poured thick into the mould, it takes, nevertheleſs, a perfect impreſſion; and it is obſerved, that caſt iron is ſomewhat larger than the dimenſions of the mould, whilſt caſt figures of other metals are generally ſmaller.

The vitriolic acid diſſolves iron readily, and forms green vitriol.

This acid requires to be diluted with 304 times its quantity of water, to enable it effectually to diſſolve iron; and, during the diſſolution, a ſtrong aerial fluid ariſes, called *inflammable air*, which, on being mixed with atmoſpheric air, takes fire at the approach of the flame of a candle. A glaſs phial, of about two ounces meaſure, with one third of inflammable air, and the reſt of common air, produces a very loud report if opened in the ſame circumſtance; and if it be filled with two-thirds of inflammable air, mixed with one of dephlogiſticated air, the report will be as loud as the exploſion of a piſtol with gunpowder.

Dilute nitrous acid diſſolves iron; but this ſaline combination is incapable of cryſtalliſing. Strong nitrous acid corrodes and dephlogiſticates a conſiderable quantity of iron, which falls to the bottom.

Marine acid likewiſe diſſolves iron, and this ſolution is alſo incryſtalliſable.

The Pruſſian acid precipitates iron from its ſolutions in the form of Pruſſian blue.

This metal is likewiſe ſenſibly acted upon by alkaline and neutral liquors, and corroded even by thoſe which have no perceptible ſaline impregnation; the oils themſelves, with which iron utenſils are uſually rubbed to prevent their ruſting, often promote this effect in ſome meaſure, unleſs the oils had been previouſly boiled with litharge or calces of lead.

Galls, and other aſtringent vegetables, precipitate iron from its ſolutions, of a deep blue or purple colour, of ſo intenſe a ſhade as to appear black. It is owing to this property of iron that the common writing ink is made. The infuſion of galls, and alſo the Pruſſian alkali, are teſts of the preſence of iron by the colours they produce on any fluid. Acids, however, diſſolve the coloured precipitates by the former; and hence it ariſes that the marine acid is ſucceſsfully applied to take off ink ſpots and iron ſtains from white linens. Alkalis, however, convert theſe iron precipitates into a brown ochre.

Iron has a ſtrong affinity with ſulphur. If a bar of iron be ſtrongly ignited, and a roll of brimſtone be applied to the heated end, it will combine

bine with the iron, and form a fusible mass, which will drop down. A vessel of water ought to be placed beneath for the purpose of receiving and extinguishing it, as the fumes would otherwise be very inconvenient to the operator.

A mixture of iron-filings and sulphur in powder, moistened with water, and pressed so as to form a paste, will in a few hours swell, become hot, fume, and even burst into a flame, if the quantity is large. The residuum furnishes martial vitriol. This process is similar to the decomposition of martial pyrites; from which some philosophers account for hot spring-waters and subterraneous fires. The mixture of water in this paste seems to be necessary to enable the vitriolic acid of the sulphur to act on the iron.

For other chemical properties of this metal, see CHEMISTRY-*Index*; for its electrical and magnetic properties, see ELECTRICITY and MAGNETISM. For a more particular account of its nature and uses, and the methods of making and manufacturing it, see the articles IRON and STEEL; also METALLURGY, Part II. sect. vii. and Part III. sect. v.

Order III. SEMIMETALS.

I. Bismuth; tin-glass. *Visмutum*, *Bismutum*, *Marcasita officinalis*. It is,

a. Of a whitish yellow colour.

b. Of a laminated texture, soft under the hammer, and nevertheless very brittle.

c. It is very fusible; calcines and scorifies like lead, if not rather easier; and therefore it works on the cuppel. It is pretty volatile in the fire.

d. Its glass or slag becomes yellowish brown, and has the quality of retaining some part of the gold, if that metal has been melted, calcined, and vitrified with it.

e. It may be mixed with the other metals, except cobalt and zinc, making them white and brittle.

f. It dissolves in aquafortis, without imparting to it any colour; but to the aqua-regia it gives a red colour, and may be precipitated out of both these solutions with pure water into a white powder, which is called *Spanish white*. It is also precipitated by the acid of sea-salt; which last unites with it, and makes the *visмutum corneum*.

g. It amalgamates easily with quicksilver. Other metals are so far attenuated by the bismuth, when mixed with it, as to be strained or forced along with the quicksilver through skins or leather.

Bismuth is found in the earth.

A. Native. This resembles a regulus of bismuth, but consists of smaller scales or plates.

1. Superficial, or in crusts.
2. Solid, and composed of small cubes.

B. In form of calx.

1. Powdery or friable; *Ochra visмuti*. This is of a whitish yellow colour; it is found in form of an efflorescence.

It has been customary to give the name of *flowers of bismuth* to the pale red calx of cobalt, but it is wrong; because neither the calx of bismuth, nor its solutions, become red, this being a quality belonging to the cobalt.

C. Mineralised bismuth. This is, with respect to colour and appearance, like the coarse tessellated potter's lead ore; but it consists of very thin square plates or flakes, from which it receives a radiated appearance when broken crosswise.

1. With sulphur.
   a. With large plates or flakes.
   b. With fine or small scales.
2. With sulphurated iron.
   a. Of coarse wedge-like scales.

This mineralised bismuth ore yields a fine radiated regulus; for which reason it has been ranked among the antimonial ores by those who have not taken proper care to melt a pure regulus ore destitute of sulphur from it; while others, who make no difference between regulus and pure metals, have still more positively asserted it to be only an antimonial ore.

3. With sulphur and arsenic.
   a. Of a whitish yellow or ash colour. It has a shining appearance; and is composed of small scales or plates, intermixed very small yellow flakes: It is of a hard and solid texture: Sometimes strikes fire with hard steel: Has a disagreeable smell when rubbed: Does not effervesce with aqua-fortis; but is partially dissolved by the same acid (z).
   b. Grey, of a striated form; found at Helsingland in Sweden, and at Annaberg in Saxony.
   c. With variegated colours of red, blue, and yellow grey; found at Schneeberg in Saxony.
   d. With green fibres like an amianthus; at Misnia in Germany, and at Gillebeck in Norway.
   e. With yellow red shining particles, called *mines de bismuth Tigrees* in French, at Georgenstadt in Germany, and at Annaberg in Saxony.
   f. The *minera bismuthi arenacea*, mentioned by Wallerius and Bomare, belongs also to the same kind of the arsenicated ores.
4. By vitriolic acid. This ore is called *wismuth bluth* by the Germans. It is said to be of a yellowish, reddish, or variegated colour; and to be found mixed with the calx of bismuth, incrusting other ores. *Kirwan*, p. 334.

Uses, &c. of Bismuth. See the article BISMUTH. Also CHEMISTRY-*Index*; and METALLURGY, Part II. sect. x. and Part III. sect. viii.

II.

(z) This solution, being diluted with water, becomes a kind of sympathetic ink; as the words written with it on white paper, and dried, are not distinguished by the eye; but on being heated before the fire, they assume a yellowish colour.

SEMI-METALS. *Zinc.*

II. Zinc; ſpeltre. *Zincum.*

a. Its colour comes neareſt to that of lead, but it does not ſo eaſily tarniſh.

b. It ſhows a texture when it is broken, as if it were compounded of flat pyramids (A).

c. Its ſpecific gravity to water is as 6,900 or 7000 to 1000.

d. It melts in the fire before it has acquired a glowing heat; but when it has gained that degree of heat, it burns with a flame of a changeable colour, between blue and yellow. If in an open fire, the calx riſes in form of ſoft white flowers; but if in a covered veſſel, with the addition of ſome inflammable, it is diſtilled in a metallic form: in which operation, however, part of it is ſometimes found vitrified.

e. It unites with all the metals (B) except biſmuth and nickel, and makes them volatile. It is, however, not eaſy to unite it with iron without the addition of ſulphur. It has the ſtrongeſt attraction to gold and copper, and this laſt metal acquires a yellow colour by it; which has occaſioned many experiments to be made to produce new metallic compoſitions.

f. It is diſſolved by all the acids: of theſe the vitriolic acid has the ſtrongeſt attraction to it; yet it does not diſſolve it, if it is not previouſly diluted with much water.

g. Quickſilver amalgamates eaſier with zinc than with copper; by which means it is ſeparated from compoſitions made with copper.

h. It ſeems to become electrical by friction.

Zinc is found,

A. Native.

Zinc has been met with native, though rarely, in the form of thin and flexible filaments, of a grey colour, which were eaſily inflamed when applied to a fire. And Bomare affirms that he has ſeen many ſmall pieces of native zinc among the calamine-mines in the duchy of Limbourg and in the zinc-mines at Goſlar, where this ſemimetal was always ſurrounded by a kind of ferrugineous yellow earth, or ochraceous ſubſtances. See the detached article ZINC.

B. In form of calx.

(1.) Pure.

a. Indurated.

1. Solid
2. Cryſtalliſed.

This is of a whitiſh-grey colour, and its external appearance is like that of a lead ſpar; it cannot be deſcribed, but is eaſily known by an experienced eye.—It looks very like an artificial glaſs of zinc; and is found among other calamines at Namur and in England.

(2.) Mixed.

A. With a martial ochre.

1. Half indurated. Calamine; *Lapis calaminaris.*

a. Whitiſh yellow.

b. Reddiſh brown. This ſeems to be a mouldered or weathered blende.

B. With a martial clay or bole.

C. With a lead ochre and iron.

D. With quartz: Zeolite of Friburgh.

The real contents of this ſubſtance were firſt diſcovered by M. Pelletier. It was long taken for a true zeolite, being of a pearl colour, cryſtalliſed, and ſemitranſparent. It conſiſts of laminæ, diverging from different centres, and becoming gelatinous with acids. Its contents are 48 to 52 per cent. of quartz, 36 of calx of zinc, and 8 or 12 of water. (*Kirwan*, p. 318.)

C. Mineraliſed.

(1.) With ſulphurated iron. Blende, mock-lead, black-jack, mock-ore; *pſeudogalena* and *blende* of the Germans

A. Mineraliſed zinc in a metallic form. Zinc ore. This is of a metallic bluiſh-grey colour, neither perfectly clear as a potter's ore, nor ſo dark as the Swediſh iron ores.

1. Of a fine cubical or ſcaly texture.
2. Steel-grained.

B. In form of calx. Blende. Mock-lead; *Sterile nigrum. Pſeudo-galena* (C). This is found,

1. With courſe ſcales.

a. Yellow; ſemi-tranſparent.

b. Greeniſh.

c. Greeniſh-

(A) It cannot be reduced into powder under the hammer like other ſemimetals. When it is wanted very much divided, it muſt be granulated, by pouring it while fuſed into cold water; or filed, which is very tedious, as it ſtuffs and fi s the teeth of the file. But if heated the moſt poſſible without fuſing it, Macquer aſſerts, that it becomes ſo brittle as to be pulveriſed in a mortar.

(B) It brightens the colour of iron almoſt into a ſilver hue; changes that of copper to a yellow or gold colour, but greatly debaſes the colour of gold and deſtroys its malleability. It improves the colour and luſtre of lead and tin, rendering them firmer, and conſequently fitter for ſundry mechanic uſes. Lead will bear an equal weight of zinc, without loſing too much of its malleability.—The proceſs for giving the yellow colour to copper, by the mixture of zinc, and of its ore called *calamine*, has been deſcribed above under the *Uſes of Copper.*

(C) The varieties of pſeudo-galena, or black-jack, are in general of a lamellar or ſcaly texture, and frequently of a quadrangular form, reſembling galena. They all loſe much of their weight when heated, and burn with a blue flame; but their ſpecific gravity is conſiderably inferior to that of true galena. Almoſt all contain a mixture of lead-ore. Moſt of them exhale a ſulphureous ſmell when ſcraped; or at leaſt when vitriolic or marine acid is dropped on them.

c. Greeniſh-black; *pechblende*, or *pitch blende* of the Germans.
d. Blackiſh-brown.
2. With fine ſcales,
a. White.
b. Whitiſh-yellow.
c. Reddiſh-brown.
3. Fine and ſparkling; at Goſlar called *braun blyertz*. Its texture is generally ſcaly; ſometimes cryſtalliſed and ſemitranſparent. It gives fire with ſteel; but does not decrepitate, nor ſmoke when heated: yet it loſes about 13 *per cent.* of its weight by torrefaction.
a. Dark-brown.
b. Red, which becomes phoſphoreſcent when rubbed; found at Scharfenberg in Miſnia. (*Brunich*).
c. Greeniſh, yellowiſh-green, or red. It has different degrees of tranſparency, and is ſometimes quite opaque. When ſcraped with a knife in the dark, it emits light, even in water; and after undergoing a white heat, if it is diſtilled *per ſe*, a ſilicebus ſublimate riſes, which ſhows it contains the ſparry acid, probably united to the metal, ſince it ſublimes.
4. Of a metallic appearance; *glanz blende*.
This is of a bluiſh-grey, of a ſcaly or ſteel-grained texture, and its form generally cubical or rhomboidal. It loſes nearly one ſixth of its weight by calcination; and after calcination it is more ſoluble in the mineral acids.
100 parts of this ore afforded to Bergman about 52 of zinc, 8 of iron, 4 of copper, 26 of ſulphur, 6 of ſilex, and 4 of water.
5. Cryſtalline.
a. Dark-red, very ſcarce; found in a mine near Freyberg. Something like it is found at the Morgenſtern and Himmelsfuſte.
b. Brown. In Hungary and Tranſilvania.
c. Black. Hungary.
Theſe varieties may eaſily be miſtaken for rock cryſtals; but by experience they may be diſtinguiſhed on account of their lamellated texture and greater ſoftneſs. Their tranſparency ariſes from a very ſmall portion of iron in them.
(2.) Zinc mineraliſed by the vitriolic acid.
This ore has been already deſcribed among the middle *Salts*, at *Vitriol of zinc*.
Uſes, &c. *of zinc*. See the detached article Zinc: Alſo Chemistry-*Index*; and Metallurgy, Part II. ſect. xii. and Part III. under ſect. iii.

III. Antimony; *Antimonium Stibium*. This ſemimetal is,
a. Of a white colour almoſt like ſilver.
b. Brittle; and, in regard to its texture, it conſiſts of ſhining planes of greater length than breadth.
c. In the fire it is volatile, and volatiliſes part of the other metals along with it, except gold and platina. It may, however, in a moderate fire, be calcined into a light-grey calx, which is pretty refractory in the fire; but melts at laſt to a glaſs of a reddiſh-brown colour.
d. It diſſolves in ſpirit of ſea-ſalt and aqua regia, but is only corroded by the ſpirit of nitre into a white calx; it is precipitated out of the aqua regia by water.
e. It has an emetic quality when its calx, glaſs, or metal, is diſſolved in an acid, except when in the ſpirit of nitre, which has not this effect.
f. It amalgamates with quickſilver, if the regulus, when fuſed, is put to it; but the quickſilver ought for this purpoſe to be covered with warm water: it amalgamates with it likewiſe, if the regulus of antimony be previouſly melted with an addition of lime.
Antimony is found in the earth.
A. Native. *Regulus antimonii nativus*.
This is of a ſilver colour, and its texture is compoſed of pretty large ſhining planes.
This kind was found in Carls Ort, in the mine of Salberg, about the end of the laſt century; and ſpecimens thereof have been preſerved in collections under the name of an arſenical pyrites, until the mine-maſter Mr Von Swab diſcovered its real nature, in a treatiſe he communicated to the Royal Academy of Sciences at Stockholm in the year 1748. Among other remarkable obſervations in this treatiſe, it is ſaid, firſt, That this native antimony eaſily amalgamated with quickſilver; doubtleſs, becauſe it was imbedded in a limeſtone; ſince, according to Mr Pott's experiments, an artificial regulus of antimony may, by means of lime, be diſpoſed to an amalgamation: Secondly, That when brought in form of a calx, it ſhot into cryſtals during the cooling.
B. Mineraliſed antimony.
(1.) With ſulphur.
This is commonly of a radiated texture, compoſed of long wedge-like flakes or plates; it is nearly of a lead-colour, and rough to the touch.
a. Of coarſe fibres.
b. Of ſmall fibres.
c. Steel-grained, from Saxony and Hungary.
d. Cryſtalliſed, from Hungary.
1. Of a priſmatical, or of a pointed pyramidal figure, in which laſt circumſtance the points are concentrical.
Cronſtedt mentions a ſpecimen of this, in which the cryſtals were covered with very minute cryſtals or quartz, except at the extremities, where there was always a little hole: this ſpecimen was given for a *flos ferri* ſpar.
(2.) With ſulphur and arſenic. Red antimony ore; *Antimonium ſolare*.
This is of a red colour, and has the ſame texture with the preceding, though its fibres are not ſo courſe.

a. With ſmall fibres.
b. With abrupt broken fibres, from Braunſdorff in Saxony, and from Hungary.

All antimonial ores are ſomewhat arſenical, but this is more ſo than the preceding kinds.

(3.) With ſulphurated ſilver. Plumoſe ſilver-ore, or *federertz* of the Germans.
(4.) With ſulphurated ſilver, copper, and arſenic; the *dal fahl-ertz* of the Germans.
(5.) With ſulphurated lead; radiated lead-ore.
(6.) By the aerial acid.

This ore was lately diſcovered by Mongez, among thoſe of native antimony from the mine of Chalanges in Dauphiny. It conſiſts of a group of white cryſtalliſed filaments of a needle-form appearance, diverging from a common centre, like zeolite. They are inſoluble in nitrous acid; and, on being urged by the flame of a blow-pipe, upon a piece of charcoal, they are diſſipated into white fumes, or antimonial flowers, without any ſmell of arſenic; from whence it follows, that theſe needle-formed cryſtals are a pure calx of antimony, formed by its combination with, or mineraliſed by, the aerial acid. See *Kirwan*, p. 325, and *Journal de Phyſique* for July 1787, p. 67.

Uſes, &c. By the name of *antimony* is commonly underſtood the crude antimony (which is compounded of the metallic part and ſulphur) as it melted out of the ore; and by the name of *regulus*, the pure ſemimetal.

1. Though the regulus of antimony is a metallic ſubſtance, of a conſiderably bright white colour, and has the ſplendor, opacity, and gravity of a metal, yet it is quite unmalleable, and falls into powder inſtead of yielding or expanding under the hammer; on which account it is claſſed among the ſemimetals.
2. Regulus of antimony is uſed in various metallic mixtures, as for printing types, metallic ſpeculums, &c. and it enters into the beſt ſort of pewter ware.
3. It mixes with, and diſſolves various metals; in particular it affects iron the moſt powerfully; and, what is very remarkable, when mixed together, the iron is prevented from being attracted by the loadſtone.
4. It affects copper next, then tin, lead, and ſilver; promoting their fuſion, and rendering them all brittle and unmalleable: but it will neither unite with gold nor mercury; though it may be made to combine with this laſt by the interpoſition of ſulphur. In this caſe it reſembles the common Æthiops, and is thence called *antimonial Æthiops*.
5. Regulus of antimony readily unites with ſulphur, and forms a compound of a very faint metallic ſplendor: it aſſumes the form of long needles adhering together laterally: it uſually formed naturally alſo in this ſhape. This is called *crude antimony*.
6. But though antimony has a conſiderable affinity to ſulphur; yet all the metals, except gold and mercury, have a greater affinity to that compound. If therefore iron, copper, lead, ſilver, or tin, be melted with antimony, the ſulphur will unite with the metal, and be ſeparated from the regulus, which, however, takes up ſome part of the metal, for which reaſon it is called *martial regulus*, *regulus veneris*, &c.
7. When gold is mixed, or debaſed by the mixture of other metals, it may be fuſed with antimony; for the ſulphur combines with the baſe metals, which, being the lighter, riſe up into ſcoria, while the regulus remains united at the bottom with the gold; which being urged by a ſtronger degree of heat, is freed from the ſemimetal, which is very volatile. This method of refining gold is the eaſieſt of all.
8. But the moſt numerous purpoſes to which this metal has been applied are thoſe of the chemical and pharmaceutical preparations. Lemery, in his Treatiſe on Antimony, deſcribes no leſs than 200 proceſſes and formulæ; among which there are many good and many uſeleſs ones. The following deſerve to be mentioned on account of their utility.
9. Antimony melts as ſoon as it is moderately red hot, but cannot ſuſtain a violent degree of fire, as it is thereby diſſipated into ſmoke and white vapours, which adhere to ſuch cold bodies as they meet with, and are collected into a kind of farina or powder, called *flowers of antimony*.
10. If it be only moderately heated, in very ſmall pieces, ſo as not to melt, it becomes calcined into a greyiſh powder deſtitute of all ſplendor, called *calx of antimony*. This calx is capable of enduring the moſt violent fire; but at laſt it will run into a glaſs of a reddiſh-yellow colour, ſimilar to that of the hyacinth. The infuſion made of this coloured antimonial glaſs, in acidulous wine (ſuch as that of Bourdeaux) for the ſpace of 5 or 6 hours, is a very violent emetic.
11. If equal parts of nitre and regulus of antimony be deflagrated over the fire, the grey calx which remains is called *liver of antimony*.
12. If regulus of antimony be melted with two parts of fixed alkali, a maſs of a reddiſh-yellow colour is produced, which being diſſolved in water, and any acid being afterwards added, a precipitate is formed of the ſame colour, called *golden ſulphur of antimony*.
13. Fixed nitre, viz. the alkaline ſalt that remains after the deflagration of nitre, being boiled with ſmall pieces of regulus of antimony, the ſolution becomes reddiſh; and, on cooling, depoſits the antimony in the form of a red powder, called *mineral kermes*.
14. Equal parts of the glaſs, and of the liver of antimony, well pulveriſed and mixed with an equal quantity of pulveriſed cream of tartar, being put into as much water as will diſſolve the cream of tartar, and boiled for 12 hours, adding now and then ſome hot water to replace what is evaporated, the whole is to be filtered while hot; then being evaporated to dryneſs, the ſaline matter that remains is the emetic tartar.
15. The regulus of antimony being pulveriſed, and diſtilled

Semi-metals. *Antimony.*

distilled with corrosive sublimate of mercury, a thick white matter is produced, which is extremely corrosive, and is called *butter of antimony*. This thick substance may be rendered limpid and fluid by repeated distillations.

16. On mixing the nitrous acid with this butter of antimony, a kind of aqua regia is distilled, called *bezoardic spirit of nitre*.

17. The white matter that remains from this last distillation may be redistilled with fresh nitrous acid; and the remainder being washed with water, is called *bezoar mineral*, which is neither so volatile nor so caustic as the antimonial butter. This butter being mixed with water, a precipitate falls to the bottom, which is very improperly called *mercurius vitæ*, for it is in fact a very violent emetic.

18. But if, instead of the regulus, crude antimony be employed, and the same operation be performed, the reguline part separates from the sulphur, unites to the mercury, and produces the substance which is called *cinnabar of antimony*.

19. Crude antimony being projected in a crucible, in which an equal quantity of nitre is fused, detonates; is calcined, and forms a compound called by the French *fondant de Retrou*, or *antimoine diaphoretique non lavé*. This being dissolved in hot water, falls to the bottom after it is cold; and after decantation is known, when dry, by the name of *diaphoretic antimony*. This preparation excites animal perspiration, and is a good sudorific. The same preparation may be more expeditiously made by one part of antimony with two and a half of nitre, mixed together and deflagrated: the residue of which is the mere calx of antimony, void of all emetic power.

20. And if the detonation be performed in a tubulated retort, having a large receiver, containing some water adapted to it, both a clyssus of antimony and the antimonial flowers may be obtained at the same time, as Neumann asserts.

21. When nitre is deflagrated with antimony over the fire, the alkaline basis of the nitre unites with the calx of the semimetal, which may be separated by an acid, and is called *materia perlata*. See farther the article Antimony; also Metallurgy, Part II. sect. ix.

IV. Arsenic. In its metallic form, is,

a. Nearly of the same colour as lead, but brittle, and changes sooner its shining colour in the air, first to yellow, and afterwards to black.

b. It appears laminated in its fractures, or where broken.

c. Is very volatile in the fire, burns with a small flame, and gives a very disagreeable smell like garlic.

d. It is, by reason of its volatility, very difficult to be reduced, unless it is mixed with other metals: However, a regulus may be got from the white arsenic, if it is quickly melted with equal parts of pot ashes and soap; but this regulus contains generally some cobalt, most of the white arsenic being produced from the cobalt ores during their calcination. The white arsenic, mixed with a phlogiston, sublimes likewise into octoedral crystals of a metallic appearance, whose specific gravity is 8,308.

Semi-metals. *Arsenic.*

e. The calx of arsenic, which always, on account of its volatility, must be got as a sublimation, is white, and easily melts to a glass, whose specific gravity is 5,000. When sulphur is blended in this calx, it becomes of a yellow, orange, or red colour; and according to the degrees of colour is called *orpiment* or yellow arsenic; *sandarach*, *realgar*, or red arsenic; and also *rubinus arsenici*.

f. This calx and glass are dissoluble in water, and in all liquids; though not in all with the same facility. In this circumstance arsenic resembles the salts; for which reason it also might be ranked in that class.

g. The regulus of arsenic dissolves in spirit of nitre; but as it is very difficult to have it perfectly free from other metals, it is yet very little examined in various menstrua.

h. It is poisonous, especially in form of a pure calx or glass: But probably it is less dangerous when mixed with sulphur, since it is proved by experience, that the men at mineral works are not so much affected by the smoke of this mixture as by the smoke of lead, and that some nations make use of the red arsenic in small doses as a medicine.

i. It unites with all metals, and is likewise much used by nature itself to dissolve, or, as we term it, to *mineralise*, the metals, to which its volatility and dissolubility in water must greatly contribute. It is likewise most generally mixed with sulphur.

k. It absorbs or expels the phlogiston, which has coloured glasses, if mixed with them in the fire.

Arsenic is found,

[1.] Native; called *Scherbencobolt* and *Fliegenstein* by the Germans.

It is of a lead colour when fresh broken, and may be cut with a knife, like black lead, but soon blackens in the air. It burns with a small flame, and goes off in smoke.

A. Solid and testaceous; *Scherbencobolt*.

B. Scaly.

C. Friable and porous; *Fliegenstein*.

(1.) With shining fissures.

This is by some called *Spigel cobolt*.

[2.] In form of a calx.

A. Pure, or free from heterogeneous substances.

1. Loose or powdery.
2. Indurated, or hardened. This is found in form of white semi-transparent crystals.

B. Mixed.

A. With sulphur.

1. Hardened.

a. Yellow. Orpiment; *Auripigmentum*.

b. Red. Native realgar, or sandarach.

B. With the calx of tin, in the tin-grains.

C. With sulphur and silver; in the *rothgulden* or red silver ore.

D. With calx of lead, in the lead-spar.

E. With calx of cobalt, in the efflorescence of cobalt.

SEMI-METALS. *Cobalt.*

[3.] Mineraliſed.

A. With ſulphur and iron. Arſenical pyrites or marcaſite. Theſe kinds in Cornwall are called *ſilvery* or *white mundics* and *plate mundics*.

This alone produces red arſenic when calcined. It is of a deeper colour than the following.

B. With iron only. This differs with regard to its particles; being,

1. Steel-grained.
2. Coarſe-grained.
3. Cryſtalliſed.
   a. In an octoedral figure. This is the moſt common kind.
   b. Priſmatical. The ſulphureous marcaſite is added to this kind when red arſenic is to be made; but in Sweden it is ſcarcer than the ſulphureous arſenical pyrites.

C. With cobalt, almoſt in all cobalt ores.

D. With ſilver. } See under *Silver*, *Copper*, and *Antimony*, *ſupra*.
E. With copper. }
F. With antimony. }

For the *Uſes of Arſenic*, ſee the detached article ARSENIC, and CHEMISTRY-*Index*; alſo METALLURGY, Part II. ſect. xiii. and Part III. ſect. viii.

V. Cobalt.

This ſemimetal is,

a. Of a whitiſh grey colour, nearly as fine-tempered ſteel.
b. Is hard and brittle, and of a fine-grained texture; hence it is of a duſky, or not ſhining appearance.
c. Its ſpecific gravity to water is 6000 to 1000.
d. It is fixed in the fire, and becomes black by calcination: it then gives to glaſſes a blue colour, inclining a little to violet, which colour, of all others, is the moſt fixed in fire.
e. The concentrated oil of vitriol, aquafortis, and aqua-regia, diſſolve it; and the ſolutions become red. The cobalt calx is likewiſe diſſolved by the ſame menſtrua, and alſo by the volatile alkali and the ſpirit of ſea-ſalt.
f. When united with the calx of arſenic in a ſlow (not a briſk) calcining heat, it aſſumes a red colour: the ſame colour is naturally produced by way of efflorescence, and is then called the *bloom* or *flowers of cobalt*. When cobalt and arſenic are melted together in an open fire, they produce a blue flame.
g. It does not amalgamate with quikſilver by any means hitherto known.
h. Nor does it mix with biſmuth, when melted with it, without addition of ſome medium to promote their union.

[1.] Native cobalt. Cobalt with arſenic and iron in a metallic form.

Pure native cobalt has not yet been found: that which paſſes for ſuch, according to Kirwan, is mineraliſed by arſenic. Bergman, however, in his Sciagraphia, has entered this preſent ore under the denomination of *native cobalt*: and certain it is, that among all the cobaltic ores, this is the neareſt to the native ſtate of this ſemimetal. It always contains a ſmall quantity of iron, beſides the arſenic, by which it is mineraliſed. SEMI-METALS. *Cobalt.*

This is of a dim colour when broken, and not unlike ſteel. It is found,

a. Steel-grained, from Loos in the pariſh of Farila in the province of Helſingeland, and Schneeberg in Saxony.
b. Fine-grained, from Loos.
c. Coarſe-grained.
d. Cryſtalliſed:
1. In a dendritical or arboreſcent form;
2. Polyhedral, with ſhining ſurfaces;
3. In radiated nodules.

[2.] Calciform cobalt. Cobalt is moſt commonly found in the earth mixed with iron.

A. In form of a calx.

1.) With iron without arſenic.
   a. Looſe or friable; cobalt ochre. This is black, and reſembles the artificial zaffre.
   b. Indurated: *Minera cobalti vitrea.* The ſchlacken or ſlag cobalt. This is likewiſe of a black colour, but of a glaſſy texture, and ſeems to have loſt that ſubſtance which mineraliſed it, by being decayed or weathered.

2.) With arſenical acid; cobalt-blut, Germ. *Ochra cobalti rubra*; bloom, flowers, or efflorescence of cobalt.
   a. Looſe or friable. This is often found of a red colour like other earths, ſpread very thin on the cobalt ores; and is, when of a pale colour, erroneouſly called *flowers of biſmuth*.
   b. Indurated. This is commonly cryſtalliſed in form of deep red ſemitranſparent rays or radiations: It is found at Schneeberg in Saxony.

B. Mineraliſed.

1.) With ſulphurated iron.

This ore is of a light colour, nearly reſembling tin or ſilver. It is found cryſtalliſed in a polygonal form.
   a. Of a ſlaggy texture.
   b. Coarſe-grained.

This ore is found in Baſtnaſgrufva at Raddarſhyttan in Weſtmanland, and diſcovers not the leaſt mark of arſenic. The coarſe-grained becomes ſlimy in the fire, and ſticks to the ſtirring hook during the calcination in the ſame manner as many regules do: It is a kind of regule prepared by nature. Both theſe give a beautiful colour.

2.) With ſulphur, arſenic, and iron. This reſembles the arſenicated cobalt ore, being only rather of a whiter or lighter colour. It is found,
   a. Coarſe-grained.
   b. Cryſtalliſed;
      1. In a polygonal figure, with ſhining ſurfaces, or *glanzkobolt*. It is partly of a white or light colour, and partly of a ſomewhat reddiſh yellow.

3.) With

Semi-metals. *Nickel.*

3.) With ſulphurated and arſenicated nickel and iron; ſee *Kupfer-nickel*, below.

Uſes, &c. See the article COBALT. See alſo CHEMISTRY-*Index*; and METALLURGY, Part II. ſect. xi.

VI. Nickel; *Niccolum*. This is the lateſt diſcovered ſemimetal. It was firſt deſcribed by its diſcoverer Mr Cronſtedt, in the Acts of the Royal Academy of Sciences at Stockholm for the years 1751 and 1754, where it is ſaid to have the following qualities:

1. It is of a white colour, which, however, inclines ſomewhat to red.
2. Of a ſolid texture, and ſhining in its fractures.
3. Its ſpecific gravity to water is as 8,500 to 1000.
4. It is pretty fixed in the fire; but, together with the ſulphur and arſenic, with which its ore abounds, it is ſo far volatile as to riſe in form of hairs and branches, if in the calcination it is left without being ſtirred.
5. It calcines to a green calx.
6. The calx is not very fuſible, but, however, tinges glaſs of a tranſparent reddiſh-brown or jacinth colour.
7. It diſſolves in aquafortis, aqua-regia, and the ſpirit of ſea-ſalt; but more difficultly in the vitriolic acid, tinging all theſe ſolutions of a deep green colour. Its vitriol is of the ſame colour; but the colcothar of this vitriol, as well as the precipitates from the ſolutions, become by calcination of a light green colour.
8. Theſe precipitates are diſſolved by the ſpirit of ſal ammoniac, and the ſolution has a blue colour; but being evaporated, and the ſediment reduced, there is no copper, but a nickel regulus is produced.
9. It has a ſtrong attraction to ſulphur; ſo that when its calx is mixed with it, and put on a ſcorifying teſt under the muffel, it forms with the ſulphur a regule: this regule reſembles the yellow ſteel-grained copper-ores, and is hard and ſhining in its convex ſurface.
10. It unites with all the metals, except quickſilver and ſilver. When the nickel regulus is melted with the latter, it only adheres cloſe to it, both the metals lying near one another on the ſame plane; but they are eaſily ſeparated with a hammer. Cobalt has the ſtrongeſt attraction to nickel, after that to iron, and then to arſenic. The two former cannot be ſeparated from one another but by their ſcorification; which is eaſily done, ſince,
11. This ſemimetal retains its phlogiſton a long time in the fire, and its calx is reduced by the help of a very ſmall portion of inflammable matter: it requires, however, a red heat before it can be brought into fuſion, and melts a little ſooner, or almoſt as ſoon, as copper or gold, conſequently ſooner than iron.

Nickel is found,

A. Native.

This is mentioned by Mr Rinman to have been lately met with in a mine of cobalt in Heſſe. It is very heavy, and of a liver colour, that is, dark red. When pulveriſed and roaſted under a muffle, it forms green excreſcences, and ſmokes; but its ſmoke has no particular ſmell: and no ſublimate, whether ſulphureous or arſenical, can be caught. It is ſoluble in acids, and the ſolution is green; but a poliſhed iron plate diſcovers no copper.

Semi-metals. *Manganeſe.*

B. In form of a calx. Nickel ochre, aerated nickel.

1. Mixed with the calx of iron. This is green, and is found in form of flowers on kupfer-nickel.

C. Mineraliſed.

1. With ſulphurated and arſenicated iron and cobalt; *Kupfernickel*. This is of a reddiſh yellow colour; and is found,
   a. Of a ſlaggy texture.
   b. Fine-grained; and
   c. Scaly. Theſe two are often from their colour confounded with the liver-coloured marcaſite.
2. With the acid of vitriol. This is of a beautiful green colour, and may be extracted out of the nickel ochre, or efflorescence of the Kupfernickel.

For a full account of this ſemimetal, ſee the article NICKEL, and CHEMISTRY-*Index*.

VII. Manganeſe. *Manganeſium*.

The ores of this kind are in Swediſh called *brunſten*; in Latin *ſydereæ*, or *magneſiæ nigræ*, in order to diſtinguiſh them from the *magneſia alba officinalis*; and in French *manganeſe*, &c.

1. Manganeſe conſiſts of a ſubſtance which gives a colour both to glaſſes and to the ſolutions of ſalts, or, which is the ſame thing, both to dry and to liquid menſtrua, viz.
   a. Borax, which has diſſolved manganeſe in the fire, becomes tranſparent, of a reddiſh brown or hyacinth colour.
   b. The microcoſmic ſalt becomes tranſparent with it, of a crimſon colour, and moulders in the air.
   c. With the fixed alkali, in compoſitions of glaſs, it becomes violet; but if a great quantity of manganeſe is added, the glaſs is in thick lumps, and looks black.
   d. When ſcorified with lead, the glaſs obtains a reddiſh brown colour.
   e. The lixivium of deflagrated manganeſe is of a deep red colour.
2. It deflagrates with nitre, which is a proof that it contains ſome phlogiſton.
3. When reckoned to be light, it weighs as much as an iron ore of the ſame texture.
4. When melted together with vitreous compoſitions, it ferments during the ſolution: but it ferments in a ſtill greater degree when it is melted with the microcoſmic ſalt.
5. It does not excite any effervescence with the nitrous acid: aqua-regia, however, extracts the colour out of the black manganeſe, and diſſolves likewiſe a great portion of it, which by means of an alkali is precipitated to a white powder.

6. Such

Semi-metals. *Molybdena.*

6. Such colours as are communicated to glaſſes by manganeſe, are eaſily deſtroyed by the calx of arſenic or tin: they alſo vaniſh of themſelves in the fire.
7. It is commonly of a looſe texture, ſo as to colour the fingers like ſoot, though it is of a metallic appearance when broken.

Manganeſe is found,

[1.] Native; of the diſcovery and qualities of which, an account is given under the article MANGANESE in its alphabetieal order. See alſo CHEMISTRY-*Index*.

[2.] Calciform.

A. Looſe and friable.

a. Black; which ſeems to be weathered or decayed particles of the indurated kind.

B. Indurated.

1.) Pure, in form of balls, whoſe texture conſiſts of concentric fibres. *Pura ſphærica radiis concentratis.*

a. White; very ſcarce.

2.) Mixed with a ſmall quantity of iron.

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

1. Solid, of a flaggy texture.
2. Steel-grained.
3. Radiated.
4. Cryſtalliſed, in form of coherent hemiſpheres.

VIII. Molybdena.

A. Lamellar and ſhining, its colour ſimilar to that of the potter's lead ore.

This ſubſtance reſembles plumbago or black-lead; and has long been confounded with it, even by Cronſtedt. But it poſſeſſes very different properties; in particular,

1. Its laminæ are larger, brighter: and, when thin, ſlightly flexible. They are of an hexagonal figure.
2. It is of a lead colour, and does not ſtrike fire with hard ſteel.
3. Its ſpecific gravity is = 4,569, according to Kirwan; and 4,7385, according to Briſſon.
4. When rubbed on white papper, it leaves traces of a dark brown or bluiſh colour, as the plumbago or black lead does; but they are rather of an argentine gloſs; by which circumſtance the molybdena, according to Dr d'Arcet, may be eaſily diſtinguiſhed from black-lead, as the traces made by this laſt are of leſs brilliant, and of a deeper tinge.
5. In an open fire, it is almoſt entirely volatile and infuſible. Microcoſmic ſalt or borax ſcarcely affect it; but it is acted upon with much efferveſcence by mineral alkali, and forms with it a reddiſh maſs, which ſmells of ſulphur.
6. It conſiſts of an acid of peculiar nature (ſee CHEMISTRY-*Index*.) united to ſulphur. A ſmall proportion of iron is commonly found in it, but this ſeems merely fortuitous: 100 parts of molybdena contain about 45 of this acid and 55 of ſulphur.
7. It is decompoſed either by detonation with nitre, or by ſolution in nitrous acid.

Semi-metals. *Wolfram.*

8. This acid is ſoluble in 570 times its weight of water in the temperature of 60; the ſolution reddens that of litmus, precipitates ſulphur from the ſolution of liver of ſulphur, &c. The ſpecific gravity of the dry acid is 3,460.
9. This acid is precipitable from its ſolution in water by the Pruſſian alkali, and alſo by tincture of galls: the precipitate is reddiſh brown.
10. If this acid be diſtilled with three times its weight of ſulphur, it reproduces molybdena.
11. The ſolution of this acid in water unites to fixed alkalies, and forms cryſtalliſable ſalts; as it alſo does with calcareous earth, magneſia, and argil: theſe laſt combinations are difficultly ſoluble. It acts alſo on the baſe metals, and with them aſſumes a bluiſh colour.
12. This ſolution procipitates ſilver, mercury, or lead, from the nitrous acid, and lead from the marine, but not mercury.
13. It alſo precipitates barytes from the nitrous and marine acids, but no other earth. Molybdenous baroſelenite is ſoluble in cold water.
14. This acid is itſelf ſoluble in the vitriolic acid by the aſſiſtance of heat; and the ſolution is blue when cold, though colourleſs while hot; it is alſo ſoluble in the marine acid, but not in the nitrous.
15. Molybdena tartar and ammoniac precipitate all metals from their ſolutions by a double affinity. Gold, ſublimate corroſive, zinc, and manganeſe, are precipitated white; iron or tin, from the marine acid, brown; cobalt, red; copper, blue; alum and calcareous earth, white.
16. This acid has been lately reduced by Mr Hielm; but the properties of the regulus thus obtained are not yet publiſhed.
17. Mr Pelletier obtained alſo the regulus or molybdena, by mixing its powder with oil into a paſte, and expoſing it with powdered charcoal in a crucible to a very violent fire for two hours. See CHEMISTRY-*Index*, n° 14, 97.
18. This ſemimetal being urged by a ſtrong fire for an hour, produces a kind of ſilvery flowers, like thoſe of antimony.
19. Molybdena is ſaid to be ſoluble in melted ſulphur; which ſeems highly probable, as ſulphur is one of its component parts.

See farther the article MOLYBDENA, and CHEMISTRY-*Index*.

IX. Wolfram. *Wolfranum, Spuma Lupi*, Lat. See the detached article WOLFRAM.

This mineral has the appearance of manganeſe, blended with a ſmall quantity of iron and tin.

1. With coarſe fibres.

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

X. Siderite. } See thoſe words in the order of the
XI. Saturnite. } alphabet.

Appendix. Saxa.

APPENDIX.

Of Saxa and Petrifactions.

THOUGH the *Saxa*, and foſſils commonly called *Petrifactions*, cannot, in ſtrictneſs, be ranked in a mineral ſyſtem, for the reaſons formerly given; yet as theſe bodies, eſpecially the latter, occupy ſo conſiderable a place in moſt mineral collections, and the former muſt neceſſarily be taken notice of by the miners in the obſervations they make in ſubterranean geography, it appeared proper to ſubjoin them in ſuch an order as might anſwer the purpoſe for which they are regarded by miners and mineralogiſts.

Order I. Saxa. *Petræ.*

Theſe may be divided into two kinds.

1. Compound ſaxa, are ſtones whoſe particles, conſiſting of different ſubſtances, are ſo exactly fitted and joined together, that no empty ſpace, or even cement, can be perceived between them; which ſeems to indicate, that ſome, if not all, of theſe ſubſtances have been ſoft at the inſtant of their union.

2. Conglutinated ſtones, are ſtones whoſe particles have been united by ſome cementitious ſubſtance, which, however, is ſeldom perceivable, and which often has not been ſufficient to fill every ſpace between the particles: in this caſe the particles ſeem to have been hard, worn off, and in looſe, ſingle, unfigured pieces, before they were united.

I. Compound ſaxa.

A. Ophites. Scaly limeſtone with kernels or bits of ſerpentine ſtone in it.

1. *Kolmord marble.* It is white and green.
2. *Serpentino antico*, is white, with round pieces of black ſteatites in it. This muſt not be confounded with the *ſerpentino verde antico.*
3. The *Haraldſio marble.* White, with quadrangular pieces of a black ſteatites.
4. The *marmor pozzevera di Genova.* Dark green marble, with white veins. This kind receives its fine poliſh and appearance from the ſerpentine ſtone.

B. Stellſten or *geſtelſtein.* Granitello.

1. Of diſtinct particles. In ſome of theſe the quartzoſe particles predominate, and in others the micaceous: in the laſt caſe it is commonly ſlaty, and eaſy to ſplit.
2. Of particles which are wrapt up in one another.
   a. Whitiſh grey.
   b. Greeniſh.
   c. Reddiſh.

C. Norrka. Murkſten of the Swedes. *Saxum compoſitum mica, quartzo, et granato.* Saxum Appendix. Saxa.

1. With diſtinct garnets or ſhirl.
   a. Light grey.
   b. Dark grey.
   c. Dark grey, with priſmatical, radiated, or fibrous cockle or ſhirl.
2. With kernels of garnet-ſtone.
   a. Of pale red garnet ſtone.

The firſt of this kind, whoſe ſlaty ſtrata makes it commonly eaſy to be ſplit, is employed for mill-ſtones, which may without difficulty be accompliſhed, if ſand is firſt ground with them; becauſe the ſand wearing away the micaceous particles on the ſurfaces, and leaving the garnets predominent, renders the ſtone fitter for grinding the corn.

D. The whetſtone, *Cos. Saxum compoſitum mica, quartzo, et forſan argilla martiali in nonnullis ſpeciebus.*

1. Of coarſe particles.
   a. White.
   b. Light grey.
2. Of fine particles.
   a. Liver brown colour.
   b. Blackiſh grey.
   c. Light grey.
   d. Black. The table-ſlate, or that kind uſed for large tables and for ſchool ſlates.
3. Of very minute and cloſely combined particles. The Turkey-ſtone *. This is of an olive colour, and ſeems to be the fineſt mixture of the firſt ſpecies of this genus. The beſt of this ſort come from the Levant, and are pretty dear. The whetſtone kinds, when they ſplit eaſily and in thin plates, are very fit to cover houſes with, though moſt of them are without thoſe properties.

* See V. (p. 86. col. 1.)

F. Porphyry; *Porphyrites.* Italorum *porfido. Saxum compoſitum jaſpide et feltſpato, interdum mica et baſalte* (D). See the article Porphyry.

a. Its colour is green, with light-green feltſpat, *Serpentino verde antico.* It is ſaid to have been brought from Egypt to Rome, from which latter place the ſpecimens of it now come.
b. Deep red, with white feltſpat.
c. Black, with white and red feltſpat.
d. Reddiſh brown, with light red and white feltſpat.
e. Dark grey, with white grains of feltſpat alſo. The dark red porphyry has been moſt employed for ornaments in building; yet it is not the only one known by the name

(D) Great part of the hill of Bineves in Lochaber is compoſed of a kind of porphyry. It is remarkably fine, beautiful, and of an elegant reddiſh colour; "in which (ſays Mr Williams) the pale roſe, the bluſh, and the yellowiſh white colours, are finely blended and ſhaded through the body of the ſtone; which is of a jelly-like texture, and is undoubtedly one of the fineſt and moſt elegant ſtones in the world. On this hill alſo is found a kind of porphyry of a greeniſh colour, with a tinge of browniſh red. It is ſmooth, compact, and heavy; of a cloſe uniform texture, but has no brightneſs when broken. It has angular ſpecks in it of a white quartzy ſubſtance."

name of *porfido*, the Italians applying the ſame name alſo to the black kind.

G. The *trapp* of the Swedes. *Saxum compoſitum jaſpide martiali molli, ſeu argilla martiali indurata.* See the article TRAPP.

This kind of ſtone ſometimes conſtitutes or forms whole mountains; as, for example, the mountain called *Hunneberg* in the province of Weſtergotland, and at Drammen in Norway; but it is oftener found in form of veins in mountains of another kind, running commonly in a ſerpentine manner, contrary or acroſs to the direction of the rock itſelf. It is not homogeneous, as may be plainly ſeen at thoſe places where it is not preſſed cloſe together; but where it is preſſed cloſe, it ſeems to be perfectly free from heterogeneous ſubſtances.—When this kind is very coarſe, it is interſperſed with feltſpat; but it is not known if the finer ſorts likewiſe contain any of it. Beſides this, there are alſo ſome fibrous particles in it, and ſomething that reſembles a calcareous ſpar; this, however, does not ferment with acids, but melts as eaſy as the ſtone itſelf, which becomes a black ſolid glaſs in the fire. By calcination it becomes red, and yields in aſſays 12 or more *per cent.* of iron. No other ſort of ore is to be found in it, unleſs now and then ſomewhat merely ſuperficial lies in its fiſſures; for this ſtone is commonly, even to a great depth in the rock, cracked in acute angles, or in form of large rhomboidal dice. It is employed at the glaſs-houſes, and added to the compoſition of which bottles are made. In the air it decays a little, leaving a powder of a brown colour; it cracks commonly in the fire, and becomes reddiſh brown if made red-hot. It is found,

1. Of coarſe chaffy particles.
   a. Dark grey.
   b. Black.
2. Coarſe-grained.
   a. Dark grey.
   b. Reddiſh.
   c. Deep brown.
3. Of fine imperceptible particles.
   a. Black. The touchſtone; *Lapis lydius.*
   b. Bluiſh.
   c. Grey.
   d. Reddiſh.

The black variety (3. *a.*) is ſometimes found ſo compact and hard, as to take a poliſh like the black agate: it melts, however, in the fire to a black glaſs; and is, when calcined, attracted by the load-ſtone.

H. Amygdaloides. The carpolithi or fruit-ſtone rocks of the Germans.

It is a martial jaſper, in which elliptical kernels of calcareous ſpar and ſerpentine ſtone are included.

a. Red, with kernels of white limeſtone, and of a green ſteatites. This is of a particular appearance, and when calcined is attracted by the loadſtone; it decays pretty much in the air, and has ſome affinity with the trapp, and alſo with the porphyry. There are ſometimes found pieces of native copper in this ſtone.

I. The *grønſten* of the Swedes.

Its baſis is horneblende, interſperſed with mica. It is of a dark green colour, and in Smoland is employed in the iron furnaces as a flux to the bog-ore.

K. The granite. *Saxum compoſitum feltſpata, mica et quartzo, quibus accidentaliter interdum horneblende ſteatites, granatus et baſaltes immixti ſunt.* Its principal conſtituent parts are felt-ſpat, or rhombic quartz, mica, and quartz. See the article GRANITE.

It is found,

(1.) Looſe or friable. This is uſed at the Swediſh braſs-works to caſt the braſs in, and comes from France.

(2.) Hard and compact.
   a. Red.
      1. Fine-grained;
      2. Coarſe-grained.
   b. Grey, with many and various colours (E).

II. Con-

(E) Mr Wiegleb has analyſed a ſpecies of green granite found in Saxony. The cryſtals are heaped together, and form very compact layers; the colour ſometimes an olive green, ſometimes reſembling a pear, and ſometimes of a reddiſh brown; ſome of them being perfectly tranſparent, and others nearly ſo. According to Mr Warren, they contain 25 per cent. of iron; whence they have been called green ore of iron. An ounce of theſe cryſtals heated red hot in a crucible loſt two grains in weight, and became of the colour of honey. The remainder was put into a retort, and diſtilled with marine acid, with which it evidently effervesced. The reſiduum was lixiviated with diſtilled water, freſh muriatic acid added, and the diſtillation and lixiviation repeated. The iron precipitated from this lixivium, and reduced partly to its metallic ſtate, weighed two drachms. M. Wiegleb concludes, that the ſpecimen contained two drams 26½ grains of lime. From further experiments he concludes, that 100 parts of the ſubſtance contained 36.5 of ſiliceous earth; lime 30.8; iron 28.7; and water and fixed air 4.0.

Scotland is remarkable for a great number of excellent granites, little or nothing inferior to porphyry. Of theſe the following kinds are mentioned by Mr Williams.

1. The grey granite, or *moor-ſtone* as it is called in Cornwall, is very common in this country. In ſome places it ſhows no marks of ſtrata; and in others it is diſpoſed in thick unwieldy irregular beds, which are commonly broken tranſverſely into huge maſſes or blocks of various ſizes and ſhapes. There is a great variety in this kind of ſtones; ſome of them differing but little in appearance from baſaltes; others are compoſed of almoſt equal parts of black and white grains, about the ſize of ſmall peaſe, whence it is called *peaſy whin* by

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II. Conglutinated saxa.

A. Of larger or broken pieces of stones of the same kinds conglutinated together. *Breccia.*

1. Of limestone cemented by lime.

a. Calcareous breccia; the *marmi brecciati* of the Italians.

When these kinds have fine colours, they are polished and employed for ornaments in architecture and other œconomical uses.

b. The *lumachella* of the Italians, or shell marbles. These are a compound of shells and corals, which are petrified or changed into lime, and conglutinated with a calcareous substance. When they have many colours, they

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the common people. In Galloway and other places it frequently has a longitudinal grain, as if the component parts had been all moved one way by a gentle flow of water. When this kind of granite begins to undergo a spontaneous decomposition by exposure to the atmosphere, we observe that it is composed of pretty large grains of the figures of cubes, rhomboids, &c. some of them so large as to deserve the name of fragments; and the largest of these are always of quartz or feldspath, and talc.

2. Reddish granite, of a gellied texture, which, Mr Williams says, is one of the finest and most elegant stones in the world. The mountains of Bineves, he says, are principally composed of this stone; and it is found in great abundance in many other parts of Scotland, but he never saw it exhibit any marks of stratification.

3. The fine reddish granites, in which several fine shades of colours are blended together, not spread out in tints as in the former. Neither this nor the former are stratified: "On the contrary (says our author), both exhibit such a degree of uniform regularity, that in some places there is no difference between a stone and a mountain, excepting only in magnitude; as many mountains of granite are nothing more than one regularly uniform mass throughout, in which not the least mark of a bed is to be seen, nor hardly a crack or fissure, unless it be at the edge of some precipice or declivity. These two varieties of elegant red granite are met with in the Highlands and Lowlands of Scotland, in Galloway, and many other places. We often find masses of talc so large in this second variety, that some of them may be called fragments, not disposed in any order, but higgledy-piggledy through the body of the stone.

4. Stratified reddish granite, resembling the third in colour and quality, but not always quite so pure or free from admixture of other stony matter of a different quality. This variety frequently contains larger and smaller fragments of fine laminated talc. Mr Williams, however, has seen this kind of granite disposed in pretty regular strata in the shires of Moray and Nairn, and other parts of Scotland.

5. Granite of a white and whitish colour, generally of a granulated texture, containing a great quantity of mica, or small-leaved talc, and the grains of quartz sometimes large and angular. This variety is subject to spontaneous decomposition; part frequently dissolves and falls into lakes, in such an exceedingly fine and attenuated state, that it does not sink in the water. "I have found (says Mr Williams) this substance in many places where water had been accidentally drained off, resembling fine shell marle, only much lighter. When thoroughly dry, it is the lightest fossile substance I ever handled; and, when blanched with rain, it is as white as snow. This variety of granite is either not stratified, or exhibits thick irregular beds. It frequently contains a considerable quantity of talc, in masses and scales too large to be called mica."

Our author is of opinion, that this fine white substance produced from the decomposition of the granite, is the true kaolin of the Chinese, one of the component parts of porcelain ware. "The authors of the History of China (says he) informs us, that the fine porcelain ware is composed of two different fossile substances, called by them *petuntse* and *kaolin*. We are further told, that the petuntse is a fine white vitrescible stone, compact and ponderous, and of considerable brightness in the inside when broken, which they grind to a fine powder; and that the kaolin is not a stone, but a fine white earthy substance, not vitrifiable, at least not in the heat of a common potter's furnace: that they mix the kaolin and the flour of the petuntse together, and form a paste of this mixture, which they mould into all sorts of porcelain vessels. Now, from the best accounts of this matter which I have been able to obtain, after a good deal of search and inquiry, it appears to me, that the sediment which I have mentioned above is the true kaolin; and that as the fine white glassy quartz, which is found in irregular masses, and in irregular discontinuous veins or ribs, in some of the rocks of schistus, is the true petuntse; and if this observation is really true, it deserves to be remarked, that Scotland is as well furnished with the best materials for making fine porcelain as most countries in the world. The species of quartz which I suppose to be petuntse is of a pure fine uniform glassy texture, semitransparent, and of a pure snowy whiteness. A broken piece of this stone, and a newly broken piece of fine porcelain, are very like one another. There is a great quantity of petuntse, or pure white quartz, in many places of Scotland, particularly in the north and Highlands. There is a considerable quantity of it upon the shore and washed by the tide between Banff and Cullen, generally in pretty large masses in rocks of bluish schistus; and to the best of my memory it is very fine of the kind. There is also a considerable quantity of it in discontinuous ribs and masses, in rocks of blue schist, about three or four miles north of Callendar in Monteith, upon the side of the high road which runs parallel to Lochleodunich, which I think also very fine. In some places this sort of quartz is tinged with a flesh colour from the neighbourhood of iron, which renders it unfit for porcelain; but there is plenty to be found of a pure white in almost all parts of Scotland, without any mineral tinge whatever. The kaolin is perhaps as plentiful in Scotland as the petuntse, there being many extensive lakes easily drained, which contain a considerable depth of it; and moreover, it is to be found in many places that have been lakes, which are now laid dry by accident. There is a quantity of kaolin about

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they are called *marbles*, and employed for the ſame purpoſes as the preceding (F).

2. Of kernels of jaſper cemented by a jaſpery ſubſtance. *Breccia jaſpidea. Diaſpro brecciato* of the Italians.

Of this kind ſpecimens from Italy are ſeen in collections. A coarſe jaſper breccia is ſaid to be found not far from Frejus in Provence in France.

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3. Of ſiliceous pebbles, cemented by a jaſpery ſubſtance,

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100 yards below the high road upon the ſouth ſide of a bridge, about a mile and a half or two miles ſouth of the inn of Aviemore in the Highlands. It lies beneath a ſtratum of peat bog, in a place which has been a lake, but is now drained by the river Spey cutting through one ſide of the mound which formed the lake.—There is more than one ſtratum of the kaolin in this place, and ſome of it is exceeding white, eſpecially when blanched by the rain; and there is a white granite rock up the rivulet, at ſome diſtance above the bridge, the decompoſition and diſſolution of which is ſuppoſed to produce this fine and curious ſediment. Several lakes in the Highlands of Scotland are nearly full of kaolin. One of them is ſituated in the country of Strathe-rig in Inverneſs-ſhire, leſs than a mile north of the public road, and upon the weſt ſide of the farm of Drimin. It is a pretty long lake, and there is a conſiderable depth of kaolin in it, which may be drained at a moderate expence; and, if I remember well, the granite rocks which ſurround it are pretty white and fine. If the kaolin originates from coloured granite, it is good for nothing, eſpecially if it contains the leaſt tinge of iron, becauſe this will diſcolour and ſpoil the beauty of the porcelain; but wherever white granite is found compoſed of quartz, feldſpath, and mica, without any admixture of ſhirl, and eſpecially iron, the kaolin ſhould be diligently ſought after in that neighbourhood. Lochdoon, in Galloway, is ſaid to contain a great quantity of kaolin. It was drained ſome years ago on the ſuppoſition of its containing ſhell marle; but on trying the ſubſtance contained in it, it was found not to be marle but kaolin. Theſe ſubſtances may eaſily be miſtaken for one another at firſt; but they are eaſily diſtinguiſhed by trying them with acids, the marle readily effervеſcing with the weakeſt, and the kaolin not at all with the ſtrongeſt acid liquors."

6. Grey compoſite granite is a very beautiful ſtone, and when broken looks as if compoſed of ſmall fragments of various ſizes and ſhapes, not unlike calve's-head jelly. When poliſhed, the fragments appear as if ſet or inlaid in a fine pellucid or water-coloured matter. There is a ſingle ſtratum of very curious compoſite granite, a little to the weſt of Loſſiemouth, in the county of Moray, in Scotland of about ſix or eight feet thick. It is compoſed chiefly of grains and fragments of various bright and elegant colours, moſt of which are as large as peaſe and beans, all fine, hard, and ſemipellucid; there is about an eighth part of good lead ore in the compoſition of this ſtone, of the kind commonly called potter's ore; and it is likewiſe remarkable, that there is no other granite in that neighbourhood but this ſingle ſtratum, all the ſtrata above and below it being moſtly a coarſe, imperfect, grey ſand-ſtone.

7. Granite of a looſe friable texture, ſubject to ſpontaneous decompoſition, and reduction to granite gravel. There is a remarkable rock of this kind near the Queen's-ferry in Scotland, on the road to Edinburgh, which appears in prodigious thick irregular ſtrata. This rock ſeems to be compoſed chiefly of quartz, ſhirl, and ſome iron; and produces excellent materials for the high roads.

8. In many parts of the north of Scotland, in the Highlands, and in Galloway, there is found an excellent ſpecies of grey granite, compoſed chiefly of red and black coloured grains. This is a fine and very durable ſtone, very fit for all kinds of architecture.

In ſpeaking of theſe ſtones, Mr Williams obſerves, that the finer and moſt elegant red granites, and the fineſt granite-like porphyries, ſo much reſemble one another, that he does not attempt to diſtinguiſh them; and Scotland is remarkable for a great number and variety of them. "The elegant reddiſh granite of Bineves, near Fort William (ſays he), is perhaps the beſt and moſt beautiful in the world; and there is enough of it to ſerve all the kingdoms on earth, though they were all as fond of granite as ancient Egypt. There are extenſive rocks of red granite upon the ſea-ſhore to the weſt of the ferry of Ballachyliſh in Appin, and likewiſe at Strontian, as well as many other parts of Argyleſhire. I have ſeen beautiful red granite by the road ſide, near Dingwall, and in ſeveral other parts of the north of Scotland, which had been blown to pieces with gunpowder, and turned off the fields. There are extenſive rocks of reddiſh granite about Peterhead and Slains, and both of red and grey granite in the neighbourhood of Aberdeen. The hill of Cruffel in Galloway, and ſeveral lower hills and extenſive rocks in that neighbourhood, are of red and grey granite, where there are great varieties of that ſtone, and many of them excellent. Upon the ſea ſhore near Kinnedore, weſt of Loſſiemouth, in Moray, there is a bed of ſtone about eight feet thick, which I think ſhould be called a compoſite granite. It is compoſed of large grains, or rather ſmall pieces of bright and beautiful ſtones of many different colours; and all the ſtony parts are exceedingly hard, and fit to receive the higheſt poliſh. About a ſixth or eighth part of it alſo conſiſts of lead ore, of that ſpecies called potter's ore. The ſeparate ſtony parts compoſing this ſtratum are all hard, fine, ſolid, and capable of the moſt brilliant poliſh; and if ſolid blocks can be raiſed free from all cracks and blemiſhes, I imagine, from the beauty and variety of colours of the ſtony part, and the quantity of bright lead ore which is blended through the compoſition and body of the ſtone, that this would be a very curious and beautiful ſtone when poliſhed."

(F) The ſtones called *Ludi Helmontii* or *Paracelſi*, have ſome ſimilarity in their form to the *brecciæ*, *a. b.*; for they are compoſed of various lumps of a marly whitiſh-brown matter, ſeparated into a great number of polygonous compartments, of various ſizes, formed of a whitiſh-yellow cruſt of a red calcareous ſpar, ſometimes

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substance, or something like it. The plum-pudding stone of the English; *Breccia silicea.* Its basis, which at the same time is the cement, is yellow; wherein are contained single flinty or agaty pebbles, of a grey colour or variegated. This is of a very elegant appearance when cut and polished: it is found in England and Scotland (G).

4. Of quartzose kernels combined with an unknown cement. *Breccia quartzosa.*
5. Of kernels of several different kinds of stones. *Breccia saxosa.*

a. Of kernels of porphyry, cemented by a porphyry or coarse jaspery substance; *Breccia porphyrea.*

b. Of kernels of several saxa; *Breccia indeterminata.*

c. Of conglutinated kernels of sandstone; *Breccia arenacea.* This kind consists of sandstone kernels, which have been combined a second time together.

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The above mentioned breccias of themselves must demand the distinctions here made between, but which perhaps may seem to be carried too far.

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times pyritous, which often rise a little above the external surface, and inclose each of them on the inside. According to Bomare, the *ludus stellatus helmontii*, found in the county of Kent, is covered with a kind of striated selenite resembling the zeolite. They are for the most part of a globose figure, seldom flat, but often convex on the outside; and sometimes with a concave surface.

According to Wallerius, the *ludus helmontii* loses by calcination about half of its weight; and, on being urged by fire, is melted into a black glassy slag. It effervesces strongly with aqua-fortis, and this solution is of a yellow colour. But what seems very extraordinary, by adding to it some oil of tartar *per deliquium*, bubbles are produced, from which a great number of slender black threads or filaments are produced, sticking like a cobweb to the sides and bottom of the vessel.

These stones are found quite separate by themselves, as well as various stalagmites and crustaceous bodies, on the strata of argillaceous earth, in various parts of Europe, chiefly in Lorrain, Italy, England (in the counties of Middlesex and Kent), and elsewhere.

Wallerius ranges the *ludus helmontii* among the *tophi*, in the Spec. 425. of his System of Mineralogy. Paracelsus had attributed to these stones a lithontriptic power, and Dr Grew says that they are diuretic; but there is not the least proof of their really possessing such qualities.

(G) The breccia stratum, or plumpudding-rock, exhibits a singular appearance as it lies in the ground; being composed of water-rounded stones of all qualities and of all sizes, from small gravel up to large rounded stones of several hundreds weight each; the interstices being filled up with lime and sand. It frequently also contains lime and iron. Sometimes it exhibits a grotesque and formidable appearance; containing many large bullets of various sizes and shapes, without any marks of regular stratification, but looking like one vast mass of bullets of unequal thickness; and in this manner frequently swelled to the size of a considerable mountain. It is frequently cemented very strongly together; so that parts of the hills composed of it will frequently overhang in dreadful precipices, less apt to break off than other rocks in the same situation; one reason for which, besides the strength of the cement, is, that the breccia, when composed of bullets, is less subject to fissures and cutters than other rocks; being frequently found in one solid mass of great extent and thickness. Some of the plumpudding-rocks are made up of smaller parts, coming near to the size of coarse gravel. It is evident, however, that all the parts of the breccia, whether course or fine, have been rounded by agitation in water, as the rocks differ nothing in appearance from the coarser and finer gravel found upon the beach of the sea, excepting only that the parts are strongly cemented together in the rocks, and are loose upon the shores of the ocean.

Some of the breccia is composed of finely rounded stones of various and beautiful colours, about the size of plums or nuts, all very hard and fine. Were this species sawed and polished, it would appear as beautiful and elegant as any stone in Europe; much resembling mosaic work in small patterns.

In general, the breccia is regularly stratified or not according to the size of the component parts of the stone. Such rocks as are composed of round gravel and small bullets are generally very regular in their stratification, while those which contain bullets somewhat larger in size are commonly disposed in thick and coarse beds, and such rocks as are made up of the largest kind of bullets seldom show any marks of stratification at all.

Among many other places in Scotland, where breccia or pudding-stone abounds, there are extensive rocks and high cliffs of it upon the south shore at the west end of the Pentland Frith, to the westward of Thurso in Caithness, which stretch quite across the county of Caithness into Sutherland; and in Sutherland as well as Caithness, this rock is of a rough contexture, and appears in pretty high hills, deep glens, overhanging rocks, and frightful precipices, to the west of Brora, Dunrobin, and Dornoch, which gives it a grotesque and formidable appearance in that country. This range of breccia stretches also quite through Sutherland, and likewise through Rossshire, the west side of Ferndonald, and Dingwall, where it exhibits the very same phenomena as in Sutherland and Caithness. It continues the same longitudinal line of bearing, which is nearly from north-east to south-west, quite through the highland countries of Inverness and Perthshire; and it forms considerable hills, and very high and rugged rocks, upon both sides of that beautiful piece of fresh water Lochness. Much of the stone here, as well as in other places in this range, is composed of large bullets; the rock is very hard and strong, and it hangs in frightful precipices upon both sides of the lake, through which rock Ge-

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far, ſince their particles are ſo big and plain as to be eaſily known from one another. Theſe ſtones are a proof both of the ſubverſions which the mountains in many centuries have undergone, and of ſome hidden means which nature makes uſe of in thus cementing different kinds of ſtones together. Any certain bigneſs for the kernels or lumps in ſuch compounds, before they deſerve the name of *breccia*, cannot be determined, becauſe that depends on a compariſon which every one is at liberty to imagine. In ſome places, the kernels of porphyry have a diameter of ſix feet, while in others they are no bigger than walnuts. Sometimes they have a progreſſive ſize down to that of a fine ſandſtone. Moſt of this kind of ſtone is fit for ornaments, though the workmanſhip is very difficult and coſtly.

B. Conglutinated ſtones of granules or ſands of different kinds. Sandſtone; *Lapis arenaceus.*

In this diviſion are reckoned thoſe which conſiſt of ſuch minute particles, that all of them cannot eaſily be diſcovered by the naked eye. The greateſt part, however, conſiſt of quartz and mica; which ſubſtances are the moſt fit to be granulated, without being brought to a powder.

1. Cemented by clay.
   a. With an apyrous or refractory clay. This is of a looſe texture; but hardens, and is very refractory in the fire.
   b. With common clay.
2. With lime; reſembles mortar made with coarſe ſand.
   a. Conſiſting of tranſparent and greeniſh grains of quartz and white limeſtone.
   b. Of no viſible particles. This is of a looſe texture, and hardens in the air.
3. With an unknown cement.
   a. Looſe.
   b. Harder.
   c. Compact.
   d. Very hard.
4. Cemented by the ruſt or ochre of iron. Is found in form of looſe ſtones at ſeveral places, and ought perhaps to be reckoned among the *mineræ arenaceæ* or ſand ores; at leaſt when the martial ochre makes any conſiderable portion of the whole.
5. Grit-ſtone. This is of greater or leſs hardneſs, moſtly of a grey, and ſometimes of a yelloviſh colour; compoſed of a ſiliceous and micaceous ſand, and rarely of a ſparry kind, with greater or leſſer particles cloſely compacted and united by an argillaceous cement. It gives ſome ſparks with ſteel, is indiſſoluble for the moſt part in acids, and vitriſiable in a ſtrong fire. It is uſed for millſtones and whetſtones, ſometimes for filtering ſtones and for building. *Fabroni.*

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N. B. The *argillaceous* grit has been before deſcribed, p. 89. col. 1.

6. Elaſtic. A ſingular ſpecies of ſandſtone, of which a ſpecimen was ſhown ſome years ago to the Royal Academy of Sciences at Paris by the Baron de Dietrich. It is flexible and elaſtic; and 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 de 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 effervеſce with aqua-fortis; and there is alſo in it a little mixture of ſmall particles of talc or mica. See *Journ. de Phyſ.* for Oct. 1784, p. 275. See alſo the article MARBLE (*Elaſtic.*)

C. Stones and ores cemented together; *Mineræ arenaceæ.*

1. Of larger fragments.
   a. Mountain green, or *viride montanum cupri*, and pebbles cemented together, from Siberia.
   b. Potters lead-ore, with limeſtone, ſlate-kernels, and ſhells.
   c. Yellow or marcaſitical copper ore, with ſmall pebbles.
2. Of ſmaller pieces.
   a. Potter's lead-ore with a quartzoſe ſand.
   b. Mountain green with ſand from Siberia.
   c. Cobalt ore with ſand.
   d. Martial ochre with ſand.

Order II. MINERAL CHANGES, or PETRIFACTIONS.

THESE are mineral bodies in the form of animals or vegetables, and for this reaſon no others belong to this order than ſuch as have been really changed from the ſubjects of the other two kingdoms of nature.

I. Earthy changes; *Terræ larvatæ.*

A. Extraneous bodies changed into a lime ſubſtance, or calcareous changes; *Larvæ calcareæ.*

(1.) Looſe or friable. Chalky changes; *Cretæ larvatæ.*

a. In

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neral Wade cut a fine military road upon the ſouth ſide of the lake, at a great expence of time, labour, and gunpowder. Theſe rocks are ſeen ſtretching through the mountains of Stratherig into Badenoch, where it forms a remarkable rock and precipice called *Craigdow* or the *Black Rock*. The ſame range is again ſeen farther towards the ſouth-weſt, in ſeveral places to the ſouth of the Black Mount, and in the country of Glenorchy in Argyleſhire: and Mr Williams ſuppoſes, that the longitudinal line of this rock, ſo far as it has been juſt pointed out, is little leſs than 200 miles, and in ſome places it ſpreads eight or ten miles in what may be called the latitudinal line acroſs the bearing of the rocks.

Appendix. PETRIFACTIONS.

a. In form of vegetables.
b. In form of animals.
1. Calcined or mouldered ſhells; *Humus conchaceus.*
(2.) Indurated; *Petrifacta calcarea.*
a. Changed and filled with ſolid limeſtone.
1. In form of animals.
2. In form of vegetables.
b. Changed into a calcareous ſpar; *Petrifacta calcarea ſpatoſa.*
1. In form of animals.
2. In form of vegetables.

B. Extraneous bodies changed into a flinty ſubſtance. Siliceous changes; *Larvæ ſiliceæ.* Theſe are, like the flint,
(1.) Indurated.
a. Changed into flints.
1. Carnelians in form of ſhells, from the river Tomm in Siberia.
2. Agat in form of wood. Such a piece is ſaid to be in the collection of Count Teſſin.
3. Coralloids of white flint, (*Millepora.*)
4. Wood of yellow flint.

C. Extraneous bodies changed into clay. Argillaceous changes; *Larvæ argillaceæ.*
A. Looſe and friable.
1. Of porcelain clay.
a. In form of vegetables.
A piece of white porcelain clay from Japan, with all the marks of the root of a tree, has been obſerved in a certain collection.
B. Indurated.
1. In an unknown clay.
a. In form of vegetables. *Oſteocolla.* It is ſaid to be changed roots of the poplar tree, and not to conſiſt of any calcareous ſubſtance.
A ſort of foſſile ivory is ſaid to be found, which has the properties of a clay; but it is doubtful if it has been rightly examined.

II. Saline extraneous bodies, or ſuch as are penetrated by mineral ſalts. *Corpora peregrina inſalita. Larvæ inſalitæ.*
A. With the vitriol of iron.
1. Animals.
a. Human bodies have been twice found in the mine at Falun in Dalarne; the laſt was kept a good many years in a glaſs-caſe, but began at laſt to moulder and fall to pieces.
2. Vegetables.
a. Turf, and
b. Roots of trees.
Theſe are found in water ſtrongly impregnated with vitriol. They do not burn with a flame, but only like coal in a ſtrong fire; neither do they decay in the air.

III. Extraneous bodies penetrated by mineral inflammable ſubſtances, or mineral phlogiſton.
A. Penetrated by the ſubſtance of pit-coals.
1. Vegetables, which commonly have been woods, or appertaining to them.
a. Fully ſaturated. *Gagas*, Jet. (See p. 104. col. 2.) The jet is of a ſolid ſhining texture.
b. Not perfectly ſaturated; *Mumia vegetabilis.* It is looſe; reſembles umber, and may be uſed as ſuch.
B. Penetrated by rock-oil or aſphaltum.
1. Vegetables.
a. Turf.
The Egyptian mummies cannot have any place here, ſince art alone is the occaſion that thoſe human bodies have in length of time been penetrated by the aſphaltum, in the ſame manner as has happened naturally to the wood in pit-coal ſtrata. See MUMMY.
C. Penetrated by ſulphur which has diſſolved iron, or by marcaſite and pyrites. *Pyrite impregnata. Petrifacta pyritacea.*
1. Animals.
a. Human.
b. Bivalves.
c. Univalves.
d. Inſects.

IV. Metals in form of extraneous bodies; *Larvæ metalliferæ.*
A. Silver; *Larvæ argentiferæ.*
(1.) Native.
a. On the ſurfaces of ſhells.
(2.) Mineraliſed with copper and ſulphur.
a. Fahlertz, or grey ſilver ore in form of ears of corn, &c. and ſuppoſed to be vegetables, are found in argillaceous ſlate at Frankenberg and Tahlitteren in Heſſe.
B. Copper; *Larvæ cupriferæ.*
(1.) Copper in form of calx.
a. In form of animals, or of parts belonging to them.
1. Ivory and other bones of the elephant. The Turcois or Turquoiſe; which is of a bluiſh green colour, and much valued in the eaſt.
At Simore in Languedoc bones of animals are dug, which during the calcination aſſume a blue colour; but it is not probable that the blue colour is owing to copper.
(2.) Mineraliſed copper, which impregnates extraneous bodies; *Cuprum mineraliſatum corpora peregrina ingreſſum.*
A. With ſulphur and iron. The yellow or marcaſitical copper ore that impregnates,
1. Animals.
a. Shells.
b. In form of fiſh.
B. With ſulphur and ſilver. Grey ſilver ore or fahlerts, like ears of corn, from the ſlate-quarries in Heſſe.
C. Changes into iron; *Larvæ ferriferæ.*
(1.) Iron in form of calx, which has aſſumed the place or the ſhape of extraneous bodies; *Ferrum calciforme corpora peregrina ingreſſum.*
a. Looſe; *Larvæ ochraceæ.*
1. Of vegetables.
Roots of trees, from the lake Langelma in Finland. See the acts of the Swediſh Academy of Sciences for the year 1742.
b. Indu-

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b. Indurated; *Larvæ hæmatiticæ.*

1. Of vegetables.

(2.) Iron mineraliſed, aſſuming the ſhape of extraneous bodies.

a. Mineraliſed with ſulphur. Marcaſite. *Larvæ pyritaceæ.*

V. Extraneous bodies decompoſing, or in a way of deſtruction; *Corpora peregrina in gradibus deſtructionis conſiderata.* Mould; *Humus.* Turf; *Turba.*

A. From animals. Animal-mould; *Humus animalis.*

1. Shells. *Humus conchaceus.*

2. Mould of other animals; *Humus diverſorum animalium.*

B. Vegetable mould; *Humus vegetabilis.*

1. Turf; *Turba.*

a. Solid, and hardening in the air; *Turba ſolida aere indurêſcens.* This is the beſt of the kind to be uſed for fuel, and comes neareſt to the pit-coals. It often contains a little of the vitriolic acid.

b. Lamellated turf; *Turba foliata.* This is in the firſt degree of deſtruction.

2. Mould of lakes; *Humus lacuſtris.* This is a black mould which is edulcorated by water.

3. Black mould; *Humus ater.* This is univerſally known, and covers the ſurface of that looſe earth in which vegetables thrive beſt.

Order III. Volcanic Products (H).

I. Slags; *Scoriæ vulcanorum.*

Slags are found in great abundance in many places of the world, not only where volcanoes yet exiſt, but likewiſe where no ſubterraneous fire is now known: Yet, in Mr Cronſtedt's opinion, they cannot be produced but by means of fire. Theſe are not properly to be called *natural*, ſince they have marks of violence, and of the laſt change that mineral bodies can ſuffer without the deſtruction of the world; nor are they *artificial*, according to the univerſally received meaning of this word. We cannot, however, avoid giving them a place here, eſpecially after having admitted the petrifactions; and ſhall therefore arrange the principal of them, according to their external marks.

A. Iceland agate; *Achates iſlandicus niger.*

It is black, ſolid, and of a glaſſy texture; but in thin pieces it is greeniſh and ſemitranſparent like glaſs-bottles, which contain much iron. The moſt remarkable circumſtance is, that ſuch large ſolid maſſes are found of it, that there is no poſſibility of producing the like in any glaſs-houſe.

It is found in Iceland, and in the iſland of Aſcenſion: The jewellers employ it as an agate, though it is too ſoft to reſiſt wear.

B. Rheniſh millſtone; *Lapis molaris Rhenanus.*

Is blackiſh-grey, porous, and perfectly reſembles a ſort of ſlag produced by mount Veſuvius. A variety of lava, according to Kirwan.

C. Pumice-ſtone; *Pumex.*

It is very porous and bliſtered, in conſequence of which it is ſpecifically very light. It reſembles that frothy ſlag which is produced in our iron furnaces.

1. White.

2. Black.

The colour of the firſt is perhaps faded or bleached, becauſe the ſecond kind comes in that ſtate from the laboratory itſelf, *viz.* the volcanoes.

D. Pearl ſlag; *Scoriæ conſtantes globulis vitreis conglomeratis.*

It is compounded of white and greeniſh glaſs particles, which ſeem to have been conglutinated while yet ſoft or in fuſion. Found on the Iſle of Aſcenſion.

E. Slag-ſand or aſhes; *Scoriæ pulverulentæ, cineres vulcanorum.*

This is thrown out from volcanoes in form of larger or ſmaller grains. It may perhaps be the principle of the Terra Puzzolana; becauſe ſuch an earth is ſaid at this time to cover the ruins of Herculaneum near Naples, which hiſtory informs us was deſtoyed by a volcano during an earthquake.

II. Lavas.

Lava has been generally underſtood to denote the aggregate maſs of melted matters which flow out of the mouths, or burſt out from the ſides, of burning mountains. According to Mr Kirwan, however, lavas are the immediate produce of liquefaction or vitrification by the volcanic fires, and "ſhould carefully be diſtinguiſhed from the ſubſequent productions affected by the water either in a liquid or fluid ſtate, which generally is ejected at the ſame time." And of lavas, ſo diſtinguiſhed, he deſcribes ſeveral varieties. See the article Lava, in the order of the alphabet; where the nature, origin, kinds, and phenomena of lavas, are copiouſly deſcribed and explained.

III. Baſaltes.

This ſort of ſtone was by Cronſtedt, in the firſt edition of his Mineralogy, ranked among the garnet earths, and confounded with the ſhoerls; an impropriety which was pointed out by Bergman in his *Sciagraphia*, ſect. 120.—Mr Kirwan conſiders baſaltes as an imperfect lava, and aſcribes its origin both to fire and water. He deſcribes it as found, either, 1. In opaque triangular or polyangular columns; which is the proper baſaltes: Or, 2. In amorphous maſſes of different magnitudes; forming ſolid blocks, from the ſmalleſt ſize to that of whole mountains; which kind is called *trapp*. See the detached article Basaltes (I); where its ſpecies and varieties

(H) For the nature, hiſtory, theory, &c. of volcanoes, ſee the article Volcano.

(I) In that article, p. 46. col. 1. l. 9. *dele* the words, "The Engliſh miners call it *cockle*, the German *ſchoerl*."—P. 47. col. 2. l. 28. for "a kind of marble," read "a volcanic production." The *Lapis Lydius*, or Touchſtone, mentioned in the ſame paragraph, ſhould have been ſpecified to be of the ſort called *Trapp*.

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rieties are particularly described, and different opinions ſtated concerning its formation. See alſo the article TRAPP.—Some plauſible arguments againſt the volcanic origin of baſaltes will be mentioned in the courſe of the ſubjoined note (K), extracted from *Williams's Natural Hiſtory of the Mineral Kingdom*.

Appendix. VOLCANIC PRODUCTS

(K) There is a great variety of baſaltes in Scotland, particularly of the grey kinds; ſome of which are capable of the higheſt degree of poliſh. A good black kind is met with on the ſouth ſide of Arthur's Seat near Edinburgh, where it forms a ſmooth perpendicular rock, with ſeveral of the columns broken off, and the ſuſpended pieces threatening to fall down upon the paſſengers below. This ſtone is capable of receiving a fine poliſh; and, in the opinion of Mr Williams, would be fit for all ſorts of ornaments about ſepulchral monuments. It will poliſh to a bright and beautiful black, which will be unfading.

There is another kind, heavy and hard, of a black or blackiſh-grey colour; of which great quantities have been carried from the Frith of Forth to pave the ſtreets of London. This, for the moſt part, is coarſely granulated in the inſide, though ſometimes the grain is pretty fine. Sometimes it is bright in the inſide when broken. It is compoſed of grains of quartz and ſhirl of different ſizes, and commonly contains ſome iron. It always appears in thick, irregular, beds, ſome of which are enormouſly thick; and ſeldom or ever equally ſo: on the contrary, where it is found uppermoſt, it frequently ſwells into little hills of various ſizes. Moſt of the ſmall iſlands in the Frith of Forth are compoſed of this kind of ſtone; as well as ſome hills in the neighbourhood of Inverkeithing and of Edinburgh.

The known characteriſtic of the baſaltes is to form itſelf into balls, columns, and other regular figures. The columnar kind aſſumes a pentagonal, hexagonal, or heptagonal figure; but quadrangular columns are not common. They are all ſmooth on the outſide, and lie parallel and contiguous to one another; ſometimes perpendicular, ſometimes inclining, in proportion to the poſition of the ſtratum which is thus divided: If the ſtratum lies horizontal, the columns are perpendicular; if inclining, the pillars alſo incline in exact proportion to the declivity of the ſtrata, being always broken right acroſs the ſtratum. Some are of one piece from top to bottom; others divided by one or more joints laid upon one another, which form a column of ſeveral parts. The rock called the *Giant's Cauſeway* in Ireland is a pretty good ſpecimen of the jointed columnar baſaltes: but there is a more beautiful ſpecies above Hillhouſe lime-quarry, about a mile ſouth of Linlithgow in Scotland; and a coarſer one near the toll-bar north ſide of Queen's Ferry, and ſeveral other places in Fife. In ſome places the baſaltes are formed into magnificent columns of great length; and in others afford an aſſemblage of ſmall and beautiful pillars reſembling a range of balluſtrades or organ pipes. Some of the columns on the ſouth ſide of Arthur's Seat already mentioned are very long; and there are likewiſe magnificent columns of great length in the iſland of Egg, and others of the Hebrides. Theſe columns, when broken, are frequently of a black, or blackiſh grey, in the inſide; ſome of them being compoſed of ſmall grains, which gives them an uniform and ſmooth texture; but much of this ſpecies of ſtone has larger grains in its compoſition, rough, ſharp, and unequal, when broken. All the grains, however, are fine, hard, and bright; and the ſtone in general is capable of a fine poliſh.

The other ſpecies of baſaltes which forms itſelf into diſtinct maſſes, aſſumes ſometimes a quadrangular, ſometimes an oval, globular, or indeterminate figure. They are found of all ſizes from the ſize of an egg to that of an houſe: but though they differ in ſhape from the columnar baſaltes, they agree in almoſt every other reſpect; whence Mr Williams thinks that they are only to be accounted a variety of the columnar kind. It is common to ſee one ſtratum of the baſaltine rocks exhibiting, in one place, regular pillars or globes; and near theſe, very irregular ones, differing very little from the common cutters found in all rocks; and at no great diſtance, the ſame rock is found to run into one entire maſs, exhibiting no tendency to be broken or divided into any columns whatever. Of this the rock of Arthur's Seat is an inſtance. Some of theſe only produce ſolid maſſes of different figures and ſizes; while others produce quantities of a ſofter, friable, ſtony matter, of the ſame quality in which the hard maſſes of different figures are found imbedded. Pretty good ſpecimens of the ſecond kind or variety of baſaltes are met with on the road-ſide between Cramond bridge and the Queen's Ferry, and in ſeveral other places in the Lothians and in Fife.

The cruſtated baſaltes are of two kinds; 1. Such as have the cruſts more dry and friable than the internal parts; and, 2. Such as are dry and friable throughout the whole maſs.

The firſt of theſe has not only a cruſt of the friable matter adhering to it, but is likewiſe imbedded in a quantity of the ſame. Our author has ſeen many quarries of this kind of baſaltes dug for the high roads, in which the quantity of ſoft friable matter greatly exceeded that of the hard maſſes, and in which incruſted ſtones of various ſizes and ſhapes appeared. In ſuch quarries, ſome of the largeſt maſſes have only a few coats of penetrable friable matter, ſurrounding a nucleus which varies in ſize, but is uniformly hard throughout; and we ſhall find other yolks in the ſame quarry imbedded in the ſofter matter, which, when broken, exhibit a neſt of ſtones including one another like the ſeveral coats of an onion. Theſe cruſtated baſaltes which envelope one another are a curious ſpecies of ſtone. The ſeveral coats of ſurrounding matter differ nothing in quality from the ſtones contained in them, and ſome of the inner cruſts are often very hard; but the nucleus within, though ſmall, is always the hardeſt. The decompoſition by the weathering of the ſofter matter found ſurrounding and enveloping the harder maſſes of ſtone in this and the ſecond ſpe-

cies

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cies of baſaltine rocks, has produced a phenomenon frequently met with in Great Britain, eſpecially in Scotland, which greatly puzzles many. It is very common in low grounds, and upon ſome moderate eminences, to ſee a prodigious multitude of ſtones of all ſhapes and ſizes, very hard, and pretty ſmooth on the outſide. Theſe ſtones are ſometimes ſo numerous and large, that it is often found impracticable to clear a field of them. Where thoſe ſtones are a ſpecies of baſaltes, which they commonly are, and of the ſecond ſpecies of baſaltes deſcribed above, they alway originate from a decompoſition of the more ſoft or friable parts of thoſe rocks, which moulder or fall away, and leave the harder ſtones detached and ſcattered about, and the decompoſed matter diſſolves by degrees, and becomes good corn mould.

Here Mr Williams takes occaſion to conteſt the opinion of thoſe who think that ſtones grow or vegetate like plants. He owns indeed that they increaſe in bulk: but this, he ſays, is only in ſuch ſituations as are favourable for an accretion of matter carried down and depoſited by the water; in all other ſituations they grow leſs and leſs. "Others (ſays he) imagine, that theſe ſtones (on which this extraneous matter has been depoſited) were rolled about; that the aſperities and ſharp angles were by that means worn off; and that they were all at laſt depoſited as we ſee them, by the waters of the univerſal deluge: and, having their obtuſe ſides and angles, as if they had been rounded by rolling in water, makes theſe gentlemen confident that they are right; and if we did not frequently find ſtones exactly of the ſame figure, ſize, and quality in the rock, it would be very difficult to overthrow this hypotheſis. I have taken great pains to inveſtigate this point, having frequently examined circumſtances; and never failed to diſcover the ſtratum of rock which thoſe detached ſtones originally belonged to. "The ſtrata or beds of the ſeveral ſpecies of baſaltes ſpread as wide, and ſtretch as far, as the other concomitant ſtrata in the neighbourhood where they are found: but they often lie very flat, or with a moderate degree of declivity; and conſequently, when the ſofter and more friable matter found in the interſtices of theſe rocks, which incloſes and binds the harder maſſes in their native beds, is decompoſed, the harder ſtones muſt then lie ſcattered wide upon the face of the ground."

The ſecond ſpecies of the cruſtated baſaltes, viz. that which is dry and friable throughout the whole maſs, is generally of a coarſe and granulated texture, and of all the various ſhades of grey colours; from a ruſty black to a light-coloured grey. This kind of cruſtated baſaltes is developed when the maſſes are either broken or in a ſtate of decompoſition; and there are maſſes of it of all ſizes and ſhapes found in the rocks, reſembling the ſecond and third ſpecies of the baſaltes; appearing alike ſmooth on the outſide, with obtuſe angles; in ſhort, reſembling the baſaltes in every reſpect: but when they are expoſed to the external air and weather for any conſiderable time, the ſeveral incruſtations decay, decompoſe, and crumble down by degrees. When they quarry this ſpecies of baſaltes for the roads, they are able to break and pound them ſmall with eaſe; but the harder ſpecies are ſo hard and coheſive, that they are with the greateſt difficulty broken into ſufficiently ſmall parts.

Compoſite baſaltes reſembles the three laſt ſpecies, in figure, colour, and all other external appearances; being diſtinguiſhable from them only in the internal ſtructure or grain of the ſtone. It reſembles ſome of the granites, as conſiſting of much larger grains than the other baſaltes. Many of the larger grains in the compoſite baſaltes are more than an eighth part of an inch over, and ſome more than a fourth; appearing with ſmooth flat ſurfaces, and of a tabulated texture, exactly reſembling the quartzy grains ſo commonly found in the compoſition of moſt of the granites. The chief, if not the only, diſtinguiſhable difference between the grains in each of them is the colour. They are evidently large grains of quartz, &c. which exhibit flat ſhining ſurfaces in both. Thoſe grains or fragments are commonly white, yelloviſh, red, or black, in the compoſition of moſt of the granites; whereas they are often ſeen of a pale blue, or a bluiſh grey colour, in the compoſite baſaltes, and ſome of them approaching to white. It is only in the *internal* ſtructure, however, that theſe baſaltes have any reſemblance to the granites; in all the external characters, they differ nothing from the reſt of their own genus.

A fifth ſpecies of baſaltes is indurated through the whole ſtratum, ſolid and uniform through all its parts, and exhibiting only ſuch cracks and fiſſures or cutters as are commonly met with in other hard beds of ſtones. Many beds of this ſpecies are frequently met with in the coal-fields, and the miners are often obliged to ſink through them in their coal-pits. "The Saliſbury craigs at Edinburgh (ſays our author) might be ſingled out as a good example of this ſpecies of ſtone, were it not that part of the ſame ſtratum is formed into columns on Arthur's ſeat; though, I believe, this is no good exception, as it evidently appears that the beds of baſaltes which are formed into columns, glebes, &c. only aſſume theſe figures where they are expoſed to the influence of the external air, or have but little cover of rock above them. When any of thoſe beds ſtrike deep under the cover of ſeveral other ſtrata, they are not found in columns, &c. Nothing but an uniform maſs then appears, although the ſame bed is regularly formed near the ſurface; which proves that the columnar and other baſaltes are formed by ſhrinking and chapping.

"The ſtrata of baſaltes ſpread as wide, and ſtretch as far in the longitudinal bearing, as the other different ſtrata which accompany them in the countries where they are found. The rocks of baſaltes alſo are generally found in very thick ſtrata; and that generally in places where no other rock is found above the baſaltes, the ſtrata of it are often very unequal in thickneſs. But this, in general, is only in ſituations where no other rock is found above it; for when it fairly enters into the ſurface of the earth, ſo as to have other regular ſtrata above it, which is ſeen in an hundred places in the Lothians, Fife, and other parts of Scotland, it then appears pretty equal in thickneſs, as equal as moſt other beds of ſuch great thickneſs are; and yet it is remarkable, that although moſt of the ſtrata of baſaltes are of great thickneſs, there are frequently thin

Appendix. Volcanic Products

ſtrata of various kinds found both above and below it. We have numerous examples of this in all the parts of Scotland where baſaltes is found; as for inſtance, there are thin and regular ſtrata ſeen and quarried both above and below the thick bed of that rock in the Saliſbury craigs near Edinburgh. In the Bathgate hills, ſouth of Linlithgow, and in many other parts of Scotland, there are ſeveral ſtrata of baſaltes, and likewiſe of coal, limeſtone, freeſtone, and other concomitants of coal blended promiſcuouſly *ſtratum ſuper ſtratum*; and the baſalt is frequently found immediately above, and immediately below regular ſtrata of coal; of courſe baſaltes *is not the lava of volcanoes*. We can prove to ocular demonſtration, from the component parts, and from the ſituation, ſtretch, and bearing of the ſtrata of baſaltes, that they are real beds of ſtone, coeval with all the other ſtrata which accompany them; and are blended with them in the ſtructure of that part of the globe where they are found, as they dip and ſtretch as far every way as the other ſtrata found above and below them. If baſaltes, therefore, be a volcanic production, the other ſtrata muſt of neceſſity be ſo likewiſe. But how volcanoes ſhould produce coal, and how that coal ſhould come into contact with burning lava, is not a little problematical; or rather it is ſtrangely abſurd to imagine that burning lava can come into contact with coal without deſtroying it.

Appendix. Volcanic Products

The regularly ſtratified quartzy white-mountain rock is ſcarce or rather not to be found in moſt parts of Britain. In the Highlands, however, it is very common; and in ſome places of them Mr Williams has ſeen it ſtratified as regularly as any of the ſand-ſtones, with other regular ſtrata of different qualities immediately above and below it; and ſometimes compoſing large and high mountains entirely of its own ſtrata. This ſtone is exceedingly hard, dry, and brittle, full of cracks and ſharp angles; the different ſtrata ſometimes moderately ſolid, but often naturally broken into ſmall irregular maſſes, with angles as ſharp as broken glaſs, and of an uniformly fine and granulated texture, reſembling the fineſt ſugar-loaf. There are large and high mountains of this ſtone in Roſsſhire and Inverneſsſhire, which, in a clear day, appear at a diſtance as white as ſnow, without any ſort of vegetation on them except a little dry heath round the edge of the hill.

MIN

Minerva.

MINERVA, or PALLAS, in Pagan worſhip, the goddeſs of ſciences and of wiſdom, ſprung completely armed from Jupiter's brain; and on the day of her nativity it rained gold at Rhodes. She diſputed with Neptune the honour of giving a name to the city of Athens; when they agreed that whoſoever of them ſhould produce what was moſt uſeful to mankind, ſhould have that advantage. Neptune, with a ſtroke of his trident, formed a horſe; and Minerva cauſed an olive to ſpring from the ground, which was judged to be moſt uſeful, from its being the ſymbol of peace. Minerva changed Arachne into a ſpider, for pretending to excel her in making tapeſtry. She fought the giants; favoured Cadmus, Ulyſſes, and other heroes; and refuſed to marry Vulcan, chooſing rather to live in a ſtate of celibacy. She alſo deprived Tireſias of ſight, turned Meduſa's locks into ſnakes, and performed ſeveral other exploits.

Minerva is uſually repreſented by the poets, painters, and ſculptors, completely armed, with a compoſed but agreeable countenance, bearing a golden breaſt-plate, a ſpear in her right-hand, and her ægis or ſhield in the left, on which is repreſented Meduſa's head encircled with ſnakes, and her helmet was uſually entwined with olives.

Minerva had ſeveral temples both in Greece and Italy. The uſual victim offered her was a white heifer, never yoked. The animals ſacred to her were the cock, the owl, and the baſiliſk.

MINERVÆ Caſtrum, *Arx Minervæ*, *Minervium*, or *Templum Minervæ*, (anc. geogr.), a citadel, temple, and town on the Ionian ſea, beyond Hydrus; ſeen a great way out at ſea. Now *Caſtro*, a town of Otranto in Naples. E. Long. 19. 25. N. Lat. 46. 8.

MINERVÆ Promontorium (anc. geogr.), the ſeat of the Sirens, a promontory in the Sinus Paeſtanus, the ſouth boundary of Campania on the Tuſcan coaſt; ſo called from a temple of Minerva on it: ſituated to the

MIN

ſouth of Surrentum, and therefore called *Surrentinum*. Now *Capo della Minerva*, on the weſt coaſt of Naples, over-againſt the iſland Capri.

Minervalia Mingrelia.

MINERVALIA, in Roman antiquity, feſtivals celebrated in honour of Minerva, in the month of March; at which time the ſcholars had a vacation, and uſually made a preſent to their maſters, called from this feſtival *Minerval*.

MINGRELIA, anciently COLCHIS, a part of Weſtern Georgia, in Aſia; bounded on the eaſt by Iberia, or *Georgia* properly ſo called; on the weſt, by the Euxine Sea; on the ſouth, by Armenia, and part of Pontus; and on the north, by Mount Caucaſus.

Colchis, or Mingrelia, is watered by a great many rivers; as the Corax, the Hippus, the Cyaneus, the Chariſtus, the Phaſis, where the Argonauts landed, the Abſarus, the Ciſſa, and the Ophis, all emptying themſelves into the Euxine Sea. The Phaſis does not ſpring from the mountains in Armenia, near the ſources of the Euphrates, the Araxes, and the Tigris, as Strabo, Pliny, Ptolemy, Dionyſius, and after them Arrian, Reland, Calmet, and Sanſon, have falſely aſſerted; but riſes in Mount Caucaſus; and flows not from ſouth to north, but from north to ſouth, as appears from the map of Colchis or Mingrelia in Thevenot's collection, and the account which Sir John Chardin gives of that country. This river forms in its courſe a ſmall iſland called alſo *Phaſis*; whence the pheaſants, if Iſidorus is to be credited, were firſt brought to Europe, and thence called by the Greeks *Phaſiani*. The other rivers of Colchis are conſiderable.

The whole kingdom of Colchis was in ancient times very pleaſant and fruitful, as it is ſtill where duly cultivated; abounded in all the neceſſaries of life; and was enriched with many mines of gold, which gave occaſion to the fable of the Golden Fleece and the Argonautic expedition ſo much celebrated by the ancients.

Mingrelia.

Sir John Chardin tells us, that this country extends above 100 miles in length and 60 in breadth; being not near ſo extenſive as the ancient Colchis, which reached from the frontiers of Iberia or Georgia Proper, weſtward to the Palus Mæotis: that it is beautifully diverſified with hills, mountains, valleys, woods, and plains, but badly cultivated: that there are all the kinds of fruits which are found in England, growing wild, but taſteleſs and inſipid for want of culture: that, if the natives underſtood the art of making wines, thoſe of this country would be the fineſt in the world: that there are many rivers which have their ſource in Mount Caucaſus, particularly the Phaſus, now called the *Rione:* that the country abounds in beeves, hogs, wild boars, ſtags, and other veniſon; and in partridges, pheaſants, and quails: that falcons, eagles, pelicans, lions, leopards, tigers, wolves, and jackals, breed on Mount Caucaſus, and ſometimes greatly annoy the country: that the people are generally handſome, the men ſtrong and well made, and the women very beautiful; but both ſexes very vicious and debauched: that they marry their nieces, aunts, or other relations, indifferently; and take two or three wives if they pleaſe, and as many concubines as they will: that they not only make a common practice of ſelling their children, but even murder them, or bury them alive, when they find it difficult to bring them up: that the common people uſe a ſort of paſte, made of a plant called *gom*, inſtead of bread; but that of the better ſort conſiſts of wheat, barley, or rice: that the gentry have an abſolute power over their vaſſals, which extends to life, liberty, and eſtate: that their arms are the bow and arrow, the lance, the ſabre or broad-ſword, and the buckler: that they are very naſty; and eat ſitting croſs-legged upon a carpet, like the Perſians; but the poorer ſort upon a mat or bench, in the ſame poſture: that the country is very thin of inhabitants, no leſs than 12,000 being ſuppoſed to be ſold yearly to the Turks and Perſians: that the principal commodities exported from it are, honey, wax, hides, caſtor, martin-ſkins, flax-ſeed, thread, ſilk, and linen-cloth; but that there are no gold or ſilver mines now, and very little money: that the revenue of the prince or viceroy amounts to about 20,000 crowns *per annum:* that the inhabitants call themſelves *Chriſtians;* but that both they and their prieſts are altogether illiterate, and ignorant of the doctrines and precepts of Chriſtianity: that their biſhops are rich, have a great number of vaſſals, and are clothed in ſcarlet and velvet: and that their ſervice is according to the rites of the Greek church, with a mixture of Judaiſm and Paganiſm.

Minho, Miniature.

The cities of moſt note in this country in ancient times were Pityus; Dioſcurias, or Dioſcorias, which was ſo called from Caſtor and Pollux, two of the Argonauts, by whom it is ſuppoſed to have been founded, and who in Greek are ſtyled *Dioſcuroi*, at preſent known by the name of *Savatapoli;* Aea on the Phaſis, ſuppoſed to be the ſame as Hupolis; *Phaſis*, ſo called from the river on which it ſtood; Cyta, at the mouth of the river Cyaneus, the birth-place of the famous Medea, called from thence, by the poets, *Cytæis;* Saracæ, Zadris, Surium, Madia, and Zoliſſa. As for modern cities, it does not appear that there are any here conſiderable enough to merit a deſcription; or, if there are, they ſeem to be little, if at all, known to Europeans.

MINHO, a great river in Spain, which taking its riſe in Galicia, divides that province from Portugal, and falls into the Atlantic at Caminha.

MINIATURE, in a general ſenſe, ſignifies repreſentation in a ſmall compaſs, or leſs than the reality.

MINIATURE-PAINTING;

A DELICATE kind of painting, conſiſting of little points or dots; uſually done on vellum, ivory, or paper, with very thin, ſimple water-colours.—The word comes from the Latin *minium*, "red-lead;" that being a colour much uſed in this kind of painting. The French frequently call it *mignature*, from *mignon*, "fine, pretty," on account of its ſmallneſs and delicacy: and it may be ultimately derived from μικρος "ſmall."

Miniature is diſtinguiſhed from other kinds of painting by the ſmalluneſs and delicacy of its figures and faintneſs of the colouring; on which account it requires to be viewed very near.

Sect. I. *Of Drawing and Deſigning.*

To ſucceed in this art, a man ſhould be perfectly ſkilled in the art of deſigning or drawing: but as moſt people who affect the one, know little or nothing of the other, and would have the pleaſure of painting without giving themſelves the trouble of learning to deſign (which is indeed an art that is not acquired without a great deal of time, and continual application), inventions have been found out to ſupply the place of it; by means of which a man deſigns or draws, without knowing how to deſign.

The firſt is chalking: that is, if you have a mind to do a print or deſign in miniature, the backſide of it, on another paper, muſt be blackened with ſmall-coal, and then rubbed very hard with the finger wrapped in a linen cloth: afterwards the cloth muſt be lightly drawn over the ſide ſo blackened that no black grains may remain upon it to ſoil the vellum you would paint upon; and the print or draught muſt be faſtened upon the vellum with four pins, to keep it from ſhifting. And if it be another paper that is blackened, it muſt be put between the vellum and the print, or draught, with the blackened ſide upon the vellum. Then, with a blunted pin or needle, you muſt paſs over the principal lines or ſtrokes of the print, or draught, the contours, the plaits of the drapery, and over every thing elſe that muſt be diſtinguiſhed; preſſing ſo hard, that the ſtrokes may be fairly marked upon the vellum underneath.

Copying by ſquares is another convenient method for ſuch as are but little ſkilled in the art of deſigning, and would copy pictures, or other things, that cannot be chalked. The method is this: The piece muſt be

divided

SUPPLEMENT

TO THE THIRD EDITION OF THE

ENCYCLOPÆDIA BRITANNICA,

OR, A

DICTIONARY

OF

ARTS, SCIENCES,

AND

MISCELLANEOUS LITERATURE.

IN TWO VOLUMES.

Illuſtrated with Fifty Copperplates.

By GEORGE GLEIG, LL.D. F.R.S. Edin.

NON IGNORO, QUÆ BONA SINT, FIERI MELIORA POSSE DOCTRINA, ET QUÆ NON OPTIMA, ALIQUO MODO ACUI TAMEN, ET CORRIGI POSSE.——*Cicero.*

VOL. II.

THE SECOND EDITION, WITH IMPROVEMENTS.

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Meninſki, Merchetta.

words are added, from Wankuli and Ferhengi, the beſt Arabic and Perſic lexicographers whom the Eaſt has produced; and from Herbelot are inſerted the names of kingdoms, cities, and rivers, as well as phraſes in common uſe among the Turks, &c. *Diminiſhed*, becauſe many uſeleſs ſynonyma are omitted, which rather puzzled than aſſiſted the ſtudent; as well as all the French, Poliſh, and German interpretations, the Latin being conſidered as ſufficient for all men of learning. *Amended*, with reſpect to innumerable typographical errors; which, however, from a work of this nature, no care can perhaps altogether exclude. The other works of Meninſki were occaſioned chiefly by a violent conteſt between him and a man named J. B. Podeſta, in which much acrimony was employed on both ſides. Theſe it is hardly worth while to enumerate, but they may all be ſeen in the account of his life from which this article is taken (A). It ſhould be obſerved, however, that in 1674, Podeſta publiſhed a book, intitled, "Prodromus novi linguarum orientalium collegii, juſſu Aug. &c. erigendi, in Univ. Viennenſi;" to which Meninſki oppoſed, 2. "Meninſkii Antidotum in Prodromum novi ling. orient. collegii, &c." 4to. But ſuch was the credit of his antagoniſt in the univerſity, that ſoon after there came out a decree in the name of the rector and conſiſtory, in which that antidote of Meninſki's is proſcribed and prohibited, for ſix ſpecific reaſons, as impious and infamous. Meninſki was defended againſt this formidable attack by a friend, in a ſmall tract, intitled, "Veritas defenſa, ſeu juſtitia cauſæ Dn. F. de M. M. [Meninſki] contra infame decretum Univerſitatis Viennenſis, Anno 1674, 23 Novembris, &c. ab Amico luci expoſita, Anno 1675," in which this friend expoſes, article by article, the falſehood of the decree, and exclaims ſtrongly againſt the arts of Podeſta. This tract is in the Britiſh Muſeum. Podeſta was oriental ſecretary to the emperor, and profeſſor of thoſe languages at Vienna; but is deſcribed in a very ſatirical manner by the defender of Meninſki. "Podeſta, natura Semi-Italus, ſtatura nanus, cæcutiens, balbus, imo bardus repertus, aliiſque vitiis ac ſtultitiis plenus, adeoque ad diſcendas linguas orientales inhabilis." A liſt of the works of Podeſta is, however, given by the late editors of Meninſki.

MERCHETTA, or *Marchetta Mulierum*, is commonly ſuppoſed to have been a right which, during the prevalence of the feudal ſyſtem, the lord had of paſſing the firſt night after marriage with his female villain. This opinion has been held by the greater part of our antiquarians; and we have adopted it in our hiſtory of Scotland publiſhed in the *Encyclopædia*. It appears, however, to be a miſtake. That there was a cuſtom called *merchetta mulierum*, which prevailed not only in England, Scotland, Wales, and the iſle of Guernſey, but alſo on the continent, is indeed a fact unqueſtionable; but Mr Aſtle has clearly proved, that, inſtead of being an adulterous connection, the *merchetta* was a compact between the lord and his vaſſal for the redemption of an *offence* committed by that vaſſal's *unmarried* daughter. He admits, however, that it denoted likewiſe a fine paid by a *ſokeman* or a *villain* to his lord for a licence to marry his daughter to a free man; and that if the vaſſal gave her away without obtaining ſuch a licence, he was liable to pay a heavier fine. He quotes two authorities in ſupport of his opinion from Bracton; one of which we ſhall tranſcribe, as being alone complete evidence.

Meridian.

"Ric. Burre tenet unum meſuagium et debet telliagium ſectam curiæ, et *merchet*, hoc modo, *quod ſi maritare voluerit filiam ſuam cum quodam libero homine, extra villam, faciet pacem domini pro maritagio, et ſi eam maritaverit alicui cuſtumario villæ, nihil debuit pro maritagio.*"

"The probable reaſon of the cuſtom (ſays Mr Aſtle) appears to have been this. Perſons of low rank, reſiding on an eſtate, were either *aſcripti glebæ*, or were ſubjected to ſome ſpecies of ſervitude ſimilar to the *aſcripti glebæ*. They were bound to reſide on the eſtate, and to perform ſeveral ſervices to the lord. As women neceſſarily followed the reſidence of their huſbands, the conſequence was, that when a woman of low rank married a ſtranger, the lord was deprived of part of his live ſtock; he therefore required a fine to indemnify him for the loſs of his property," Further particulars on the *merchetta* are to be found in the Appendix to vol. 1ſt of *Sir David Dalrymple's Annals of Scotland.*

MERIDIAN Line, an arch or part of the meridian of the place, terminated each way by the horizon. Or, a meridian line is the interſection of the plane of the meridian of the place with the plane of the horizon, often called a north and ſouth line, becauſe its direction is from north to ſouth.

In the article Astronomy (*Encycl.*), n° 376. and 377. we have given two methods of drawing a meridian line; but it may be proper to add, in this place, the following improvement of the former of theſe from Dr Hutton's Mathematical Dictionary. "As it is not eaſy (ſays the Doctor) to determine preciſely the extremity of the ſhadow, it will be beſt to make the ſtile flat at the top, and to drill a ſmall hole through it, noting the lucid point projected by it on the ſeveral concentric circles, inſtead of marking the extremity of the ſhadow itſelf on theſe circles."

We ſhall give another method of drawing a meridian line from the ſame valuable dictionary.

"Knowing the ſouth quarter pretty nearly, obſerve the altitude FE of ſome ſtars on the eaſt ſide of it, and not far from the meridian HZRN: then, keeping the quadrant firm on its axis, ſo as the plummet may ſtill cut the ſame degree, direct it to the weſtern ſide of the meridian, and wait till you find the ſtar has the ſame altitude as before, as *fe*. Laſtly, biſect the angle EC*e*, formed by the interſection of the two planes in which the quadrant has been placed at the time of the two obſervations, by the right line HR, which will be the meridian ſought." Plate XXXVI.

Magnetical Meridian, is a great circle paſſing thro' or by the magnetical poles; to which meridians the magnetical needle conforms itſelf. See Magnetism, *Suppl.*

MESO-

(A) We have taken this article from the Biographical Dictionary; the editors of which took it from the life of Meninſki prefixed to the new edition of his great work.

Archæologia, vol. xii.

Meſo-Logarithm || Mills.

MESO-LOGARITHM, a term uſed by Kepler to ſignify the logarithms of the coſines and cotangents.

MESURATA, a ſea port of the kingdom of Tripoli, in Africa. A caravan proceeds from this place to Fezzan, and other interior parts toward the ſouth of Africa. It is 260 miles north of Mourzook. E. Lon. 15. 5. N. Lat. 31. 3.

METALLIC TRACTORS. See PERKINISM in this *Suppl.*

METONIC CYCLE, called alſo the *Golden Number*, and *Lunar Cycle*, or *Cycle of the Moon*, that which was invented by Meton the Athenian; being a period of 19 years. See CYCLE, *Encycl.*

MHA RAJAH, the higheſt title of Hindoos.

MICROCOUSTICS, or MICROPHANES, inſtruments contrived to magnify ſmall ſounds, as microſcopes do ſmall objects.

MICROCOSMIC SALT. See CHEMISTRY-*Index*, *Suppl.*

MIDDLE LATITUDE, is half the ſum of two given latitudes; or the arithmetical mean, or the middle between two parallels of latitude. Therefore,

If the latitudes be of the ſame name, either both north or both ſouth, add the one number to the other, and divide the ſum by 2; the quotient is the middle latitude, which is of the ſame name with the two given latitudes. But,

If the latitudes be of different names, the one north and the other ſouth; ſubtract the leſs from the greater, and divide the remainder by 2, ſo ſhall the quotient be the middle latitude, of the ſame name with the greater of the two.

MIDSUMMER-DAY, is held on the 24th of June, the ſame day as the nativity of St John the Baptiſt is held.

MILK, or MILKYET, property in Bengal.

MILLS of various kinds are deſcribed in the article MECHANICS (*Encycl.*); and he who ſhall ſtudy that article, together with *Water-Works*, and MACHINERY, in this *Supplement*, will have a ſufficient knowledge of the principles upon which mills muſt be conſtructed, ſo as that they may produce their proper effects. The ſubject is introduced into this place merely to put it into the power of our countrymen to adopt, if they ſhall think fit, the improvements which have been made in the machinery of flour mills in America. Mills.

The chief of theſe conſiſt in a new application of the ſcrew, and the introduction of what are called elevators, the idea of which was evidently borrowed from the chain-pump. The ſcrew is made by ſticking ſmall thin pieces of board, about three inches long and two wide, into a cylinder, ſo as to form the ſpiral line. This ſcrew is placed in a horizontal poſition, and by turning on its axis it forces wheat or flour from one end of a trough to the other. For inſtance, in the trough which receives the meal immediately coming from the ſtones, a ſcrew of this kind is placed, by which the meal is forced on, to the diſtance of ſix or eight feet, perhaps, into a reſervoir; from thence, without any manual labour, it is conveyed to the very top of the mill by the elevators, which conſiſt of a number of ſmall buckets of the ſize of tea cups, attached to a long band that goes round a wheel at the top, and another at the bottom of the mill. As the band revolves round the wheels, theſe buckets dip into the reſervoir of wheat or flour below, and take their loads up to the top, where they empty themſelves as they turn round the upper wheel. The elevators are incloſed in ſquare wooden tubes, to prevent them from catching in any thing, and alſo to prevent duſt. By means of theſe two ſimple contrivances, no manual labour is required from the moment the wheat is taken to the mill till it is converted into flour, and ready to be packed, during the various proceſſes of ſcreening, grinding, ſifting, &c.

That this is a conſiderable improvement is obvious; and we are not without hopes that it may be adopted. The licentiouſneſs of an Engliſh mob has indeed perſecuted an Arkwright, expelled the inventor of the fly-ſhuttle from his native country, and by ſuch conduct prevented the re-erection of the Albion mills, and the general eſtabliſhment of ſaw-mills through the kingdom; but their ſovereignty perhaps will not be rouſed by ſo eaſy and ſimple a contrivance as this to leſſen the quantity of manual labour. For an account of the Dutch oil-mill, which was ſomehow omitted in its proper place in the *Encyclopædia*, ſee *Oil-Mill* in this *Supplement*.

MINERALOGY

1 Definition.

IS a ſcience, the object of which is the deſcription and arrangement of *inorganic bodies* or *minerals*; or of *all* the bodies which belong to our globe, excepting *animal* and *vegetable* ſubſtances.

Since the publication of the article MINERALOGY, *Encycl.* ſcarcely a ſingle day has paſſed without the diſcovery of ſome new mineralogical fact, or the detection of ſome old and unſuſpected error. Theſe improvements cannot be overlooked in the preſent *Supplement*. But they are ſo numerous in every part of the ſcience, that we can hardly notice them without giving a pretty complete view of the preſent ſtate of mineralogy. This will ſcarcely occupy more room, and muſt be much more uſeful as well as entertaining, than an undigeſted maſs of annotations and remarks. We undertake this taſk the more readily, becauſe in the article MINERALOGY in the *Encyclopædia*, the improvements of Mr Werner and his diſciples, to which the ſcience is indebted for a great part of its preſent accuracy, have been entirely overlooked.

2 Object.

The object of mineralogy is twofold. 1. To *deſcribe* every mineral with ſo much accuracy and preciſion, that it may be eaſily diſtinguiſhed from every other mineral. 2. To *arrange* them into a ſyſtem in ſuch a manner that every mineral may be eaſily referred to its proper place, and that a perſon may be able, merely by the help of the ſyſtem, to diſcover the *name* of any mineral whatever. When theſe two objects are accompliſhed, mineralogy,

Description of Minerals.

neralogy, ſtrictly ſo called, is completed. But were we to ſtop here, the utility of the ſcience, if it would be entitled to the name of ſcience, could hardly be conſidered as very great. We muſt therefore apply *chemiſtry* to diſcover the ingredients of which minerals are compoſed, and to detect, if poſſible, the laws which theſe ingredients have obſerved in their combination. Thus we ſhall really extend our knowledge of inorganic nature, and be enabled to apply that knowledge to the improvement of almoſt every art and manufacture.

3 Diviſion of the article.

Mineralogy naturally divides itſelf into three parts. The *firſt* treats of the method of deſcribing minerals; the *ſecond*, of the method of arranging them; and the *third* exhibits them in a ſyſtem deſcribed and arranged according to the rules laid down in the two firſt parts. Theſe three parts ſhall be the ſubjects of the following chapters; and we ſhall finiſh the article with a chapter on the chemical analyſis of minerals.

Chap. I. Of the Description of Minerals.

Nothing, at firſt ſight, appears eaſier than to deſcribe a mineral, and yet, in reality, it is attended with a great deal of difficulty. The mineralogical deſcriptions of the ancients are ſo looſe and inaccurate, that many of the minerals to which they allude cannot be aſcertained; and conſequently their obſervations, however valuable in themſelves, are often, as far as reſpects us, altogether loſt. It is obvious, that to diſtinguiſh a mineral from every other, we muſt either mention ſome peculiar property, or a collection of properties, which exiſt together in no other mineral. Theſe properties muſt be deſcribed in terms rigidly accurate, which convey preciſe ideas of the very properties intended, and of no other properties. The ſmalleſt deviation from this would lead to confuſion and uncertainty. Now it is impoſſible to deſcribe minerals in this manner, unleſs there be a peculiar term for each of their properties; and unleſs this term be completely underſtood. Mineralogy therefore muſt have a language of its own; that is to ſay, it muſt have a *term* to denote every mineralogical property, and each of theſe terms muſt be accurately defined. The language of mineralogy was invented by the celebrated Werner of Freyberg, and firſt made known to the world by the publication of his treatiſe on *The External Characters of Minerals*. Of this language we ſhall give a view in the following general deſcription of the properties of minerals (A).

4 Properties of minerals.

The properties of minerals may be divided into two claſſes. 1*ſt*, Properties diſcoverable without deſtroying the texture of the mineral; 2*d*, Properties reſulting from the action of other bodies on it. The firſt claſs has, by Werner and his diſciples, been called *external* properties, and by ſome French writers *phyſical*; the ſecond claſs has been called *chemical*.

The *external* properties may be arranged under the following heads:

External Characters.

1. Figure,	8. Ductility,	14. Sound,
2. Surface,	9. Fracture,	15. Smell,
3. Tranſparency,	10. Texture,	16. Taſte,
4. Colour,	11. Structure,	17. Gravity,
5. Scratch,	12. Fragments,	18. Magnetiſm,
6. Luſtre,	13. Feel,	19. Electricity.
7. Hardneſs,		

5 Figure.

I. By figure is meant the ſhape or form which a mineral is obſerved to have. The *figure* of minerals is either *regular*, *particular*, or *amorphous*. 1. Minerals which aſſume a regular figure are ſaid to be cryſtallized *. The *ſides* of a cryſtal are called *faces*; the ſharp line formed by the inclination of two faces is called an *edge*; and the corner, or angle, formed by the meeting of ſeveral edges in one point, is called a *ſolid angle*, or ſimply *an angle*. Thus a cube has ſix faces, twelve edges, and eight angles. 2. Some minerals, though not cryſtallized, affect a *particular* figure. Theſe particular figures are the following: *Globular*, like a globe; *oval*, like an oblong ſpheroid; *ovate*, like an egg; *cheeſe-ſhaped*, a very flattened ſphere; *almond-ſhaped*, like an almond; *centicular*, like a double convex lenſe, compreſſed and gradually thinner towards the edges; *cuneiform*, like a wedge; *nodulous*, having depreſſions and protuberances like a potatoe; *botryoidal*, like grapes cloſely preſſed together; *dentiform*, longiſh and tortuous, and thicker at the bottom than the top; *wireform*, like a wire; *capillary*, like hair, finer than the preceding; *retiform*, threads interwoven like a net; *dentritic*, like a tree, having branches iſſuing from a common ſtem; *ſhrubform*, branches not ariſing from a common ſtem; *coraloidal*, branched like coral; *ſtalactitical*, like icicles; *clavated*, like a club, long, and thicker at one end than another; *faſciform*, long ſtraight cylindrical bodies, united like a bundle of rods; *tubular*, cylindrical and hollow. 3. When minerals have neither a regular nor particular ſhape, they are ſaid to be *amorphous*.

* See Chemistry, Part III. ch. iv. *Suppl.*

6 Surface.

II. By surface is meant the appearance of the external ſurface of minerals. The *ſurface* is either *uneven*, compoſed of ſmall unequal elevations and depreſſions; *ſcabrous*, having very ſmall *ſharp* and rough elevations, more eaſily felt than ſeen; *druſy*, covered with very minute cryſtals; *rough*, compoſed of very minute *blunt* elevations, eaſily diſtinguiſhable by the feel; *ſcaly*, compoſed of very minute thin ſcale-like leaves; *ſmooth*, free from all inequality or roughneſs; *ſpecular*, having a ſmooth poliſhed ſurface like a mirror; or *ſtreaked*, having elevated, ſtraight, and parallel lines. This laſt character is confined to the *ſurface* of cryſtals. The *ſtreaks* are either *tranſverſe*; *longitudinal*; *alternate*, in different directions on different faces; *plumoſe*, running from a middle rib; or *decuſſated*, croſſing each other.

7 Tranſparency.

III. By transparency is meant the proportion of light which minerals are capable of tranſmitting. They are *tranſparent* or *pellucid* when objects can be ſeen diſtinctly through them; *diaphanous*, when objects are

(A) The fulleſt account of Werner's external characters which we have ſeen in the Engliſh language, has been given by Dr Townſon in his *Philoſophy of Mineralogy*. We have availed ourſelves of this book, in order to exhibit ſome of the lateſt improvements of Werner and his diſciples. The reader may alſo conſult *Werner's Treatiſe*, publiſhed at Leipſic in 1774; or the *French tranſlation* publiſhed at Dijon in 1790. See alſo *Romé de Liſle. Des Caracters Exterieur des Mineraux.* And *Hauy Jour. d'Hiſt. Nat.* II. 56.

External Characters.

seen through them indiſtinctly; *ſubdiaphanous*, when light paſſes but in ſo ſmall a quantity that objects cannot be ſeen through them (B); *opaque*, when no light is tranſmitted.

When opaque minerals become tranſparent in water, they are called *hydrophanous*. When objects are ſeen double through a tranſparent mineral, it is ſaid to *refract doubly*.

8 Colour.

IV. The colours of minerals may be reduced to eight claſſes.

1. *Whites.*

Snow white. Pure white.

Reddiſh white. White with a light tint of red.

Yellowiſh white. White with a light tint of yellow.

Silver white. Yellowiſh white with a metallic luſtre.

Greyiſh white. White with a light tint of black.

Greeniſh white. White with a light tint of green.

Milk white. White with a light tint of blue.

Tin white. Milk white of a metallic luſtre.

2. *Greys.*

Bluiſh grey. Grey with a little blue.

Lead grey. Bluiſh grey with a metallic luſtre.

Pearl grey. Light grey with a ſlight mixture of violet blue.

Smoke grey. Dark grey with a little blue and brown.

Greeniſh grey. Light grey tinged with green.

Yellowiſh grey. A light grey tinged with yellow.

Steel grey. A dark grey with a light tint of yellow and a metallic luſtre.

Black grey. The darkeſt grey with a tint of yellow.

3. *Blacks.*

Greyiſh black. Black with a little white.

Browniſh black. Black with a tint of brown.

Black. Pure black.

Iron black. Pure black with a ſmall mixture of white and a metallic luſtre.

Bluiſh black. Black with a tint of blue.

4. *Blues.*

Indigo blue. A dark blackiſh blue.

Pruſſian blue. The pureſt blue.

Azure blue. A bright blue with ſcarce a tint of red.

Smalt blue. A light blue.

Violet blue. A mixture of azure blue and carmine.

Lavender blue. Violet blue mixed with grey.

Sky blue. A light blue with a ſlight tint of green.

5. *Greens.*

Verdigris green. A bright green of a bluiſh caſt.

Seagreen. A very light green, a mixture of verdigris green and grey.

Beryl green. The preceding, but of a yellowiſh caſt.

Emerald green. Pure green.

Graſs green. Pure green with a tint of yellow.

Apple green. A light green formed of verdigris green and white.

Leek green. A very dark green with a caſt of brown.

Blackiſh green. The darkeſt green, a mixture of leek green and black.

Piſtachio green. Graſs green, yellow and a little brown. External Characters.

Olive green. A pale yellowiſh green with a tint of brown.

Aſparagus green. The lighteſt green, yellowiſh with a little brown and grey.

6. *Yellows.*

Sulphur yellow. A light greeniſh yellow.

Braſs yellow. The preceding, with a little leſs green and a metallic luſtre.

Lemon yellow. Pure yellow.

Gold yellow. The preceding with a metallic luſtre.

Honey yellow. A deep yellow with a little reddiſh brown.

Wax yellow. The preceding, but deeper.

Pyritaceous. A pale yellow with grey.

Straw yellow. A pale yellow, a mixture of ſulphur yellow and reddiſh grey.

Wine yellow. A pale yellow with a tint of red.

Ochre yellow. Darker than the preceding, a mixture of lemon yellow with a little brown.

Iſabella yellow. A pale browniſh yellow, a mixture of pale orange with reddiſh brown.

Orange yellow. A bright reddiſh yellow, formed of lemon yellow and red.

7. *Reds.*

Aurora red. A bright yellow red, a mixture of ſcarlet and lemon yellow.

Hyacinth red. A high red like the preceding, but with a ſhade of brown.

Brick red. Lighter than the preceding; a mixture of aurora red and a little brown.

Scarlet red. A bright and high red with ſcarce a tint of yellow.

Copper red. A light yellowiſh red with the metallic luſtre.

Blood red. A deep red, a mixture of crimſon and ſcarlet.

Carmine red. Pure red verging towards a caſt of blue.

Cochineal red. A deep red; a mixture of carmine with a little blue and a very little grey.

Crimſon red. A deep red with a tint of blue.

Fleſh red. A very pale red of the crimſon kind.

Roſe red. A pale red of the cochineal kind.

Peach bloſſom red. A very pale whitiſh red of the crimſon kind.

Mordoré. A dark dirty crimſon red; a mixture of crimſon and a little brown.

Browniſh red. A mixture of blood red and brown.

8. *Browns.*

Reddiſh brown. A deep brown inclining to red.

Clove brown. A deep brown with a tint of carmine.

Yellowiſh brown. A light brown verging towards ochre yellow.

Umber brown. A light brown, a mixture of yellowiſh brown and grey.

Hair brown. Intermediate between yellow brown and clove brown with a tint of grey.

Tombac brown. A light yellowiſh brown, of a metallic luſtre, formed of gold yellow and reddiſh brown.

Liver

(B) After Mr Kirwan, we have denoted theſe three degrees of tranſparency by the figures 4, 3, 2. When a mineral is ſubdiaphanous only at the edges, that is denoted by the figure 1. Opacity is ſometimes denoted by 0.

External Characters.

Liver brown. A dark brown; blackish brown with a tint of green.

Blackish brown. The darkest brown.

Colours, in respect of intensity, are either *dark*, *deep*, *light*, or *pale*. When a colour cannot be referred to any of the preceding, but is a mixture of two, this is expressed, by saying, that the prevailing one *verges* towards the other, if it has only a small tint of it; *passes* into it, if it has a greater.

9 Streak.

V. By the SCRATCH or STREAK, is meant the mark left when a mineral is scratched by any hard body, as the point of a knife. It is either *similar*, of the same colour with the mineral; or *dissimilar*, of a different colour.

10 Lustre.

VI. LUSTRE, is the gloss, or brightness which appears on the external surface of a mineral, or on its internal surface when fresh broken. The first is called *external*, the second *internal* lustre. Lustre is either *common*, that which most minerals possess; *silky*, like that of silk or mother-of-pearl; *waxy*, like that of wax; *greasy*, like that of grease; or *metallic*, like that of metals.

As to the degree, the greatest is called *splendent*, the next *shining*, the third *dullish*; and when only a few scattered particles shine, the lustre is called *dull* (c).

11 Hardness.

VII. We have used figures to denote the comparative HARDNESS of bodies; for an explanation of which, we refer to the article CHEMISTRY, Vol. I. p. 226. of this *Supplement*.

12 Ductility and brittleness.

VIII. With respect to DUCTILITY and BRITTLENESS, minerals are either *malleable*; *sectile*, capable of being cut without breaking, but not malleable; *flexile*, capable of being bent, and when bent retaining their shape; or *elastic*, capable of being bent, but recovering their former shape. Minerals destitute of these properties are *brittle*. Brittle minerals, with respect to the ease with which they may be broken, are either *very tough*, *tough*, *fragile*, or *very fragile*.

13 Fracture.

IX. By FRACTURE is meant the fresh surface which a mineral displays when broken. It is either *flat*, without any general elevation or depression; or *conchoidal*, having wide extended roundish hollows and gentle risings. When these are not *very* evident, the fracture is called *flat* conchoidal; when they are small, it is called *small* conchoidal; and when of great extent, *great* conchoidal.

The fracture may also be *even*, free from all asperities; *uneven*, having many small, sharp, abrupt, irregular elevations and inequalities; and from the size of these, this fracture is denominated *coarse*, *small*, or *fine*; *splintery*, having small, thin, half detached, sharp edged splinters, according to the size of which this fracture is denominated *coarse* or *fine*; or *rugged*, having many very minute sharp hooks, more sensible to the hand than the eye.

14 Texture.

X. By TEXTURE is meant the internal structure or disposition of the matter of which a mineral is composed, which may be discovered by breaking it. The texture is either *compact*, without any distinguishable parts, or the appearance of being composed of smaller parts; *earthy*, composed of very minute *almost* imperceptible rough parts; *granular*, composed of small shapeless grains; *globuliform*, composed of small spherical bodies; *fibrous*, composed of fibres which may be *long*, *short*, *straight*, *crooked*, *parallel*, *divergent*, *stellated*, *fasciculated*, or *decussated*; *radiated*, consisting of long narrow flattish lamellæ; or *lamellar* or *foliated*, consisting of smooth continued plates covering each other; these plates may be either *straight*, *crooked*, or *undulating*. External Characters.

15 Structure.

XI. The STRUCTURE or COMPOUND TEXTURE is the manner in which the parts that form the texture are disposed. It is either *slaty*, in straight layers like slate; *testaceous*, in incurvated layers; *concentric*, in concentric layers; or *columnar*, in columns.

The *texture* and *structure* may at first view appear the same; but in reality they are very different. Thus common slate has often the *slaty structure* and *earthy texture*. The texture of pitcoal is compact, but its structure is often slaty.

16 Fragments.

XII. By FRAGMENTS is meant the shape of the pieces into which a mineral breaks when struck with a hammer. They are either *cubic*; *rhomboidal*; *wedge-shaped*; *splintery*, thin, long, and pointed; *tabular*, thin, and broad, and sharp at the corners, as common slate; or *indeterminate*, without any particular resemblance to any other body. The *edges* of indeterminate fragments are either *very sharp*, *sharp*, *sharpish*, or *blunt*.

17 Feel.

XIII. By the FEEL of minerals is meant the sensation which their surfaces communicate when handled. The feel of some minerals is *greasy*, of others, *dry*, &c.

18 Sound.

XIV. Some minerals when struck give a *clear* SOUND, as common slate; others a *dull* sound.

The SMELL, TASTE, SPECIFIC GRAVITY, and MAGNETISM of minerals, require no explanation.

With respect to ELECTRICITY, some minerals become electric when *heated*, others when *rubbed*, others cannot be rendered electric. The electricity of some minerals is *positive* or *vitreous*, of others *negative* or *resinous*.

As for the CHEMICAL properties of minerals, they have been already explained in the article CHEMISTRY, which makes a part of this *Supplement*. And for the description of the blow-pipe, and the manner of using it, we refer the reader to a treatise on that subject prefixed to the article MINERALOGY in the *Encyclopædia*.

CHAP. II. Of the ARRANGEMENT of MINERALS.

MINERALS may be arranged two ways, according to their external characters, and according to their chemical composition. The first of these methods has been called an *artificial* classification; the second, a *natural* one. The first is indispensably necessary for the student of nature; the second is no less indispensable for the proficient who means to turn his knowledge to account. Without the first, it is impossible to discover the *names* of minerals; and without the second, we must remain ignorant of their use.

Almost every system of mineralogy hitherto published, at least since the appearance of Werner's *external characters*, has attempted to combine these two arrangements, and to obtain at one and the same time the advantages peculiar to each. Bnt no attempt of this kind has hitherto succeeded. Whether this be owing to any thing impossible in the undertaking, or to the

(c) These four degrees have been denoted by Kirwan by the figures 4, 3, 2, 1, and no lustre by 0. We have imitated him in the present article.

Artificial Syſtem.

preſent imperfect ſtate of mineralogy, as is more probable, we do not take upon us to determine. But ſurely the want of ſucceſs, which has hitherto attended all attempts to combine the two arrangements, ought to ſuggeſt the propriety of ſeparating them. By adhering ſtrictly to one language, the trouble of ſtudying two different ſyſtems would be entirely prevented. They would throw mutual light upon each other; the artificial ſyſtem would enable the ſtudent to diſcover the *names* of minerals; the natural would enable him to arrange them, and to ſtudy their properties and uſes.

The happy arrangement of Cronſtedt, together with the ſubſequent improvements of Bergman, Werner, Kirwan, Hauy, and other celebrated mineralogiſts, has brought the *natural* ſyſtem of mineralogy to a conſiderable degree of perfection. But an *artificial* ſyſtem is ſtill a deſideratum; for excepting Linnæus, whoſe ſucceſs was precluded by the ſtate of the ſcience, no one has hitherto attempted it. Though we are very far from thinking ourſelves ſufficiently qualified for undertaking ſuch a taſk, we ſhall nevertheleſs venture, in the next chapter, to ſketch out the rudiments of an artificial ſyſtem. The attempt, at leaſt, will be laudable, even though we ſhould fail.

Chap. III. Artificial System.

19 Artificial claſſes.

Minerals may be divided into ſix claſſes:

1. Minerals that cannot be fuſed by the blow-pipe *per ſe*.
2. Minerals fuſible *per ſe* by the blow-pipe.
3. Minerals fuſible by the blow-pipe *per ſe* when expoſed to the blue flame, but not when expoſed to the yellow flame.
4. Minerals fuſible *per ſe* by the blow-pipe; and when in fuſion, partly evaporating in a viſible ſmoke.
5. Minerals which totally evaporate before the blow-pipe.
6. Minerals totally ſoluble in muriatic acid with effervescence, the ſolution colourleſs.

Under theſe heads we ſhall arrange the ſubjects of the mineral kingdom.

Class I. INFUSIBLE.

ORDER I. Specific gravity from 16 to 12.
- Genus I. Colour whitiſh iron grey.
  - *Species* 1. Native platinum.

ORDER II. Sp. gr. 8.5844 to 7.006.
- Genus I. Attracted by the magnet.
  - *Sp.* 1. Native iron.
- Genus II. Not attracted by the magnet.
  - *Sp.* 1. Native copper.
    Flexible and malleable. Colour uſually red.
  - *Sp.* 2. Wolfram.
    Brittle. Colour uſually brown or black.

ORDER III. Sp. gr. from 6.4509 to 5.8.
- Genus I. Forms a blue glaſs with microcoſmic ſalt, which becomes colourleſs in the yellow, but recovers its colour in the blue flame.
  - *Sp.* 1. Tungſtat of lime.
- Genus II. Forms with microcoſmic ſalt a permanently coloured bead.
  - *Sp.* 1. Sulphuret of cobalt.

ORDER IV. Sp. gr. from 4.8 to 4.5.
- Genus I. Tinges borax dark green.
  - *Sp.* 1. Common magnetic iron ſtone.
- Genus II. Tinges borax reddiſh brown.
  - *Sp.* 1. Grey ore of manganeſe.

ORDER V. Sp. gr. from 4.4165 to 3.092. Infuſible with fixed alkalies.
- Genus I. Hardneſs 20.
  - *Sp.* 1. Diamond.
- Genus II. Hardneſs 15 to 17. Cauſes ſingle refraction.
  - *Sp.* 2. Teleſia.
  - *Sp.* 2. Corundum.
- Genus III. Hardneſs 13. Single refraction.
  - *Sp.* 1. Ruby.
    Cryſtallizes in octahedrons.
- Genus IV. Hardneſs 12. Single refraction.
  - *Sp.* Chryſoberyl.
- Genus V. Hardneſs 12. Cauſes double refraction. Becomes electric when heated.
  - *Sp.* 1. Topaz.
- Genus VI. Hardneſs 10 to 16. Double refraction. Sp. gr. 4.2 to 4.165.
  - *Sp.* 1. Zircon.
- Genus VII. Hardneſs 6 to 9. Feels greaſy.
  - *Sp.* 1. Cyanite.
- Genus VIII. Hardneſs 9 to 10. Feel not greaſy. Double refraction. Sp. gr. 3.283 to 3.285.
  - *Sp.* 1. Chryſolite.
- Genus IX. Hardneſs 12. Infuſible with borax. Colour of large maſſes black, of thin pieces deep green.
  - *Sp.* 1. Cylanite.

(Phoſphat of lime.)

ORDER VI. Sp. gr. from 2.9829 to 1.987. Infuſible with fixed alkalies.
- Genus I. Hardneſs 12.
  - *Sp.* 1. Emerald.
- Genus II. Hardneſs 10.
  - *Sp.* 1. Jade.
- Genus III. Hardneſs 6 to 7. Somewhat tranſparent.
  - *Sp.* 1. Phoſphat of lime.
    Before the blow-pipe becomes ſurrounded with a luminous green vapour.
- Genus IV. Hardneſs 6. Opaque.
  - *Sp.* 1. Micarelle.
- Genus V. Stains the fingers. Colour lead grey.
  - *Sp.* 1. Plumbago.
    Spaniſh wax rubbed with plumbago does not become electric; or if it does, the electricity is negative. Streak lead grey even on earthen ware.

ORDER VII. Sp. gr. from 4.7385 to 4.569. Fuſible with fixed alkalies.
- Genus I. Stains the fingers. Colour lead grey.
  - *Sp.* 1. Molybdena.
    Spaniſh wax rubbed with molybdena becomes poſitively electric. Streak on earthen ware yellowiſh green.

ORDER VIII. Sp. gr. from 4.1668 to 2.479. Fuſible with fixed alkalies.

* Hardneſs from 10 to 12.

Genus

Genus I. Uſually white. Cryſtals dodecahedrons. Double refraction. Fracture imperfectly conchoidal or ſplintery. Brittle.
Sp. 1. Quartz.
Genus II. Uſually dark brown. Fracture perfectly conchoidal. Brittle. Eaſily breaks into ſplinters.
Sp. 1. Flint.
Genus III. Not brittle. Fracture even or imperfectly conchoidal.
Sp. 1. Chalcedony.
Sp. 2. Jaſper.
Genus IV. Forms with potaſs a violet glaſs, with ſoda or borax a brown glaſs, with microcoſmic ſalt a honey yellow glaſs. Colour green. Amorphous.
Sp. 1. Chryſopraſium.
Genus V. Tinges ſoda red. The colour diſappears before the blue flame, and returns before the yellow flame.
Sp. 1. Oxide of manganeſe and barytes.
Sp. 2. Black ore of manganeſe.
Sp. 3. Carbonat of manganeſe.
(Brown ore of iron. Red ore of iron.)
** Hardneſs 9 to 3.
Genus VI. Flexible and elaſtic in every direction.
Sp. 1. Elaſtic quartz.
Genus VII. Emits white flakes before the blow-pipe.
Sp. 1. Blende.
Genus VIII. Becomes electric when heated.
Sp. 1. Calamine.
Genus IX. Tinges borax green. Blackens before the blow-pipe.
Sp. 1. Mountain blue.
Colour blue.
Sp. 2. Green carbonat of copper.
Colour green.
Genus X. Tinges borax green. Becomes attractable by the magnet by the action of the blow-pipe.
Sp. 1. Brown iron ore.
Colour brown.
Sp. 2. Red iron ore.
Colour red.
Genus XI. Tinges borax ſmutty yellow. Becomes browniſh black before the blow-pipe.
Sp. 1. Carbonat of iron.
Genus XII. Feels greaſy.
Sp. 1. Steatites.
(Black ore of Manganeſe. Carbonat of manganeſe. Mica.)

ORDER IX. Sp. gr. from 2.39 to 1.7.
Genus I. Luſtre glaſſy.
Sp. 1. Opal.
Sp. 2. Hyalite.
Genus II. Luſtre greaſy.
Sp. 1. Pitchſtone.
Genus III. Luſtre waxy or pearly.
Sp. 1. Staurolite.

Class II. FUSIBLE.

ORDER I. Sp. gr. from 19 to 10.
Genus I. Colour yellow.
Sp. 1. Native gold.
Genus II. Colour white.
Sp. 1. Native ſilver.
Genus III. Colour yellowiſh white.
Sp. 1. Alloy of ſilver and gold.

ORDER II. Sp. gr. from 7.786 to 4.5.
Genus I. Flexible and malleable.
Sp. 1. Sulphuret of ſilver.
** Brittle.
Genus II. Tinges borax white.
Sp. Tinſtone.
Genus III. Tinges borax green.
Sp. 1. Sulphuret of copper.
Colour bluiſh grey.
Sp. 2. Chromat of lead.
Colour aurora red.
Sp. 3. Purple copper ore.
Colour purple.
Genus IV. Tinges borax faint yellow. Becomes black when expoſed to the vapour of ſulphuret of ammonia.
Sp. 1. Galena.
Colour bluiſh grey. Luſtre metallic. Fragments cubic.
Sp. 2. Black lead ore.
Colour black. Luſtre metallic.
Sp. 3. Lead ochre.
Colour yellow, grey, or red. Luſtre o.
Sp. 4. Carbonat of lead.
Colour white. Luſtre waxy.
Sp. 5. Phoſphat of lead.
Uſually green. Luſtre waxy. After fuſion by the blow-pipe cryſtallizes on cooling.
Sp. 6. Molybdat of lead.
Colour yellow. Streak white. Luſtre waxy.

ORDER III. Sp. gr. from 4.35 to 3.
* Hardneſs 14 to 9.
Genus I. Melts without frothing into a grey enamel.
Sp. 1. Garnet.
Colour red.
Genus II. Melts into a browniſh enamel.
Sp. 1. Shorl.
Colour black. Opaque.
Genus III. Froths and melts into a white enamel.
Sp. 1. Tourmaline.
Becomes electric by heat.
Genus IV. Froths and melts into a greeniſh black enamel.
Sp. 1. Baſaltine.
Genus V. Froths and melts into a black enamel.
Sp. 1. Thallite.
Colour dark green.
Sp. 2. Thumerſtone.
Colour clove brown.
** Hardneſs 5 to 8.
Genus VI. Melts into a tranſparent glaſs.
Sp. 1. Fluat of lime.
Powder phoſphoreſces when thrown on a hot iron.
Genus VII. Melts into a black glaſs.

Sp. 1.

Artificial System.

Sp. 1. Hornblende.

GENUS VIII. Melts into a black bead with a ſulphureous ſmell, and depoſits a blue oxide on the charcoal.

Sp. 1. Sulphuret of tin.

GENUS IX. Melts into a brown glaſs. Tinges borax violet.

Sp. 1 Aſbeſtoid.
Colour green.

GENUS X. Melts into a brown (?) glaſs. When fuſed with potaſs, and diſſolved in water, the ſolution becomes of a fine orange yellow.

Sp. 1. Chromat of iron.

GENUS XI. Before the blow-pipe yields a bead of copper.

Sp. 1. Red oxide of copper.
(Sulphuret of copper.)

ORDER IV. Sp. gr. from 2.945 to 2.437.

GENUS I. Compoſed of ſcales.

Sp. 1. Talk.
Feels greaſy. Spaniſh wax rubbed by it becomes poſitively electric.

GENUS II. Compoſed of thin plates, eaſily ſeparable from each other.

Sp. 1. Mica.
Plates flexible and elaſtic, may be torn but not broken. Spaniſh wax rubbed by it becomes negatively electric.

Sp. 2. Stilbite.
Plates ſomewhat flexible. Colour pearl white. Powder renders ſyrup of violets green. Froths and melts into an opaque white enamel.

Sp. 3. Lepidolite.
Colour violet. Powder white with a tint of red. Froths and melts into a white ſemitranſparent enamel full of bubbles.

GENUS III. Texture foliated.

Sp. 1. Felſpar.
Fragments rhomboidal. Hardneſs 9 to 10.

Sp. 2. Leucite.
Always cryſtallized. White. Powder renders ſyrup of violets green. Hardneſs 8 to 10.

Sp. 3. Argentine felſpar.
Always cryſtallized. Two faces dead white, two ſilvery white.

Sp. 4. Prehnite.
Colour green. Froths and melts into a brown enamel.

GENUS IV. Texture fibrous. Fibres eaſily ſeparated.

Sp. 1. Aſbeſtus.
Feels ſomewhat greaſy.

GENUS V. Texture ſtriated.

Sp. 1. Ædelite.
Abſorbs water. Froths and melts into a frothy maſs.

GENUS VI. Texture earthy or compact.

Sp. 1. Lazulite.
Froths and melts into a yellowiſh black maſs. If previouſly calcined, gelatinizes with acids.

Artificial System.

Sp. 2. Borat of lime.
Tinges the flame greeniſh, froths and melts into a yellowiſh enamel garniſhed with ſmall projecting points. If the blaſt be continued, theſe dart off in ſparks.

ORDER V. Sp. gr. from 2.348 to 0.68.

GENUS I. Hardneſs 10.

Sp. 1. Obſidian.
Colour blackiſh, in thin pieces green.

GENUS II. Hardneſs 6 to 8.

Sp. 1. Zeolite.
Gelatinizes with acids. Becomes electric by heat.

GENUS III. Hardneſs 3 to 4.

Sp. 1. Amianthus.
Feels greaſy. Texture fibrous.

Sp. 2. Mountain cork.
Elaſtic like cork.

CLASS III. FUSIBLE BY THE BLUE FLAME, INFUSIBLE BY THE YELLOW.

GENUS I. Sp. gr. from 4.43 to 4.4.

Sp. 1. Sulphat of barytes.

GENUS II. Sp. gr. from 3.96 to 3.51.

Sp. 1. Sulphat of ſtrontites.

GENUS III. Sp. gr. from 2.311 to 2.167.

Sp. 1. Sulphat of lime.

CLASS IV. FUSIBLE, AND PARTLY EVAPORATING.

ORDER I. Sp. gr. from 10 to 5.

GENUS I. Colour white or grey. Luſtre metallic.
* Sp. gr. 9 to 10.

Sp. 1. Native amalgam.
Tinges gold white. Creaks when cut.

Sp. 2. Alloy of ſilver and antimony.
Powder greyiſh black.
** Sp. gr. from 6.467 to 5.309.

Sp. 3. Sulphuret of biſmuth.
Melts when held to the flame of a candle.

Sp. 4. Dull grey cobalt ore.
Streak bluiſh grey. Hardneſs 10. When ſtruck emits an arſenical ſmell. Luſtre ſcarcely metallic.

GENUS II. Colour red, at leaſt of the ſtreak.

Sp. 1. Red ſilver ore.
Burns with a blue flame.

Sp. 2. Hepatic mercurial ore.
Does not flame, but gives out mercury before the blow-pipe.

GENUS III. Colour blue.

Sp. 1. Blue lead ore.
Burns with a blue flame and ſulphureous ſmell, and leaves a button of lead.

GENUS IV. Colour yellowiſh green.

Sp. 1. Phoſphat and arſeniat of lead combined.
When fuſed by the blow-pipe, cryſtallizes on cooling.

GENUS V. Colour uſually that of copper. Sp. gr.

Artificial Syſtem.

gr. 6.6084 to 6 6481.
Sp. 1. Sulphuret of nickel.
Exhales before the blow-pipe an arſenical ſmoke.

ORDER II. Sp. gr. from 4.6 to 3.44.
GENUS I. Colour grey.
Sp. 1. Grey ore of antimony.
Burns with a blue flame, and leaves a white oxyd.
Sp. 2. Grey copper ore.
Crackles before the blow-pipe.
GENUS II. Colour yellow.
Sp. 1. Pyrites.
Burns with a blue flame and ſulphureous ſmell, and leaves a browniſh bead.
Sp. 2. Yellow copper ore.
Melts into a black maſs.

CLASS V. EVAPORATING.

ORDER I. Sp. gr. 13.6.
GENUS I. Fluid.
Sp. 1. Native mercury.

ORDER II. Sp. gr. from 10 to 5.419.
GENUS I. Colour red.
Sp. 1. Native cinnibar.
GENUS II. Colour white or grey. Luſtre metallic.
Sp. 1. Native biſmuth.
Melts into a white bead, and then evaporates in a yellowiſh white ſmoke. Sp. gr. 9 to 9.5.
Sp. 2. Native antimony.
Melts and evaporates in a grey ſmoke. Sp. gr. 6.6 to 6.8.
Sp. 3. Native arſenic.
Evaporates without melting, and gives out a garlic ſmell.

ORDER III. Sp. gr. from 4.8 to 3.33.
GENUS I. Colour red.
Sp. 1. Red antimonial ore.
Melts with a ſulphureous ſmell. Sp. gr. 4.7.
Sp. 2. Realgar.
Melts with a garlic ſmell. Sp. gr. 3.384
GENUS II. Colour yellow.
Sp. 1. Orpiment.

CLASS VI. SOLUBLE WITH EFFERVESCENCE IN MURIATIC ACID.

Natural Syſtem.

GENUS I. Sp. gr. from 4.338 to 4.3.
Sp. 1. Carbonat of barytes.
GENUS II. Sp. gr. from 3.66 to 3.4.
Sp. 1. Carbonat of ſtrontites.
GENUS III. Sp. gr. from 2.8 to 1 or under.
Sp. 1. Carbonat of lime.

We have purpoſely avoided giving names to the claſſes, orders, and genera; becauſe a more careful examination will doubtleſs ſuggeſt many improvements in the arrangement, and an artificial ſyſtem ought to be brought to a great degree of perfection before its claſſes, orders, and genera be finally ſettled.

We have excluded from this arrangement all thoſe bodies which in the following ſyſtem are arranged under the claſs of combuſtibles; becauſe there can ſcarcely be any difficulty in diſtinguiſhing them both from the other claſſes and from one another. For ſimilar reaſons we have excluded the claſs of ſalts.

CHAP. IV. NATURAL SYSTEM.

Avicenna, a writer of the 11th century, divided minerals into four claſſes; ſtones, ſalts, inflammable bodies, and metals (D). This diviſion has been, in ſome meaſure, followed by all ſucceeding writers. Linnæus, indeed, the firſt of the moderns who publiſhed a ſyſtem of mineralogy, being guided by the external characters alone, divided minerals into three claſſes, *petræ*, *mineræ*, *foſſilia:* but Avicenna's claſſes appear among his orders. The ſame remark may be made with reſpect to the ſyſtems of Wallerius, Wolſterdorf, Cartheuſer, and Juſti, which appeared in ſucceſſion after the firſt publication of Linnæus's *Syſtema Naturæ*, in 1736. At laſt in 1758, the ſyſtem of Cronſtedt appeared. He reinſtated the claſſes of Avicenna in their place; and his ſyſtem was adopted by Bergman, Kirwan, Werner, and the moſt celebrated mineralogiſts who have written ſince. We alſo ſhall adopt his claſſes, with a few ſlight exceptions; becauſe we are not acquainted with any other diviſion which is intitled to a preference.

We ſhall therefore divide this treatiſe into four claſſes. I. Stones. II. Salts. III. Combuſtibles. IV. Ores. 20 Natural Claſſes.

The firſt claſs comprehends all the minerals which are compoſed chiefly or entirely of earths; the ſecond, all the combination of acids and alkalies which occur in the mineral kingdom; the third, thoſe minerals which are capable of combuſtion, and which conſiſt chiefly of ſulphur, carbon, and oil; the fourth, the mineral bodies which are compoſed chiefly of metals.

CLASS I. EARTHS AND STONES.

WE ſhall divide this claſs into three orders. The firſt order ſhall comprehend all chemical combinations of earths with each other; the ſecond order, chemical combinations of earths with acids; and the third order, mechanical mixtures of earths or ſtones. All the minerals belonging to the firſt order exhibit the ſame homogeneous appearance to the eye as if they were ſimple bodies. We ſhall therefore, for want of a better name, call the firſt order *ſimple;* the ſecond order we ſhall diſtinguiſh by the epithet of *faline;* and the third we ſhall call

(D) Corpora mineralia in quatuor ſpecies dividuntur, ſcilicet in lapides, et in liquifactiva, ſulphurea, et ſales. Et horum quædam ſunt raræ ſubſtantiæ et debilis compoſitionis, et quædam fortis ſubſtantiæ, et quædam ductibilia, et quædam non. *Avicenna de congelatione et conglutinatione lapidum*, Cap. 3. *Theatrum Chemicum* t. iv. p. 997.

Earths and Stones.

call *aggregates*; becauſe moſt of the minerals belonging to it conſiſt of various *ſimple ſtones*, cemented, as it were, together.

Order I. SIMPLE STONES.

21 Cronſtedt's genera.

Cronstedt divided this order into nine genera, correſponding to nine earths; one of which he thought compoſed the ſtones arranged under each genus. The names of his genera, were *calcareæ*, *ſilicæ*, *granatinæ*, *argillaceæ*, *micaceæ*, *fluores*, *aſbeſtinæ*, *zeolithicæ*, *magneſiæ*. All his earths were afterwards found to be compounds, except the firſt, ſecond, fourth, and ninth. Bergman, therefore, in his Sciagraphia, firſt publiſhed in 1782, reduced the number of genera to five; which was the number of primitive earths known when he wrote. Since that period three new earths have been diſcovered. Accordingly, in the lateſt ſyſtems of mineralogy, the genera belonging to this order amount to eight. Each genus is named from an earth; and they are arranged in the neweſt Wernerian ſyſtem, which we have ſeen, as follows:

22 Improved.

1. Jargon genus.
2. Siliceous genus.
3. Glucina genus.
4. Argillaceous genus.
5. Magneſian genus.
6. Calcareous genus.
7. Barytic genus.
8. Strontian genus.

Mr Kirwan, in his very valuable ſyſtem of mineralogy, has adopted the ſame genera. Under each genus, thoſe ſtones are placed, which are compoſed chiefly of the earth which gives a name to the genus, or which at leaſt are ſuppoſed to poſſeſs the characters which diſtinguiſh that earth.

23 Still deficient.

A little conſideration will be ſufficient to diſcover that there is no natural foundation for theſe genera. Moſt ſtones are compoſed of two, three, or even four ingredients; and, in many caſes, the proportion of two or more of theſe is nearly equal. Now, under what genus ſoever ſuch minerals are arranged, the earth which gives it a name muſt form the ſmalleſt part of their compoſition. Accordingly, it has not been ſo much the chemical compoſition, as the external character, which has guided the mineralogiſt in the diſtribution of his ſpecies. The genera cannot be ſaid properly to have any character at all, nor the ſpecies to be connected by any thing elſe than an arbitrary title. This defect, which muſt be apparent in the moſt valuable ſyſtems of mineralogy, ſeems to have ariſen chiefly from an attempt to combine together an artificial and natural ſyſtem. As we have ſeparated theſe two from each other, it becomes neceſſary for us to attend more accurately to the natural diſtribution of genera than has hitherto been done. We have accordingly ventured to form new genera for this order, and we have formed them according to the following rules.

24 New genera.

The only ſubſtances which enter into the minerals belonging to this order, in ſuch quantity as to deſerve attention, are the following:

Alumina,	Glucina,
Silica,	Zirconia,
Magneſia,	Oxide of iron,
Lime,	Oxide of chromum,
Barytes,	Potaſs,

Simple Stones.

All thoſe minerals which are compoſed of the *ſame* ingredients we arrange under the *ſame* genus. According to this plan, there muſt be as many genera as there are varieties of combinations of the above ſubſtances exiſting in nature. The varieties in the *proportion* of the ingredients conſtitute ſpecies. We have not impoſed names upon our genera, but, in imitation of Bergman*, have denoted each by a ſymbol. This ſymbol is compoſed of the firſt letter of every ſubſtance which enters in any conſiderable quantity into the compoſition of the minerals arranged under the genus denoted by it. Thus, ſuppoſe the minerals of a genus to be compoſed of *alumina*, *ſilica*, and *oxide of iron*, we denote the genus by the ſymbol *aſi*. The letters are arranged according to the proportion of the ingredients; that which enters in the greateſt proportion being put firſt, and the others in their order. Thus the genus *aſi* is compoſed of a conſiderable proportion of alumina, of a ſmaller proportion of ſilica, and contains leaſt of all of iron. By this contrivance, the ſymbol of a genus contains, within the compaſs of a few letters, a pretty accurate deſcription of its nature and character. Where the proportions of the ingredients vary in the ſame genus ſo much, that the letters which conſtitute its ſymbol change their place, we ſubdivide the genus into parts; and whenever the minerals belonging to any genus become too numerous, advantage may be taken of theſe ſubdiviſions, and each of them may be formed into a ſeparate genus. At preſent this ſeems unneceſſary (E).

* *Opuſc* iv. 231.

The following is a view of the different genera belonging to this order, denoted each by its ſymbol. Every genus is followed by the ſpecies included under it; and the whole are in the order which we mean to follow in deſcribing them:

I. A.
- Teleſia,
- Corundum,
- Native alumina.

II. AMC.
- Ruby.

III. AIM.
- Ceylanite.

IV. S.
- Quartz,
- Elaſtic quartz,
- Flint,
- Opal,
- Pitchſtone,
- Chryſopraſium.

V. 1. AS.
- Topaz,
- Sommite,
- Shorlite.

2. SA.
- Rubellite,
- Hornſlate,
- Hornſtone,
- Chalcedony,
- Jaſper.
- Tripoli.

VI. 1. ASI.
- Micarell,
- Shorl,
- Granatite,

2. SAI.
- Tourmaline,
- Argentine felſpar,
- Mica,
- Talc,
- Baſaltine,
- Hornblende,
- Obſidian,
- Petrilite,
- Felſite.

VII. SAP.
- Felſpar,
- Lepidolite,
- Leucite.

VIII. SAG.
- Emerald.

IX. SAB.
- Staurolite.

X. 1. ASL.
- Chryſoberyl.

2. SAL.
- Hyalite,
- Ædelite.

3. SAWL.

(E) We need hardly remark, that the laſt three genera of Werner belong to the ſecond order of the firſt claſs of this treatiſe.

Earths and Stones.

3. SAWL.
Zeolite,
Stilbite,
Analcime.
4. SLA.
Lazulite.
XI. SALI.
Garnet,
Thumerſtone,
Prehnite,
Thallite.
XII. I. AMS.
Cyanite.
2. MSA.
Serpentine.
XIII. MSAI.
Potſtone,
Chlorite.
XIV. SLAM.
Siliceous ſpar.
XV. SAMLI.
Argillite.
XVI. SM.
Kiffekill,
Steatites.
XVII. MSI.
Chryſolite,
Jade.
XVIII. SML.
Aſbeſtus,
Aſbeſtinite.
XIX. I. SILM.
Pyroxen,
Aſbeſtoid.
2. SMIL.
Actinolite.
XX. SL.
Shiſtoſe hornſtone.
XXI. ZS.
Zircon.

25
G. I. A.
Teleſia.

GENUS I. A.

SPECIES 1. Teleſia (F).

Oriental ruby, *ſapphire*, and *topaz* of mineralogiſts.—*Rubis d'orient* of De Liſle.

Three ſtones, diſtinguiſhed from each other by their colour, have long been held in high eſtimation on account of their hardneſs and beauty. Theſe ſtones were known among lapidaries by the names of *ruby*, *ſapphire*, and *topaz*, and the epithet *oriental* was uſually added, to diſtinguiſh them from other three, known by the ſame names and the ſame colours, but very inferior in hardneſs and beauty. Mineralogiſts were accuſtomed to conſider theſe ſtones as three diſtinct ſpecies, till Romé de Liſle obſerved that they agreed in the form of their cryſtals, their hardneſs, and moſt of their other properties. Theſe obſervations were ſufficient to conſtitute them one ſpecies; and accordingly they were made one ſpecies by Romé de Liſle himſelf, by Kirwan, and ſeveral other modern mineralogical writers. But this ſpecies was deſtitute of a proper name, till Mr Hauy, whoſe labours, diſtinguiſhed equally by their ingenuity and accuracy, have contributed not a little to the progreſs of mineralogy, denominated it *teleſia*, from the Greek word τελεσις, which ſignifies *perfect*.

The teleſia is found in the Eaſt Indies, eſpecially in Pegu and the iſland of Ceylon; and it is moſt commonly cryſtallized. The cryſtals are of no great ſize: Their *primitive* form, according to Mr Hauy, is a regular ſix-ſided priſm, diviſible in directions parallel both to its baſes and its ſides; and conſequently giving for the form of its primitive nucleus, or of its *integrant molecule*, an equilateral three-ſided priſm *. The moſt uſual variety is a dodecahedron, in which the teleſia appears under the form of two very long ſlender ſix-ſided pyramids, joined baſe to baſe †. The ſides of theſe pyramids are iſoſceles triangles, having the angle at their vertex 22° 54′, and each of thoſe at the baſe 78° 48′ (G). The inclination of a ſide of one pyramid to a contiguous ſide of the other pyramid is 139° 54′ ‡. In ſome ſpecimens the ſummits of the pyramids are wanting, ſo that the cryſtal has the appearance of a ſix ſided priſm, ſomewhat thicker in the middle than towards the extremities §. The three alternate angles at each extremity of this priſm are alſo ſometimes wanting, and a ſmall triangular face inſtead of them, which renders the baſes of the ſuppoſed priſm nine-ſided. The inclination of each of theſe ſmall triangles to the baſe is 122° 18′ ¶. For figures of theſe cryſtals we refer the reader to Romé de Liſle and Hauy ‖.

Simple Stones.

The texture of the teleſia is foliated, and the joints are parallel to the baſe of the priſm *. Its luſtre varies from 3 to 4 (H). Tranſparency uſually 3 or 4, ſometimes only 2. It cauſes only a ſingle refraction. Specific gravity from 4. to 4.288. Hardneſs from 15 to 17. It is either colourleſs or red, yellow or blue. Theſe colours have induced lapidaries to divide the teleſia into the three following varieties.

Variety 1. Red teleſia.

Oriental ruby.

Colour carmine red, ſometimes verging towards violet. Sometimes various colours appear in the ſame ſtone, as red and white, red and blue, orange red. Hardneſs 17. Sp. gr. 4.288.

Variety 2. Yellow teleſia.

Oriental topaz.

Colour golden yellow. Tranſp. 4. Hardneſs 15. Sp. gr. 4.0106.

Variety 3. Blue teleſia.

Oriental ſapphyr.

Colour Berlin blue, often ſo very faint that the ſtone appears almoſt colourleſs. Tranſp. 3, 4, 2. Hardneſs 17. Sp. gr. 3.991 to 4.083 †. That variety is not probably the ſame with the ſapphyr of the ancients. Their ſapphyr was diſtinguiſhed by gold-coloured ſpots, none of which are to be ſeen in the ſapphyr of the moderns ‡.

A ſpecimen of this laſt variety, analyſed by Mr Klaproth, was found to contain in 100 parts,

98 5	alumina,
1.0	oxyd of iron,
0.5	lime,
100.0 §	

The colouring matter of all theſe varieties is, according to Bergman's experiments, iron in different ſtates of oxydation. He found that the topaz contained .06, the ruby .1, and the ſapphyr .02 of that metal ‖. But when theſe experiments were made, the analyſis of ſtones was not arrived at a ſufficient degree of perfection to enſure accuracy. No concluſion, therefore, can be drawn from theſe experiments, even though we were certain that they were made upon the real varieties of teleſia.

* *Ann de Chim.* xvii. 313.
† Plate XXXVI. fig. 1.
† *Ibid* and *Rome de Liſle*, ii. 315.
§ Fig. 2.
¶ *Hauy, ibid.*
‖ *Ibid.*
* *Hauy.*
† *Greville, Nicholſon's Jour.* iii. 11.
‡ *Hill's Theophraſtus, περι των λιθων*, p. 100.
§ *Beiträge*, i. 81.
‖ *Bergman*, ii. 96.

(F) See *Kirwan's Mineralogy*, I. 250.—*Gmelin's Syſtema Naturæ of Linnæus*, III. 170.—*Romé de Liſle's Cryſtallographie*, II. 212.—*Bermanni Opuſcula*, II. 72.

(G) In ſome inſtances, the angle at the vertex is 31°, thoſe at the baſe 74° 30′, and the inclination of two triangles 122° 36′. See *Hauy, ibid.*

(H) When the *kind* of luſtre is not ſpecified, as in the preſent inſtance, the *common* is always meant.

Earths and Stones.

26 Corundum.

SPECIES 2. Corundum (1).

Corundum of Gmelin—*Adamantine ſpar* of Klaproth and Kirwan *Corindon* of Hauy—*Corivindum* of Woodward.

This ſtone, though it appears to have been known to Mr Woodward, may be ſaid to have been firſt diſtinguiſhed from other minerals by Dr Black. In 1768, Mr Berry, a lapidary in Edinburgh, received a box of it from Dr Anderſon of Madras. Dr Black aſcertained, that theſe ſpecimens differed from all the ſtones known to Europeans; and, in conſequence of its hardneſs, it obtained the name of *adamantine ſpar*. Notwithſtanding this, it could ſcarcely be ſaid to have been known to European mineralogiſts till Mr Greville of London, who has done ſo much to promote the ſcience of mineralogy, obtained ſpecimens of it, in 1784, from India, and diſtributed them among the moſt eminent chemiſts, in order to be analyſed. Mr Greville alſo learned, that its Indian name was Corundum. It is found in Indoſtan, not far from the river Cavery, which is ſouth from Madras, in a rocky matrix, of conſiderable hardneſs, partaking of the nature of the ſtone itſelf *. It occurs alſo in China; and a ſubſtance, not unlike the matrix of corundum, has been found in Teree, one of the weſtern iſlands in Scotland †.

* *Garrow* and *Greville, Nicholſon's Jour.* ii. 540.

† *Greville, ibid.*

The corundum is uſually cryſtallized. Its primitive form, diſcovered by Mr Hauy ‡ and the Count de Bournon §, is a rhomboidal parallelopiped, whoſe ſides are equal rhombs, with angles of 86° and 94°, according to Bournon, or whoſe diagnonals are to each other as $\sqrt{17}$ to $\sqrt{15}$, according to Hauy; which is very nearly the ſame thing ¶. The moſt common variety, for the primitive form has never yet been found, is the regular ſix-ſided priſm, the alternate angles of which are ſometimes wanting ‖, and the triangular faces, which occupy their place, are inclined to the baſe at an angle of 122° 34′ *. Sometimes the corundum is cryſtallized in the form of a ſix-ſided pyramid, the apex of which is generally wanting. For a deſcription and figure of theſe, and all the other varieties of corundum hitherto obſerved, we refer the reader to the diſſertation of the Count de Bournon on the ſubject †.

‡ *Jour. de Min* N° xxviii. 262.

§ *Nicholſon's Jour.* ii. 541

¶ Fig. 3.

‖ Fig. 4

* *De Bournon.*

† See alſo *Hauy, Jour. de min.* N° xxviii. 262.

The texture of the corundum is foliated, and the natural joints are parallel to the faces of the primitive rhomboidal parallelopiped. Luſtre, when in the direction of the laminæ, 3; when broken acroſs, 0. Opake, except when in very thin pieces. Hardneſs 15. Sp. gr. from 37.10 to 4.180 ‡. Colour grey, often with various ſhades of blue and green.

‡ *Klaproth* See alſo *Mr Greville, Nicholſon's Jour.* iii. 11.

According to the analyſis of Klaproth, the corundum of India is compoſed of

89.5 alumina,
5.5 ſilica,
1.25 oxide of iron,

96.25 §.

§ *Beiträge*, i. 77.

A ſpecimen from China of

84.0 alumina,
6.5 ſilica,
7.5 oxide of iron,

98.0 ‖.

‖ *Ibid.* i. 73.

Notwithſtanding the quantity of ſilica and of iron which theſe analyſes exhibit in the corundum, we have been induced to include it in the preſent genus on account of the ſtrong reſemblance between it and the third variety of teleſia. The ſtriking reſemblance between the cryſtals of teleſia and corundum will appear evident, even from the ſuperficial deſcription which we have given; and the obſervations of De Bournon ¶ render this reſemblance ſtill more ſtriking. It is not improbable, therefore, as Mr Greville and the Count de Bournon have ſuggeſted, that corundum may be only a variety of teleſia, and that the ſeeming difference in their ingredients is owing to the impurity of thoſe ſpecimens of corundum which have hitherto been brought to Europe. Let not the difference which has been found in the primitive form of theſe ſtones be conſidered as an inſuperable objection, till the ſubject has been again examined with this preciſe object in view; for nothing is eaſier than to commit an overſight in ſuch difficult examinations.

¶ *Nicholſon's Jour.* iii. 9.

27 Native alumina.

SPECIES 3. Native alumina (K).

This ſubſtance has been found at Halles in Saxony in compact kidney-form maſſes. Its conſiſtence is earthy. Luſtre 0. Opaque. Hardneſs 4. Brittle. Sp. gr. moderate. Feels ſoft, but meagre. Adheres very ſlightly to the tongue. Stains very ſlightly. Colour pure white. Does not readily diffuſe itſelf in water.

It conſiſts of pure alumina, mixed with a ſmall quantity of carbonat of lime, and ſometimes of ſulphat of lime *.

* *Schreber.*

28 G. II. AMC. Ruby.

GENUS II. AMC.

SPECIES 1. Ruby (L).

Spinel and *balaſs Ruby* of Kirwan—*Ruby* of Hauy—*Rubis ſpinelle octoedre* of De Liſle—*Spinellus* of Gmelin.

This ſtone, which comes from the iſland of Ceylon, is uſually cryſtallized. The primitive form of its cryſtals is a regular octohedron, compoſed of two four-ſided pyramids applied baſe to baſe, each of the ſides of which is an equilateral triangle † (M). In ſome caſes two oppoſite ſides of the pyramids are broader than the other two; and ſometimes the edges of the octohedron are wanting, and narrow faces in their place. For figures and deſcriptions of theſe, and other varieties of theſe cryſtals, we refer the reader to *Romé de Liſle* and the *Abbé Eſtner* ‡.

† Fig. 5.

‡ *Cryſtal.* ii. 226. *Eſtner's Miner.* 73.

The texture of the ruby is foliated. Its luſtre is 3. Tranſp. 3.4. It cauſes a ſingle refraction. Hardneſs 13. Sp. gr. 3.570 § to 3.625 ¶. Colour red; if deep, the ruby is uſually called *balaſs*; if pale roſy, *ſpinell*. The

§ *Klaproth.*

¶ *Hatchette* and *Greville.*

(1) See *Kirwan's Mineralogy*, I.—*Klaproth in Beob. der Berlin*, VIII. 295. and *Beiträge*, I. 47.—*Mr Greville* and the *Count de Bournon* in the *Philoſophical Tranſactions* 1798, p. 403. and in *Nicholſon's Journal*, II. 540. and III. 5.—*Mr Hauy Jour. de Phyſ.* XXX. 193. and *Jour. de Min.* N° XXVIII. 262.

(K) See *Kirwan's Mineralogy*, I. 175, and *Schreber.* 15. *Stück*, p. 209.

(L) See *Kirwan's Min.* I. 253.—*Romé de Liſle*, II. 224.—*Klaproth Beob. der Berlin*, III. 336. and *Beiträge*, II. 1.—*Vauquelin Ann. de Chim.* XXVII. 3. and XXXI. 141.

(M) We ſhall afterwards diſtinguiſh this octohedron either by the epithet *regular* or *aluminiform*, becauſe it is the well-known form of cryſtals of alum.

Earths and Stones.

The ruby, according to the analyſis of Vauquelin, is compoſed of
86.00 alumina,
8.50 magneſia,
5.25 chromic acid.

99.75 *

* *Ann. de Chim.* xxvii. 15.

The ancients ſeem to have claſſed this ſtone among their hyacinths †.

† *Plinii*, l. 37. c. 9.

29
G. III. AIM. Ceylanite.

GENUS III. AIM.

SPECIES 1. Ceylanite.

The mineral denominated *ceylanite*, from the iſland of Ceylon, from which it was brought into Europe, had been obſerved by Romé de Liſle ‡; but was firſt deſcribed by La Metherie in the Journal de Phyſique for January 1793.

‡ *Cryſtallog.* iii. 180. Note 21.

It is moſt commonly found in rounded maſſes; but ſometimes alſo cryſtallized. The primitive form of its cryſtals is a regular octahedron: it commonly occurs under this form, but more commonly the edges of the octahedron are wanting, and ſmall faces in their place §.

§ *Hauy, Jour. de Min.* N° xxxviii. 264.

The fracture of the ceylanite is conchoidal ‖. Its internal luſtre is glaſſy. Nearly opaque, except when in very thin pieces. Hardneſs 12. Sp. gr. from 3.7647 * to 3.793 †. Colour of the maſs, black; of very thin pieces, deep green. Powder, greeniſh grey. According to the analyſis of Deſcotils, the ceylanite is compoſed of
68 alumina,
16 oxide of iron,
12 magneſia,
2 ſilica.

‖ *Ibid.* 263.
* *Hauy.*
† *Deſcotils.*

98 ‡

‡ *Ann. de Chim.* xxiii. 113.

30
G. IV. s. Quartz.

GENUS IV. s.

SPECIES 1. Quartz §.

§ *Kirwan's Min.* i. 241.

This ſtone, which is very common in moſt mountainous countries, is ſometimes cryſtallized, and ſometimes amorphous. The primitive form of its cryſtals, according to Mr Hauy, is a rhomboidal parallelopiped; the angles of whoſe rhombs are 93° 22′, and 86° 38′; ſo that it does not differ much from a cube ‖. The moſt common variety is a dodecahedron *, compoſed of two ſix-ſided pyramids, applied baſe to baſe, whoſe ſides are iſoſceles triangles, having the angle at the vertex 40°, and each of the angles at the baſe 70°; the inclination of a ſide of one pyramid to the contiguous ſide of the other pyramid is 104°. There is often a ſix-ſided priſm interpoſed between the two pyramids, the ſides of which always correſpond with thoſe of the pyramids †. For a deſcription and figure of the other varieties of quartz cryſtals, and for a demonſtration of the law which they have followed in cryſtallizing, we refer the reader to *Romé de Liſle* ‡ and *Mr Hauy* §.

‖ *Jour. de Min.* N° xxviii. 255.
* Fig. 6.
† Fig. 7.
‡ *Cryſtal.* ii. 71.
§ *Mem. Par.* 1786, p. 78. See alſo *Lametherie, Jour. de Phyſ.* xiii. 470.

The texture of quartz is more or leſs foliated. Fracture, conchoidal or ſplintery. Its luſtre varies from 3 to 1, and its tranſparency from 4 to 1; and in ſome caſes it is opaque. It cauſes a double refraction. Hardneſs, from 10 to 11. Sp. gr. from 2.64 to 2.67, and in one variety 2.691. Its colour is exceedingly various; a circumſtance which has induced mineralogiſts to divide it into numerous varieties. Of theſe the following are the chief:

Simple Stones.

1. Pure colourleſs, perfectly tranſparent cryſtallized quartz, having much the appearance of artificial cryſtal: known by the name of *rock cryſtal*.

2. Quartz leſs tranſparent, and with a ſplintery fracture, has uſually been diſtinguiſhed by the name of *quartz*, and ſeparated from rock cryſtal. As there is no occaſion for this ſeparation, we have, in imitation of Mr Hauy, choſen the word quartz for the *ſpecific name*, comprehending under it all the varieties.

3. Blood red quartz; formerly called *compoſtella hyacinth*, and by Hauy *quartz hematoide*. It owes its colour to oxide of iron. The mineral known to mineralogiſts by the name of *ſinople*, and conſidered by them as a variety of *jaſper*, has been diſcovered by Dolomieu to be merely this variety of quartz in an amorphous ſtate *.

* *Jour. de Min.* N° xxviii. 255.

4. Yellow quartz; called falſe topaz.

5. Roſy red quartz; called Bohemian ruby.

For a fuller enumeration of theſe varieties, we refer the reader to *Smeiſſer's Mineralogy* †, *Kirwan's Mineralogy* ‡, and Gmelin's edition of the *Syſtema Naturæ* of Linnæus §. This laſt writer, however, has arranged ſeveral minerals under quartz which do not belong to it.

† i. 89.
‡ i. 244.
§ iii. 194.

Pure quartz is compoſed entirely of ſilica; but ſome of the varieties of this ſpecies are contaminated with metallic oxides, and with a ſmall quantity of other earths.

SPECIES 2. Elaſtic Quartz (N).

31
Elaſtic quartz.

This ſingular ſtone is moderately elaſtic, and flexible in every direction. Texture, earthy. Luſtre 0 or 1. Hardneſs, 9. Brittle. Sp. gr. 2.624. Colour, greyiſh white. Phoſphoreſces when ſcraped with a knife in the dark. The ſpecimen analyſed by Mr Klaproth contained
96.5 ſilica,
2.5 alumina,
5 oxide of iron.

99.5 ‖

‖ *Beiträge*, ii. 116.

SPECIES 3. Flint (O).

32

Pyromachus—Pierre a fuſil—Silex of Hauy.

This ſtone, which has become ſo neceſſary in modern war, is found in pieces of different ſizes, and uſually of a figure more or leſs globular, commonly among chalk, and often arranged in ſome kind of order. In Saxony it is ſaid to have been found cryſtallized in hexahedrons, compoſed of two low three-ſided pyramids applied baſe to baſe *.

* *Gmelin's Syſtema Naturæ*, iii. 318.

Its texture is compact. Its fracture, ſmooth conchoidal. Luſtre, external, 0, the ſtones being always covered by a white cruſt; internal, 1, inclining to greaſy. Tranſp. 2; when very thin, 3. Hardneſs, 10 or 11. Sp. gr. from 2.58 to 2.63. Colour varies from honey yellow to browniſh black. Very brittle, and ſplits into ſplinters in every direction. Two pieces of flint rubbed ſmartly together phoſphoreſce, and emit a peculiar odour. When heated it decrepitates, and becomes white and opaque. When expoſed long to the air

(N) *Kirwan's Min.* I. 316.—*Gerhard, Mem. Berlin*, 1783, 107.—*Klaproth's Beiträge*, 2 *Band.* 113. See alſo *Jour. de Phyſ.* XLI. 91.

(O) *Kirwan's Min.* I. 301.—*Dolomieu, Jour. de Min.* N° XXXIII. 693. and *Salivet, ibid.* 713. Theſe laſt gentlemen give the only accurate account of the method of making gun flints.

Earths and Stones.

air it often becomes covered with a white cruſt. A ſpecimen of flint, analyſed by Klaproth, contained

98.00 ſilica,
.50 lime,
.25 alumina,
0.25 oxide of iron,
1.00 water.

100.00 *

* *Beiträge*, i. 46.

Another ſpecimen, analyſed by Dolomieu, was compoſed of

97 ſilica,
1 alumina and oxide of iron,
2 water.

100 †

† *Jour. de Min.* N° xxxiii. 702.

The white cruſt with which flint is enveloped, conſiſts of the ſame ingredients, and alſo a little carbonat of lime. Dolomieu diſcovered that water is eſſential to flint; for when it is ſeparated by heat the ſtone loſes its properties ‡.

‡ *Ibid.*

The manufacture of gun flints is chiefly confined to two or three departments in France. The operation is exceedingly ſimple: a good workman will make 1000 flints in a day. The whole art conſiſts in ſtriking the ſtone repeatedly with a kind of mallet, and bringing off at each ſtroke a ſplinter, ſharp at one end and thicker at the other. Theſe ſplinters are afterwards ſhaped at pleaſure, by laying the line at which it is wiſhed they ſhould break, upon a ſharp iron inſtrument, and then giving it repeatedly ſmall blows with a mallet. During the whole operation the workman holds the ſtone in his hand, or merely ſupports it on his knee §.

§ *Ibid.*

SPECIES 4. Opal (P).

33 Opal.

This ſtone is found in many parts of Europe. It is uſually amorphous. Its fracture is conchoidal, commonly ſomewhat tranſparent. Hardneſs from 6 to 10. Sp. gr. from 1.7 to 2.66. The lowneſs of its ſpecific gravity, in ſome caſes, is to be aſcribed to accidental cavities which the ſtone contains. Theſe are ſometimes filled with drops of water. Some ſpecimens of opal have the property of emitting various coloured rays, with a particular effulgency, when placed between the eye and the light. The opals which poſſeſs this property, are diſtinguiſhed by lapidaries by the epithet *oriental*; and often by mineralogiſts by the epithet *nobilis*. This property rendered the ſtone much eſteemed by the ancients.

Variety 1. Opal edler—*Opalus nobilis.*

Luſtre glaſſy, 3. Tranſp. 3 to 2. Hardneſs, 6 to 8. Colour, uſually light bluiſh white, ſometimes yellow or green. When heated it becomes opaque, and ſometimes is decompoſed by the action of the atmoſphere. Hence it ſeems to follow, that water enters eſſentially into its compoſition. A ſpecimen of this variety, analyſed by Klaproth, contained

90 ſilica,
10 water.

100 *

* *Beiträge*, ii. 153.

Variety 2. Semi-opal.

Fracture, imperfectly conchoidal. Luſtre, glaſſy, 2. Tranſp. 2 to 3. Hardneſs, 7 to 9. Its colours are very various, greys, yellows, reds, browns, greens of different kinds.

Simple Stones.

Specimens of this variety ſometimes occur with rifts: theſe readily imbibe water, and therefore adhere to the tongue. Theſe ſpecimens ſometimes become tranſparent when ſoaked in water, by imbibing that fluid. They are then called *hydrophanes*.

Variety 3. Cat's eye *.

* *Kirwan's Min.* i. 301. *Klaproth, Beiträge*, i. 90.

This variety comes from Ceylon, and is ſeldom ſeen by European mineralogiſts till it has been poliſhed by the lapidary. Mr Klaproth has deſcribed a ſpecimen which he received in its natural ſtate from Mr Greville of London. Its figure was nearly ſquare, with ſharp edges, a rough ſurface, and a good deal of brilliancy.

Its texture is imperfectly foliated. Luſtre greaſy, 2. Tranſp. 3 to 2. Hardneſs 10. Sp. gr. 2.56 to 2.66. Colour, grey; with a tinge of green, yellow, or white; or brown, with a tinge of yellow or red. In certain poſitions it reflects a ſplendid white, as does the eye of a cat; hence the name of this ſtone.

Two ſpecimens, analyſed by Klaproth, the firſt from Ceylon, the other from Malabar, were compoſed of

95.00	94.50 ſilica,
1.75	2.00 alumina,
1.50	1.50 lime,
0.25	0.25 oxide of iron.
98.5†	98 25‡

† *Beiträge*, i. 94.
‡ *Ibid.* p. 96.

SPECIES 5. Pitchſtone §.

Menelites.

34 Pitchſtone.

This ſtone, which occurs in different parts of Germany, France, and other countries, has obtained its name from ſome reſemblance which it has been ſuppoſed to have to pitch. It is moſt uſually in amorphous pieces of different ſizes; and it has been found alſo cryſtallized in ſix-ſided priſms, terminated by three-ſided pyramids.

§ *Kir. Min.* i. 292.—*Daubanton, Mem. Par.* 1787, p. 86.

Its texture is conchoidal and uneven, and ſometimes approaches the ſplintery. Luſtre greaſy, from 3 to 1. Tranſp. 2 to 1, ſometimes 0. Hardneſs 8 to 10. Exceedingly brittle; it yields even to the nail of the finger. Sp. gr. 2.049 to 2.39. Its colours are numerous, greyiſh black, bluiſh grey, green, red, yellow of different ſhades. Sometimes ſeveral of theſe colours appear together in the ſame ſtone. A ſpecimen of pitchſtone from Meſnil-montant near Paris ‖, analyſed by Mr Klaproth, contained

85.5 ſilica,
11.0 air and water,
1.0 alumina,
.5 iron,
.5 lime and magneſia.

98.5 ¶

‖ See *Jour. de Phyſ.* xxxi. 219.

¶ *Beiträge*, ii. 169.

SPECIES 6. Chryſopraſium (Q).

35 Chryſopraſium.

This mineral, which is found in different parts of Germany, particularly near Koſemütz in Sileſia, is always amorphous. Its fracture is either even or inclining to the ſplintery. Scarcely any luſtre. Tranſp. 2 to 3. Hardneſs 10 to 12. Sp. gr. 2.479. Colour, green. In a heat of 130° Wedgewood it whitens and becomes opaque.

A

(P) *Kirwan's Min.* I. 289.—*Hauy, Jour. d'Hiſt. Nat.* II. 9.—*Delius, Nouv. Jour. de Phyſ.* I. 45.
(Q) *Kirwan's Min.* I.—*Lehmann, Mem. Berlin*, 1755, p. 202.—*Klaproth Beitrage*, II. 127.

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A specimen of this stone, analysed by Mr Klaproth, contained
96.16 silica,
1.00 oxide of nickel,
0.83 lime,
0.08 alumina,
0.08 oxide of iron.
98.15 ‡

‡ *Beiträge*, ii. 133.

36
G. V. 1. As. Topaz.

GENUS V. 1. AS.

SPECIES 1. Topaz (R).

Occidental ruby, topaz, and sapphyr.

The name *topaz* has been restricted by Mr Hauy to the stones called by mineralogists occidental ruby, topaz, and sapphyr; which, agreeing in their crystallization and most of their properties, were arranged under one species by Mr Romé de Lisle. The word *topaz*, derived from an island in the Red Sea (S), where the ancients used to find topazes, was applied by them to a mineral very different from ours. One variety of our topaz they denominated *chrysolite*.

The topaz is found in Saxony, Bohemia, Siberia, and Brazil, mixed with other minerals in granite rocks.

It is commonly crystallized. The primitive form of its crystals is a prism whose sides are rectangles, and bases rhombs, having their greatest angles 124° 22′, and the integral molecule has the same form †; and the height of the prism is to a side of the rhomboidal bases as 3 to 2 ‡. The different varieties of topaz crystals hitherto observed, amount to 6. Five of these are eight-sided prisms, terminated by four sided pyramids, or wedge shaped summits, or by irregular figures of 7, 13, or 15 sides §; the last variety is a twelve-sided prism, terminated by six-sided pyramids wanting the apex. For an accurate description and figure of these varieties we refer the reader to Mr Hauy ‖.

† *Hauy, Jour. de Min.* N° xxviii. 287.
‡ Fig. 8.
§ Fig. 9.
‖ *Jour. de Min. ibid.*

The texture of the topaz is foliated. Its lustre is from 2 to 4. Transp. from 2 to 4. It causes a double refraction. Hardness 12 to 14. Sp. gr. from 3.5311 to 3.564. The Siberian and Brazil topazes, when heated, become positively electrified on one side, and negatively on the other ¶. It is infusible by the blow-pipe. The yellow topaz of Brazil becomes red when exposed to a strong heat in a crucible; that of Saxony becomes white by the same process. This shews us that the colouring matter of these two stones is different.

¶ *Hauy, ibid.*

The colour of the topaz is various, which has induced mineralogists to divide it into the following varieties:

1. Red topaz, of a red colour inclining to yellow; called *Brazilian* or *occidental ruby*.

2. Yellow topaz, of a golden yellow colour, and sometimes also nearly white; called *occidental* or *Brazil topaz*. The powder of this and the following variety causes syrup of violets to assume a green colour *.

3. *Saxon topaz.* It is of a pale wine yellow colour, and sometimes greyish white.

* *Vauquelin, Jour. de Min.* N° xxix. 165.

4. *Aigue marine.* It is of a bluish or pale green colour.

Simple Stones.

5. *Occidental sapphyr.* It is of a blue colour; and sometimes white.

A specimen of white Saxon topaz, analysed by Vauquelin, contained
68 alumina,
31 silica.
99 *.

* *Jour. de Min.* N° xxiv. 3.

37
Sommite.

SPECIES 2. Sommite.

This stone was called sommite by La Metherie, from the mountain Somma, where it was first found. It is usually mixed with volcanic productions. It crystallizes in six-sided prisms, sometimes terminated by pyramids. Colour white. Somewhat transparent. Sp. gr. 3.2741. Infusible by the blow-pipe. According to the analysis of Vauquelin, it is composed of
49 alumina,
46 silica,
2 lime,
1 oxide of iron.
98 †

† *Ibid.* N° xxviii. 279.

38

SPECIES 3. Shorlite ‡.

‡ *Kirwan's Min.* i. 286.

This stone, which received its name from Mr Klaproth, is generally found, in irregular oblong masses or columns, inserted in granite. Its texture is foliated. Fracture uneven. Lustre 2. Transparency 2 to 1. Hardness 9 to 10. Sp. gr. 3.53. Colour greenish white, or sulphur yellow. Not altered by heat. According to the analysis of Klaproth, it is composed of
50 alumina,
50 silica.
100

39
G. V. 2. SA. Rubellite.

GENUS V. 2. SA.

SPECIES 4. Rubellite (T).

Red shorl of Siberia.

This stone is found in Siberia mixed with white quartz. It is crystallized in small needles, which are grouped together and traverse the quartz in various directions. Texture fibrous. Fracture even, inclining to the conchoidal. Transparency 2; at the edges 3. Hardness 10. Brittle. Sp. gr. 3.1. Colour crimson, blood or peach red. By exposure to a red heat it becomes snow white; but loses none of its weight. It tinges soda blue, but does not melt with it.

According to the analysis of Mr Bindheim, it is composed of
57 silica,
35 alumina,
5 oxides of iron and manganese.
97

40
Hornslate.

SPECIES 5. Hornslate (U).

Shistose porphyry.

This stone, which occurs in mountains, is generally amorphous; but sometimes also in columns. Structure

(R) *Kirwan's Min.* I. 254.—*Pott. Mem. Berlin*, 1747, p. 46.—*Margraf, ibid.* 1776, p. 73. *and* 160.—*Henkel. Act. Acad. Nat. Cur.* IV. 316.

(S) It got its name from τοπαζα, *to seek*; because the island was often surrounded with fog, and therefore difficult to find. See *Plinii lb.* 37. c. 8.

(T) *Kirwan's Min.* I. 288. *Bindheim, Crell's Annals*, 1792, p. 320.

(U) *Kirwan's Min.* I. 307.—*Wiegleb, Crell's Annals*, 1787. 1 *Band.* 302.—See also *Reuss. Semml. Natur. Hist. Aufsäze*, p. 207.

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ture slaty. Texture foliated. Fracture uneven and splintery; sometimes approaching the conchoidal. Lustre 0. Transparency 1 or 0. Hardness about 10. Sp. gr. from 2.512 to 2.7. Colour different shades of *grey*, from *ash* to *bluish* or *olive green*. Melts at 145° Wedgewood into an enamel. A specimen, analysed by Wedgewood, contained

73.0 silica,
23.9 alumina,
3.5 iron.

100.4

41 Hornstone.

SPECIES 6. Hornstone (x).

Petrosilex—Chert.

This stone, which makes a part of many mountains, is usually amorphous; but, as Mr Kirwan informs us, it has been found crystallized by Mr Beyer on Schneeberg. Its crystals are six-sided prisms, sometimes terminated by pyramids: hexahedrons, consisting of two three-sided pyramids applied base to base; and cubes, or six-sided plates *. Its texture is foliated. Fracture splintery, and sometimes conchoidal. Lustre 0. Transparency 1 to 2. The crystals are sometimes opaque. Hardness 7 to 9. Sp. gr. 2.532 to 2.653. Colour usually dark blue: but hornstone occurs also of the following colours; grey, red, blue, green, and brown of different shades †,

* *Kirwan*, i. 303.

† *Schmeisser's Min.* i. 103.

According to Kirwan, it is composed of

72 silica,
22 alumina,
6 carbonat of lime.

100 ‡

‡ *Ibid.* p. 305.

42 Chalcedony.

SPECIES 7. Chalcedony.

This stone is found abundantly in many countries, particularly in Iceland and the Faro islands. It is most commonly amorphous, stalactitical, or in rounded masses; but it occurs also crystallized in six-sided prisms, terminated by pyramids, or more commonly in four or six sided pyramids, whose sides are convex. Surface rough. Fracture more or less conchoidal. Lustre 1. Somewhat transparent. Hardness 10 to 11. Sp. gr. 2.56 to 2.665. Not brittle.

According to Bergman, the chalcedony of Foroe is composed of

84 silica,
16 alumina, mixed with iron.

100

Variety 1. Common chalcedony.

Fracture even, inclining to conchoidal. Transparency 2 to 3; sometimes 1. Its colours are various; it is most commonly greyish, with a tint of yellow, green, blue, or pearl; often also white, green, red, yellow, brown, black, or dotted with red. When striped white and black, or brown, alternately, it is called *onyx*; when striped white and grey, it is called *chalcedonix*. Black or brown chalcedony, when held between the eye and a strong light, appears dark red.

Variety 2. Cornelian.

Fracture conchoidal. Transparency 3 to 1; often cloudy. Its colours are various shapes of red, brown, and yellow. Several colours often appear in the same mass. To this variety belong many of the stones known by the name of *Scotch pebbles*.

Simple Stones.

SPECIES 8. Jasper (y).

43 Jasper.

This stone is an ingredient in the composition of many mountains. It occurs usually in large amorphous masses, and sometimes also crystallized in six-sided irregular prisms. Its fracture is conchoidal. Lustre from 2 to 0, Either opaque, or its transparency is 1. Hardness 9 to 10. Sp. gr. from 2.5 to 2.82. Its colours are various. When heated, it does not decrepitate. It seems to be composed of silica and alumina, and often also contains iron.

Variety 1. Common jasper.

Sp. gr. from 2.58 to 2.7. Its colours are different shades of white, yellow, red, brown, and green; often variegated, spotted, or veined, with several colours.

Variety 2. Egyptian pebble.

This variety is found chiefly in Egypt. It usually has a spheroidal or flat rounded figure, and is enveloped in a coarse rough crust. It is opaque. Hardness 10. Sp. gr. 2 564. It is chiefly distinguished by the variety of colours, which always exist in the same specimen, either in concentric stripes or layers, or in dots or dentritical figures. These colours are, different browns and yellows, milk white, and isabella green; black also has been observed in dots.

Variety 3. Striped jasper.

This variety is also distinguished by concentric stripes or layers of different colours: these colours are, yellow, brownish red, and green. It is distinguished from the last variety by its occurring in large amorphous masses, and by its fracture, which is nearly even.

SPECIES 9. Tripoli.

44 Tripoli.

This mineral is found sometimes in an earthy form, but more generally indurated. Its texture is earthy. Its fracture often somewhat conchoidal Lustre 0. Generally opaque. Hardness 4 to 7. Sp. gr. 2.080 to 2.529. Absorbs water. Feel, harsh dry. Hardly adheres to the tongue. Takes no polish from the nail. Does not stain the fingers. Colour generally pale yellowish grey, also different kinds of yellow, brown, and white.

It contains, according to Haasse, 90 parts of silica, 7 alumina, and 3 of iron. A mineral belonging to this species was analysed by Klaproth, and found to contain

66.5 silica,
7.0 alumina,
2.5 oxide of iron,
1.5 magnesia,
1.25 lime,
19. air and water.

97.75

45 G. VI. 1. ASI. Micarell.

GENUS VI. 1. ASI.

SPECIES 1. Micarell *.

This name has been given by Mr Kirwan to a stone which former mineralogists considered as a variety of mica. It is found in granite. Its texture is foliated, and

* *Kirwan's Min.* i. 212.

(x) *Kirwan's Min.* I. 303.—*Baumer, Jour. de Phys.* II. 154. and *Monnet, ibid.* 331.—*Wiegleb, Crell's Annals*, 1788, p. 45. and 135.

(y) *Kirw. Min.* I. 309.—*Borral Hist. Natur. de Corse.*—*Henkel Act. Acad. Nat. Curios.* V. 339.

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and it may be split into thin plates. Lustre metallic, 3. Opaque. Hardness 6. Sp. gr. 2.980. Colour brownish black. At 153° Wedgewood, it melts into a black compact glass, the surface of which is reddish *.

* *Kirw. ibid.*

A specimen analysed by Klaproth contained

63.00 alumina,
29.50 silica,
6.75 iron.

99.25

46 Shorl.

SPECIES 2. Shorl †.

† *Ibid.* i. 265.

No word has been used by mineralogists with less limitation than *shorl*. It was first introduced into mineralogy by Cronstedt, to denote any stone of a columnar form, considerable hardness, and a specific gravity from 3 to 3.4. This description applied to a very great number of stones. And succeeding mineralogists, though they made the word more definite in its signification, left it still so general, that under the designation of *shorl* almost 20 distinct species of minerals were included.

Mr Werner first defined the word *shorl* precisely, and restricted it to one species of stones. We use the word in the sense assigned by him.

Shorl is found abundantly in mountains, either massive or crystallized, in three or nine sided prisms, often terminated by three sided summits. The sides of the crystals are longitudinally streaked. Its texture is foliated. Its fracture conchoidal. Lustre 2. Opaque. Hardness 10. Sp. gr. 2.92 to 3.212. Colour black. Streak grey. It does not become electric by heat. When heated to redness, its colour becomes browniish red; and at 127° Wedgewood, it is converted into a browniish compact enamel ‡. According to Wiegleb, it is composed of

‡ *Ibid.* i. 166.

41.25 alumina,
34.16 silica,
20.00 iron,
5,41 manganese.

100.82 §

§ *Crell's Beiträge*, 1. *Bandes.* 4. *Stück*, p. 21.

SPECIES 5. Granatite.

47 Granatite.

Staurotide of Hauy—*Pierre de Croix* of De Lisle—*Staurolithe* of Lametherie.

We have adopted from Mr Vauquelin the term *granatite* to denote this stone, because all the other names are ambiguous, having been applied to another mineral possessed of very different properties.

Granatite is found in Galicia in Spain, and Britanny in France. It is always crystallized in a very peculiar form; two six-sided prisms intersect each other, either at right angles or obliquely ¶. Hence the name *crossstone*, by which it was known in France and Spain *. Mr Hauy has proved, in a very ingenious manner, that the primitive form of the granatite is a rectangular prism, whose bases are rhombs, with angles of 129½° and 50½°; and that the height of the prism is to the greater diagonal of a rhomb as 1 to 6; and that its integrant molecules are triangular prisms, similar to what would be obtained by cutting the primitive crystal in two, by a plane passing vertically through the shorter diagonal of the rhomboidal base. From this structure he has demonstrated the law of the formation of the cruciform varieties †. The colour of granatite is greyish or reddish brown.

¶ Fig. 10. * *Romé de Lisle*, ii. 435.

† *Ann. de Chim.* vi. 142.

According to the analysis of Vauquelin, it is composed of

47.06 alumina,
30.59 silica,
15.30 oxide of iron,
3.00 lime.

95.95 ‡.

‡ *Ibid.* xxx. 196.

Simple Stones.

GENUS VI. 2. SAI.

48 G. VI. 2. SAI. Tourmaline.

SPECIES 4. Tourmaline (z).

This stone was first made known in Europe by specimens brought from Ceylon; but it is now found frequently forming a part of the composition of mountains. It is either in amorphous pieces, or crystallized in three or nine side prisms, with four-sided summits.

Its texture is foliated: Its fracture conchoidal. Internal lustre 2 to 3. Transparency 3 to 4; sometimes only 2 (A). Causes only single refraction §. Hardness 9 to 11. Sp. gr. 3.05 to 3.155. Colour brown, often so dark that the stone appears black; the brown has also sometimes a tint of green, blue, red, or yellow.

§ *Hauy, Jour. de Min.* N° xxviii. 265.

When heated to 200° Fahrenheit, it becomes electric; one of the summits of the crystal negatively, the other positively ¶. It reddens when heated; and is fusible *per se* with intumescence into a white or grey enamel.

¶ *Æpinus.*

A specimen of the tourmaline of Ceylon, analysed by Vauquelin, was composed of

40 silica,
39 alumina,
12 oxide of iron,
4 lime,
2.5 oxide of manganese.

97.5 *.

* *Ann. de Chim.* xxx. 105.

SPECIES 5. Argentine felspar †.

49 Argentine felspar.

This stone was discovered by Mr Dodun in the black mountains of Languedoc. It is either amorphous, or crystallized in rhomboidal tables, or six or eight sided prisms. Its texture is foliated. Fragments rectangular. Laminæ inflexible. Internal lustre 4. Transparency 2. Colour white; two opposite faces of the crystals are silver white, two others dead white. Hardness of the silvery laminæ 6, of the rest 9. Brittle. Sp. gr. 2.5. When the flame of the blow-pipe is directed against the edges of the crystal (stuck upon glass), it easily melts into a clear compact glass; but when the flame is directed against the faces, they preserve their lustre, and the edges alone slowly melt.

† *Kirwan*, i. 327.

According to the analysis of Dodun, it is composed of

46 silica,
36 alumina,
16 oxide of iron,

98

When this stone is exposed to the atmosphere, it is apt

(z) *Kirw.* I. 271.—*Berg.* II 118. and V. 402.—*Gerhard. Mem. Berlin*, 1777. p. 14.—*Hauy Mem. Par.* 1784, 270.—*Wilson Phil. Trans.* XLI. 308.—*Æpinus. Recueil sur la Tourmaline.* See also *La Porterie. Le Sapphir, l'Oeil de Chat, et la Tourmaline de Ceylon demasqués.*

(A) And when black only 1.

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apt to decay: Its surface becomes irideſcent, and at laſt changes to ochre yellow: Its ſpecific gravity is 2.3 or 2.212; and when breathed upon, it gives out an earthy ſmell.

50 Mica.

SPECIES 6. MICA *.

* *Kirw.* i. 210—*Gmelin, Nov. Com. Petrop.* xii. 549.

This ſtone forms an eſſential part of many mountains, and has been long known under the names of *glacies mariæ* and *Muſcovy glaſs*. It conſiſts of a great number of thin laminæ adhering to each other, ſometimes of a very large ſize. Specimens have been found in Siberia nearly 2½ yards ſquare (B).

It is ſometimes cryſtallized: Its primitive form is a rectangular priſm, whoſe baſes are rhombs, with angles of 120° and 60° †: Its integrant molecule has the ſame form. Sometimes it occurs in rectangular priſms, whoſe baſes alſo are rectangles, and ſometimes alſo in a ſhort ſix-ſided priſms ‡; but is much more frequently in plates or ſcales of no determinate figure or ſize §.

† Fig. 11.

‡ Fig. 12.

§ *Hauy, Jour. de Min.* N° xxviii. 296.

Its texture is foliated. Its fragments flat. The lamellæ flexible, and ſomewhat elaſtic. Luſtre metallic, from 3 to 4. Tranſparency of the laminæ 3 or 4, ſometimes only 2 (C). Hardneſs 6. Very tough. Often abſorbs water. Sp. gr. from 2.6546 to 2.9342. Feels ſmooth, but not greaſy. Powder feels greaſy. Colour, when pureſt, ſilver white or grey; but it occurs alſo yellow, greeniſh, reddiſh, brown, and black. Mica is fuſible by the blow-pipe into a white, grey, green, or black, enamel; and this laſt is attracted by the magnet (D). Spaniſh wax rubbed by it becomes negatively electric ¶.

¶ *Ibid.*

A ſpecimen of mica, analyſed by Vauquelin, contained

50.00	ſilica,
35.00	alumina,
7.00	oxide of iron.
1.35	magneſia,
1.33	lime,
94.68	*.

* *Ibid.* 302.

Mica has long been employed as a ſubſtitute for glaſs. A great quantity of it is ſaid to be uſed in the Ruſſian marine for panes to the cabin windows of ſhips; it is preferred, becauſe it is not ſo liable as glaſs to be broken by the agitation of the ſhip.

51 Talc.

SPECIES 7. Talc †.

* *Kirw.* i. 150—*Pott. Mem. Berl.* 1746, p. 65.

This ſtone has a very ſtrong reſemblance to mica, and was long conſidered as a mere variety of that mineral. It occurs ſometimes in ſmall looſe ſcales, and ſometimes in an indurated form; but it has not hitherto been found cryſtallized.

Its texture is foliated. The lamellæ are flexible, but not elaſtic. Its luſtre is from 2 to 4. Tranſparency from 2 to 4. Hardneſs 4 to 6. Sp. gr. when indurated, from 2.7 to 2.8. Feels greaſy. Colour moſt commonly whitiſh or greeniſh. Spaniſh wax rubbed with it becomes *poſitively* electric ‡.

† *Hauy, Jour. de Min.* N° xxviii. 291.

Variety 1. Scaly talc.

Talcite of Kirwan.

This variety occurs under the form of ſmall ſcales, ſcarcely cohering. Luſtre 3 to 4. Very light. Adheres to the fingers. When rubbed upon the ſkin, it gives it a gloſs. Colour white, with a ſhade of red or green; ſometimes leek green. Simple Stones.

Variety 2. Common talc.

Venetian talc.

This variety often occurs in oblong nodules. Luſtre, nearly metallic, 4. Tranſparency 2 to 3; when very thin 4. Hardneſs 4 to 5. Colour white, with a ſhade of green or red; or apple green, verging towards ſilver white. By tranſmitted light green.

Variety 3. Shiſtoſe talc.

Its ſtructure is ſlaty. Fracture hackly and long ſplintery. Eaſily crumbles when rubbed in the fracture. External luſtre 2 to 3; internal, 1: but ſometimes, in certain poſitions, 3. Colour grey, with a ſhade of white, green or blue. Becomes white and ſcaly when expoſed to the air.

A ſpecimen of *common talc*, analyſed by Mr Chenevix, contained

48.0	ſilica,
37.0	alumina,
6.0	oxide of iron,
1.5	magneſia,
1.5	lime,
5.0	water,
99.0	§.

§ *Ann. de Chim.* xxviii. 200.

SPECIES 8. Baſaltine ¶.

52 Baſaltine. ¶ *Kirw.* i. 219.

Baſaltic hornblende of Werner—*Actinote* of Hauy—*Zillertite* of Lametherie—*Shorl priſmatique hexagone* of Sauſſure.

This ſtone is found commonly in baſaltic rocks; hence its name, which we have borrowed from Mr Kirwan. It is cryſtallized, either in rhomboidal priſms, or ſix or eight ſided priſms, terminated by three-ſided pyramids. Its texture is foliated. Its fracture uneven. Luſtre 3. Tranſparency, when in very thin plates, 1. Hardneſs from 9 to 10. Sp. gr. 3.333. Colour black, dark green, or yelloviſh green. Streak white. Tranſmits a reddiſh yellow light. Before the blow-pipe, it melts into a greyiſh coloured enamel, with a tint of yellow *. A ſpecimen, ſeemingly of this ſtone, analyſed by Bergman, contained

* *Le Lievre, Jour. de Min.* N° xxviii. 269.

58	ſilica,
27	alumina,
9	iron,
4	lime,
1	magneſia,
99	†.

† *Berg.* iii. 207.

SPECIES 9. Hornblende ‡.

53 Hornblende.

Amphibole of Hauy (E).

This ſtone enters into the compoſition of various mountains. Its texture is very conſpicuouſly foliated. Fracture conchoidal. Fragments often rhomboidal. Luſtre 2. Opaque. Hardneſs 5 to 9. Tough. Sp. gr. 2.922 to 3.41. Colour black, blackiſh green, olive green,

‡ *Kirw.* i. 213.

(B) *Hiſt. General de Voyages*, T. XVIII. 272, quoted by Hauy *Jour. de Min.* N° XXVIII. 299.

(C) Black mica is often nearly opaque.

(D) *Hauy, ibid.* p. 295. Bergman, however, found pure mica infuſible *per ſe*; and this has been the caſe with all the ſpecimens of Muſcovy glaſs which we have tried.

(E) We ſuſpect, that under this name Mr Hauy comprehends *ſhorl* alſo.

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green, or leek green. Streak greenish. It neither becomes electric by friction nor heat*. Before the blow-pipe it melts into a black glass. A specimen of black hornblende, analysed by Mr Hermann, was composed of

37 silica,
27 alumina,
25 iron,
5 lime,
3 magnesia.

97 †

* *Hauy, Jour. de Min.* N° xxviii. 267.

† *Beob. der Berlin*, 5. *Band.* 317

SPECIES 10. Resplendent Hornblende.

54 Resplendent hornblende.

There are two minerals which Werner considers as varieties of hornblende, and Mr. Kirwan as constituting a distinct species These till future analyses decide the point, we shall place here under the name of resplendent hornblende, the name given them by Mr Kirwan; and we shall describe them separately.

Variety 1. Labradore hornblende.

Texture, curved foliated. Lustre, in some positions, 0; in others metallic, and from 3 to 4. Opaque. Hardness 8 to 9. Sp. gr. from 3.35 to 3.434. Colour, in most positions, greyish black; in others, it reflects a strong iron grey, sometimes mixed with copper red.

Variety 2. Shiller spar ‡.

‡ *Kirw.* i. 221.

Texture foliated. Lustre metallic, 4. Transparency, in thin pieces, 1. Hardness 8 to 9. Sp. gr. 2.882. Colour green, often with a shade of yellow; also golden yellow. In some positions it reflects white, grey, or yellow. At 141° Wedgewood, hardened into a porcelain mass. A specimen, analysed by Gmelin, was composed of

43.7 silica,
17.9 alumina,
23.7 iron,
11.2 magnesia.

96.5 §

§ *Bergbaukunde*, 1 *Band.* p. 92.

It has been found in the Hartz, stuck in a serpentine rock.

55. Obsidian.

SPECIES 11. Obsidian *.

* *Kirw.* i. 464.

Iceland agate.

This stone is found either in detached masses, or forming a part of the rocks which compose many mountains. It is usually invested with a grey or opaque crust. Its fracture is conchoidal. Its internal lustre 3. Transparency 1. Hardness 10. Sp. gr. 2.348. Colour black or greyish black; when in very thin pieces, green. It melts into an opaque grey mass. According to Bergman, it is composed of

69 silica,
22 alumina,
9 iron.

100 †

† *Berg.* iii. 204.

56 Petrilite.

SPECIES 12. Petrilite ‡.

‡ *Kirw.* i. 325.

Cubic felspar.

This stone is found in the mass of mountains. It is amorphous. Texture foliated. Fracture splintery. Fragments cubic, or inclining to that form; their faces unpolished. Lustre 2. Transparency partly 2, partly 1. Hardness 9. Sp. gr. 3.081. Colour reddish brown. Does not melt at 160° Wedgewood.

57 Felsite

SPECIES 13. Felsite §.

§ *Kirw.* i. 326.

Compact felspar.

This stone also forms a part of many mountains, and is amorphous. Texture somewhat foliated. Fracture uneven, approaching to the splintery. Lustre 1. Transparency scarce 1. Hardness 9. Colour azure blue, and sometimes brown and green Streak white. Before the blow-pipe, whitens and becomes rifty; but is infusible *per se*.

Simple Stones.

GENUS VII. SAP.

58 G. VII. SAP. Felspar.

SPECIES 1. Felspar *.

* *Kirw.* i. 316. and *Jour. de Phys.* passim.

This stone forms the principal part of many of the highest mountains. It is commonly crystallized. Its primitive form, according to De Lisle, is a rectangular prism, whose bases are rhombs, with angles of 65° and 115†°. Sometimes the edges of the prism are wanting, and faces in their place; and sometimes this is the case also with the acute angles of the rhomb. For a description and figure of these, and other varieties, we refer the reader to *Romé de Liste*‡, *Mr Hauy* §, and *Mr Pini* *.

† Fig. 13. and 14.

‡ *Crystall.* ii. 401.

§ *Mem. Par.* 1784, p. 273.

* *Sur de Nouvelle Chrystallisation*, &c. 8.

Its texture is foliated. Its cross fracture uneven. Fragments rhomboidal, and commonly smooth and polished on four sides. Lustre of the polished faces often 3. Transparency from 3 to 1. Hardness 9 to 10. Sp. gr. from 2.437 to 2.7. Gives a peculiar odour when rubbed. It is made electric with great difficulty by friction. Fusible *per se* into a more or less transparent glass. When crystallized, it decrepitates before the blow-pipe.

Variety 1. Pure Felspar.
Moon stone—Adularia.

This is the purest felspar hitherto found. It occurs in Ceylon and Switzerland; and was first mentioned by Mr Sage. Lustre nearly 3. Transparency 2 to 3. Hardness 10. Sp. gr. 2.559. Colour white; sometimes with a shade of yellow, green, or red. Its surface is sometimes iridescent.

Variety 2. Common Felspar.

Lustre of the cross fracture 0; of the fracture, in the direction of the laminæ, from 3 to 1. Transparency 2 to 1. Colour most commonly flesh red; but often bluish grey, yellowish white, milk white, browniish yellow; and sometimes blue, olive green, and even black.

Variety 3. Labradore felspar.

This variety was discovered on the coast of Labradore by Mr Wolfe; and since that time it has been found in Europe. Lustre 2 to 3. Transparency from 1 to 3. Sp. gr. from 2.67 to 2.6925. Colour grey. In certain positions, spots of it reflect a blue, purple, red, or green colour.

Variety 4. Continuous felspar.

This variety most probably belongs to a different species; but as it has not hitherto been analysed, we did not think ourselves at liberty to alter its place.

It is found in large masses. Texture earthy. Fracture uneven, sometimes splintery. Lustre 0. Transparency 1. Hardness 10. Sp. gr. 2.609. Colour reddish grey, reddish yellow, flesh red.

A specimen of green felspar from Siberia, analysed by Vauquelin, contained

62.83 silica,
17.02 alumina,
16.00 potass,
3.00 lime,
1.00 oxide of iron.

99.85†

† *Ann. de Chim.* xxx.

Earths and Stones.

SPECIES 2. Lepidolite (F).

Lilalite.

59 Lepidolite.

This ſtone appears to have been firſt obſerved by the Abbé l'oda, and to have been firſt deſcribed by De Born *. Hitherto it has only been found in Moravia in Germany, and Sudermania in Sweden †. There it is mixed with granite in large amorphous maſſes. It is compoſed of thin plates, eaſily ſeparated, and not unlike thoſe of mica ‡ Luſtre, pearly 3. Tranſparency between 1 and 2. Hardneſs 4 to 5. Not eaſily pulveriſed §. Sp. gr. from 2.816 * to 2.8549 †. Colour of the maſs, violet blue; of the thin plates, ſilvery white. Powder white, with a tint of red ‡ Before the blow-pipe, it froths, and melts eaſily into a white ſemitranſparent enamel, full of bubbles. Diſſolves in borax with effervescence, and communicates no colour to it §. Effervesces ſlightly with ſoda, and melts into a maſs ſpotted with red. With microcoſmic ſalt, it gives a pearl coloured globule *.

* *Crell's Annals*, 1791, ii 196.
† *Beyer, Ann. de Chim.* xxix. 108.
‡ *Le Lievre, Jour. de Min.* N° li. 219
§ *Ibid.*
* *Klaproth.*
† *Hauy*
‡ *Le Lievre, Jour de Min.* No li. 219.
§ *Ibid.*

This ſtone was firſt called lilalite from its colour, that of the *lily*. Klaproth, who diſcovered its component parts, gave it the name of *lepidolite* (G).

* *Klaproth, Ann. de Chim.* xxii. 37.

It is compoſed of

53	ſilica,
20	alumina,
18	potaſs,
5	fluat of lime,
3	oxide of manganeſe,
1	oxide of iron.
100 †	

† *Vauquelin, Ann. de Chim.* xxx. 105.

SPECIES 3. Leucite ‡

Veſuvian of Kirwan—*White Garnet* of Veſuvius.

60 Leucite.

This ſtone is uſually found in volcanic productions, and is very abundant in the neighbourhood of Veſuvius. It is always cryſtallized. The primitive form of its cryſtals is either a cube or a rhomboidal dodecahedron, and its integrant molecules are tetrahedrons; but the varieties hitherto obſerved are all polyhedrons: The moſt common has a ſpheroidal figure, and is bounded by 24 equal and ſimilar trapeziods §; ſometimes the faces are 12, 18, 36, 54, and triangular, pentagonal, &c. For a deſcription and figure of ſeveral of theſe, we refer the reader to Mr Hauy*. The cryſtals vary from the ſize of a pin-head to that of an inch.

‡ *Kirw.* i. 285.
§ Fig. 15.
* *Jour. de Min.* N° xxvii. 185.

The texture of the leucite is foliated. Its fracture ſomewhat conchoidal. Luſtre 3; when in a ſtate of decompoſition 0. Tranſparency 3 to 2; when decompoſing 0. Hardneſs 8 to 10; when decompoſing 5 to 6. Sp. gr. 2.4648. Colour white, or greyiſh white (H). Its powder cauſes ſyrup of violets to aſſume a green colour†.

† *Vauquelin, Jour. de Min.* N° xxxix. 165.

It is compoſed, as Klaproth has ſhewn, of

54	ſilica,
23	alumina,
22	potaſs.
99 (I)	

It was by analyſing this ſtone that Klaproth diſcovered the preſence of potaſs in the mineral kingdom; which is not the leaſt important of the numerous diſcoveries of that accurate and illuſtrious chemiſt.

Simple Stones.

Leucite is found ſometimes in rocks which have never been expoſed to volcanic fire; and Mr. Dolomieu has rendered it probable, from the ſubſtances in which it is found, that the leucite of volcanoes has not been formed by volcanic fire, but that it exiſted previouſly in the rocks upon which the volcanoes have acted, and that it was thrown out unaltered in fragments of theſe rocks ‡.

‡ *Jour. de Min.* N° xxxix. 177.

GENUS VIII. SAG.

61 G.VIII. SAG Emerald.

SPECIES 1. Emerald (K).

This ſtone has hitherto been only found cryſtallized. The primitive form of its cryſtals is a regular ſix-ſided priſm; and the form of its integrant molecules is a triangular priſm, whoſe ſides are ſquares, and baſes equilateral triangles §. The moſt common variety of its cryſtals is the regular ſix-ſided priſm, ſometimes with the edges of the priſm or of the baſes, or the ſolid angles, or both wanting *, and ſmall faces in their place †. The ſides of the priſm are generally channelled.

§ *Hauy, Jour. de Min.* N° xix 72
* Fig. 16.
† *Romé de Liſle*, ii. 245. and *Hauy, ibid.*

Its texture is foliated. Its fracture conchoidal. Luſtre uſually from 3 to 4. Tranſparency from 2 to 4. Cauſes a double refraction. Hardneſs 12. Sp. gr. 2.65 to 2.775. Colour green. Becomes electric by friction, but not by heat. Its powder does not phoſphoreſce when thrown on a hot iron ‡. At 150° Wedgewood it melts into an opaque coloured maſs. According to Dolomieu, it is fuſible *per ſe* by the blow-pipe *.

‡ *Dolomieu. Jour. de Min.* N° xviii. 19.
* *Ibid.*

This mineral was formerly ſubdivided into two diſtinct ſpecies, the *emerald*, and *beryl* or *aqua marina*. Hauy demonſtrated, that the emerald and beryl correſponded exactly in their ſtructure and properties, and Vauquelin found that they were compoſed of the ſame ingredients; henceforth, therefore, they muſt be conſidered as varieties of the ſame ſpecies.

The variety formerly called *emerald* varies in colour from the pale to the perfect green. When heated to 120° Wedgewood, it becomes *blue*, but recovers its colour when cold. A ſpecimen, analyſed by Vauquelin, was compoſed of

64.60	ſilica,
14.00	alumina,
13.00	glucina,
3.50	oxide of chromum,
2.56	lime,
2.00	moiſture or other volatile ingredient.
99.66 †	

† *Ann. de Chim.* xxvi. 264.

The *beryl* is of a greyiſh green colour, and ſometimes blue, yellow, and even white: ſometimes different colours appear in the ſame ſtone ‡ It is found in Ceylon, different parts of India, Brazil, and eſpecially in Siberia and Tartary, where its cryſtals are ſometimes a foot long §.

‡ *Dolomieu, ibid.*
§ *Ibid.*

(F) *Kirw.* I. 208.—*Karſten. Beob. der Berlin, 5 Band.* 71.—*Klaproth Beiträge*, I. 279. *and* II. 191.
(G) That is, *ſcale ſtone*, or ſtone compoſed of ſcales: From λεπις *the ſcale of a fiſh*, and λιθος *a ſtone.*
(H) Hence the name leucite, from λευκος, *white.*
(I) See *Jour. de Min.* N° XXVII. 164. and 201. and *Klaproth's Beiträge*, II. 39.
(K) *Kir.* I. 247. and 248.—*Dolomieu. Magazin Encyclopædique*, II. 17. and 145.; and *Jour de Min.* N° XVIII. 19.—*Klaproth Beiträge*, II.

Earths and Stones.

long. A specimen of beryl, analysed by Vauquelin, contained
69 silica,
13 alumina,
16 glucina,
1.5 oxide of iron.

99.5 *

* *Ann. de Chim.* xxviii. 168.

It was by analysing this stone that Vauquelin discovered the earth which he called *glucina*.

62
G. IX. SAB
Staurolite.

GENUS IX. SAB.

SPECIES 1. Staurolite †.

† *Kirw.* i. 282.

Andreolite of Lametherie and Hauy—*Hyacinthe blanche cruciforme*, var. 9. of Romé de Lisle.

This stone has been found at Andreasberg in the Hartz. It is crystallized, and the form of its crystals has induced mineralogists to give it the name of *cross-stone*. Its crystals ‡ are two four-sided flattened prisms, terminated by four-sided pyramids, intersecting each other at right angles: the plane of intersection passing longitudinally through the prisms (L).

‡ Fig. 17.

Its texture is foliated. Its lustre waxy, 2. Transparency from 1 to 3. Hardness 9. Brittle. Sp. gr. 2.355 to 2.361. Colour milk white. When heated slowly, it loses 0.15 or 0.16 parts of its weight, and falls into powder. It effervesces with borax and microcosmic salt, and is reduced to a greenish opaque mass. With soda it melts into a frothy white enamel. When its powder is thrown on a hot coal, it emits a greenish yellow light §.

§ *Hauy, Jour. de Min.* N° xxviii. 280.

A specimen analysed by Westrum was composed of
44 silica,
20 alumina,
20 barytes,
16 water.

100

Klaproth found the same ingredients, and nearly in the same proportions *.

* *Beiträge*, ii. 80.

A variety of staurolite has been found only once, which has the following peculiarities.

Its lustre is pearly, 2. Sp. gr. 2.361. Colour browniish grey. With soda it melts into a purplish and yellowish frothy enamel. It is composed, according to Westrum, of
47.5 silica,
12.0 alumina,
20.0 barytes,
16.0 water,
4.5 oxides of iron and manganese.

100.0

63
G. X. ASL.
Chrysoberyl.

GENUS X. 1. ASL.

SPECIES 1. Chrysoberyl †.

† *Kirw.* i. 261.

Oriental chrysolite of jewellers—*Cymophane* of Hauy.

Hitherto this stone has been found only in Brazil, the island of Ceylon, and as some affirm near Nortschink in Siberia. Werner first made it a distinct species, and gave it the name which we have adopted. It is usually found in round masses about the size of a pea, but it is sometimes also crystallized. The primitive form of its crystals is a four-sided rectangular prism, whose height is to its breadth as $\sqrt{3}$ to 1, and to its thickness as $\sqrt{2}$ to 1 *. The only variety hitherto observed is an eight-sided prism, terminated by six-sided summits †. Two of the faces of the prism are hexagons, two are rectangles, and four trapeziums; two faces of the summits are rectangles, and the other four trapeziums. Sometimes two of the edges of the prism are wanting, and small faces in their place ‡.

Simple Stones.

* Fig. 18.
† Fig. 19.

Its texture is foliated. Laminæ parallel to the faces of the prism. Lustre 3 to 4. Transparency 3 to 4. Causes single refraction. Hardness 12. Sp. gr. from 3.698 § to 3.7961 *. Colour yellowish green, surface sparkling. It is infusible by the blow-pipe *per se*, and with soda.

‡ *Hauy, Jour. de Min.* N° xxi. 5.

§ *Werner.*

* *Hauy.*

A specimen of chrysoberyl, analysed by Klaproth, was composed of
71.5 alumina,
18.0 silica,
6.0 lime,
1.5 oxide of iron.

97.0 †

† *Beiträge.*

64
G.X. 2. SAL.
Hyalite.

GENUS X. 2. SAL.

SPECIES 2. Hyalite *.

* *Kirw.* i. 296.

This stone is frequently found in trap. It occurs in grains, filaments, and rhomboidal masses. Texture foliated. Fracture uneven, inclining to conchoidal. Lustre glassy (M), 2 to 3. Transparency 2 to 3; sometimes, tho' seldom, it is opaque. Hardness 9. Sp. gr. 2.11 †. Colour pure white. Infusible at 150° Wedgewood; but it yields to soda ‡. According to Mr Link, it is composed of
57 silica,
18 alumina,
15 lime.

90 and a very little iron §.

† *Kirwan.*

‡ *Id.*

§ *Crell's Annals*, 1790. 2 *Band.* 232.

Species 3. Ædelite *.

65
Ædelite.

This stone has hitherto been found only in Sweden at Mossberg and Ædelfors. From this last place Mr Kirwan, who first made it a distinct species, has given it the name which we have adopted. It was first mentioned by Bergman †. Its form is tuberose and knotty. Texture striated; sometimes resembles quartz. Lustre from 0 to 1. Sp. gr. 2.515 after it has absorbed water ‡. Colour light grey, often tinged red; also yellowish brown, yellowish green, and green. Before the blow-pipe it intumesces and forms a frothy mass. Acids convert it into a jelly §. A specimen from Mossberg, analysed by Bergman, contained
69 silica,
20 alumina,
8 lime,
3 water.

* *Kirw.* i. 276.

† *Opusc.* vi. 101.

‡ See *Kirwan's Min.* i. 276.

§ *Berg.* iii. 227.

100 *

* *Opusc.* vi. 101.

A specimen from Ædelfors yielded to the same chemist
62 silica,
18 alumina,
17 lime,
4 water.

100 †.

† *Ibid.*

(L) See *Gillot, Jour. de Phys.* 1793, p. 1 and 2.

(M) Hence probably the name *hyalite*, which was imposed by Werner from ὑαλις, and λεθος, *a stone*.

Earths and Stones.

66
G. X. 3. SAWL. Zeolite.

Genus X. 3. SAWL.

SPECIES 4. Zeolite (N).

This ſtone was firſt deſcribed by Cronſtedt in the Stockholm Tranſactions for 1756. It is found ſometimes amorphous and ſometimes cryſtallized. The primitive form of its cryſtals is a rectangular priſm, whoſe baſes are ſquares. The moſt common variety is a long four-ſided priſm, terminated by low four-ſided pyramids*.

* *Hauy, Jour. de Min.* N° xiv. 86.

Its texture is ſtriated or fibrous. Its luſtre is ſilky, from 3 to 1. Tranſparency from 2 to 4; ſometimes 1. Hardneſs 6 to 8; ſometimes only 4. Abſorbs water. Sp. gr. 2.07 to 2.3. Colour white, often with a ſhade of red or yellow; ſometimes brick red, green, blue. When heated, it becomes electric like the tourmaline †. Before the blow-pipe it froths (O), emits a phoſphoreſcent light, and melts into a white ſemitranſparent enamel, too ſoft to cut glaſs, and ſoluble in acids. In acids it diſſolves ſlowly and partially without effervescence; and at laſt, unleſs the quantity of liquid be too great, it is converted into a jelly.

† *Hauy, ibid* N° xxviii. 276.

A ſpecimen of zeolite (P), analyſed by Vauquelin, contained

53.00 ſilica,
27.00 alumina,
9.46 lime,
10.00 water.

99.46 ‡.

‡ *Ibid.* N° xliv. 576.

67
Stilbite.

SPECIES 5. Stilbite.

This ſtone was firſt formed into a diſtinct ſpecies by Mr Hauy. Formerly it was conſidered as a variety of zeolite.

The primitive form of its cryſtals is a rectangular priſm, whoſe baſes are rectangles. It cryſtallizes ſometimes in dodecahedrons, conſiſting of a four-ſided priſm with hexagonal faces, terminated by four-ſided ſummits, whoſe faces are oblique parallelograms; ſometimes in ſix-ſided priſms, two of whoſe ſolid angles are wanting, and a ſmall triangular face in their place *.

* *Hauy, Jour. de Mim.* N° xiv. 86.

Its texture is foliated. The laminæ are eaſily ſeparated from each other; and are ſomewhat flexible. Luſtre pearly, 2 or 3 (Q). Hardneſs inferior to that of zeolite, which ſcratches ſtilbite. Brittle. Sp. gr. 2.500†. Colour pearl white. Powder bright white, ſometimes with a ſhade of red. This powder, when expoſed to the air, cakes and adheres as if it had abſorbed water. It cauſes ſyrup of violets to aſſume a green colour. When ſtilbite is heated in a porcelain crucible, it ſwells up and aſſumes the colour and ſemitranſparency of baked porcelain. By this proceſs it loſes 0.185 of its weight. Before the blow-pipe it froths like borax, and then melts into an opaque white-coloured enamel ‡.

† *Hauy, ibid.* N° xxviii. 276.

‡ *Vauquelin, ibid.* N° xxxix. 161.

According to the analyſis of Vauquelin, it is compoſed of

52.0 ſilica,
17.5 alumina,
9.0 lime,
18.5 water.

97.0 *

* *Ibid.* 164.

Simple Stones.

68
Analcime.

SPECIES 6. Analcime.

This ſtone, which was diſcovered by Mr Dolomieu, is found cryſtallized in the cavities of lava. It was firſt made a diſtinct ſpecies by Mr Hauy. Mineralogiſts had formerly confounded it with zeolite.

The primitive form of its cryſtals is a cube. It is ſometimes found cryſtallized in cubes, whoſe ſolid angles are wanting, and three ſmall triangular faces in place of each; ſometimes in polyhedrons with 24 faces. It is uſually ſomewhat tranſparent. Hardneſs about 8; ſcratches glaſs ſlightly. Sp. gr. above 2. When rubbed, it acquires only a ſmall degree of electricity, and with difficulty (R). Before the blow-pipe it melts without frothing, into a white ſemitranſparent glaſs†.

† *Hauy, Jour. de Min.* N°xiv. 86. and xxviii. 278.

69
G.X.4.SLA. Lazulite.

Genus X. 4. SLA.

SPECIES 7. Lazulite ‡.

This ſtone, which is found chiefly in the northern parts of Aſia, has been long known to mineralogiſts by the name of *lapis lazuli*. This term has been contracted into *lazulite* by Mr Hauy; an alteration which was certainly proper, and which therefore we have adopted.

‡ *Kirw.* i. 283.

Lazulite is always amorphous. Its texture is earthy. Its fracture uneven. Luſtre 0. Opaque, or nearly ſo. Hardneſs 8 to 9. Sp. gr. 2.76 to 2.945 *. Colour blue (S); often ſpotted white from ſpecks of quartz, and yellow from particles of pyrites.

* *Briſſon.*

It retains its colour at 100° Wedgewood; in a higher heat it intumeſces, and melts into a yellowiſh black maſs. With acids it effervesces a little, and if previouſly calcined, forms with them a jelly.

Margraff publiſhed an analyſis of lazulite in the Berlin Memoirs for 1758. His analyſis has ſince been confirmed by Klaproth, who found a ſpecimen of it to contain

46.0 ſilica,
14.5 alumina,
28.0 carbonat of lime,
6.5 ſulphat of lime,
3.0 oxide of iron,
2.0 water.

100.0†

† *Beiträge*, i. 196.

70
G.XI.SALI. Garnet.

Genus XI. SALI.

SPECIES 1. Garnet (T).

This ſtone is found abundantly in many mountains. It is uſually cryſtallized. The primitive form of its cryſtals

(N) *Kirw.* I. 278.—*Guettard*, IV. 637.—*Bucquet, Mem. Sav. Etrang.* IX. 576.—*Pelletier, Jour. de Phyſ.* XX. 420.

(O) Hence the name *zeolite*, given to this mineral by Cronſtedt; from ζεω, *to ferment*, λιθος, *a ſtone*.

(P) Dr Black was accuſtomed to mention, in the courſe of his lectures, that Dr Hutton had diſcovered *ſoda* in zeolite. This diſcovery has not hitherto been verified by any other chemical mineralogiſt.

(Q) Hence the name given to this mineral by Hauy, *ſtilbite*, from στιλβω, *to ſhine*.

(R) Hence the name *analcime* given it by Hauy, from αναλκις, *weak*.

(S) Hence the name *lazulite*, from an Arabian word *azul*, which ſignifies *blue*.

(T) *Kirw.* I. 258.—*Gerhard, Diſquiſitio phyſico-chymica Granatorum*, &c.—*Paſumot, Jour. de Phyſ.* III. 442.—*Wiegleb, Ann. de Chim.* I. 231.

Earths and stones.

cryſtals is a dodecahedron whoſe ſides are rhombs, with angles of 78° 31′ 44″, and 120° 28′ 16″. The inclination of the rhombs to each other is 120°. This dodecahedron may be conſidered as a four-ſided priſm, terminated by four-ſided pyramids *. It is diviſible into four parallelopipeds, whoſe ſides are rhombs; and each of theſe may be divided into four tetrahedrons, whoſe ſides are iſoſceles triangles, equal and ſimilar to either of the halves into which the rhomboidal faces of the dodecahedron are divided by their ſhorter diagonal. The integrant molecules of garnet are ſimilar tetrahedrons†. Sometimes the edges of the dodecahedrons are wanting, and ſmall faces in their place; and ſometimes garnet is cryſtallized in polyhedrons, having 24 trapezoidal faces. For a deſcription and figure of theſe, and other varieties of garnet, we refer to *Romé de Liſle* and *Hauy*‡.

* Fig. 20.
* *De Liſle*, ii. 322. and *Hauy, Ann. de Chim.* xvii. 305.
† *Hauy, ibid.* 306.
‡ *Ibid.*

The texture of garnet, as Bergman firſt ſhewed, is foliated §. Its fracture commonly conchoidal. Internal luſtre from 4 to 2. Tranſparency from 2 to 4; ſometimes only 1 or 0. Cauſes ſingle refraction ‖. Hardneſs from 10 to 14. Sp. gr. 3.75 to 4.188. Colour uſually red. Often attracted by the magnet. Fuſible *per ſe* by the blow-pipe.

§ *Opuſc.* ii. 9.
‖ *Hauy, Jour. de Min.* N° xxviii. 260.

Variety 1. Oriental garnet (υ).

Internal luſtre 3 to 4. Tranſparency 4. Hardneſs 13 to 14. Sp. gr. 4 to 4.188. Colour deep red, inclining to violet (χ).

Variety 2. Common garnet.

Fracture uneven, inclining to the conchoidal. Internal luſtre 2 to 3. Tranſparency from 3 to 0. Hardneſs 10 to 11; ſometimes only 9. Sp. gr. 3.75 to 4. Colour commonly deep red, inclining to violet; ſometimes verging towards black or olive; ſometimes leek green, brown, yellow.

Variety 3. Amorphous garnet.

Structure ſlaty. Luſtre 2. Tranſparency 2 to 1. Hardneſs 11 to 12. Sp. gr. 3.89. Colour browniſh or blackiſh red. Found in Sweden, Switzerland, and the Eaſt Indies.

A ſpecimen of oriental garnet, analyſed by Klaproth, contained

35.75	ſilica,
27.25	alumina,
36.00	oxide of iron,
0.25	oxide of manganeſe.
99.25 *	

* *Beiträge*, ii. 26.

A ſpecimen of red garnet, analyſed by Vauquelin, contained

52.0	ſilica,
20.0	alumina,
17.0	oxide of iron,
7.7	lime.
96.7 †	

† *Jour. de Min.* N° xliv. 575.

A ſpecimen of black garnet yielded to the ſame chemiſt

43	ſilica,
16	alumina,
20	lime,
16	oxide of iron,
4	moiſture.
99 ‡	

‡ *Ibid.* 573.

Mr Klaproth found a ſpecimen of Bohemian garnet, compoſed of

40.00	ſilica,
28.50	alumina,
16.50	oxide of iron,
10.00	magneſia,
3.50	lime,
.25	oxide of manganeſe.
98.75 *	

* *Beiträge*, ii. 21.

Simple Stones.

71 Thumerſtone.

SPECIES 2. Thumerſtone †.

Yanolite of Lamatherie—*Axinite* of Hauy.

This ſtone was firſt deſcribed by Mr Schreber, who found it near Balme d'Auris in Dauphiné, and gave it the name of *ſhorl violé* ‡. It was afterwards found near Thum in Saxony, in conſequence of which Werner called it *thumerſtone*.

† *Kirw.* i. 273.—*Pelletier, Journ. de Phyſ.* xxvi. 66.
‡ *De Liſle*, ii. 353.

It is ſometimes amorphous; but more commonly cryſtallized. The primitive form of its cryſtals is a rectangular priſm, whoſe baſes are parallelograms with angles of 101° 32′ and 78° 28′ §. The moſt uſual variety is a flat rhomboidal parallelopiped, with two of its oppoſite edges wanting, and a ſmall face in place of each ‖. The faces of the parallelopiped are generally ſtreaked longitudinally ¶.

§ *Hauy, Jour. de Min.* N° xxviii. 264.
‖ Fig. 21.
¶ *De Liſle, ibid.*

The texture of thumerſtone is foliated. Its fracture conchoidal. Luſtre 2. Tranſparency, when cryſtallized, 3 to 4; when amorphous, 2 to 1. Cauſes ſimple refraction*. Hardneſs 10 to 9. Sp. gr. 3.2956. Colour clove brown; ſometimes inclining to red, green, grey, violet, or black. Before the blow-pipe it froths like zeolite, and melts into a hard black enamel. With borax it exhibits the ſame phenomena, or even when the ſtone is ſimply heated at the end of a pincer †.

* *Hauy, ibid.*

A ſpecimen of thumerſtone, analyſed by Klaproth, contained

52.7	ſilica,
25.6	alumina,
9.4	lime,
9.6	oxide of iron with a trace of manganeſe.
97.3 ‡	

† *Vauquelin, Jour. de Min.* N° xxiii. 1.

A ſpecimen, analyſed by Vauquelin, contained

44	ſilica,
18	alumina,
19	lime,
14	oxide of iron,
4	oxide of manganeſe.
99 §	

‡ *Beiträge*, ii. 126.

§ *Jour. de Min. ibid.*

72 Prehnite.

SPECIES 3. Prehnite (ψ).

Though this ſtone had been mentioned by Sage ‖, Romé de Liſle ¶, and other mineralogiſts, Werner was the firſt who properly diſtinguiſhed it from other minerals, and made it a diſtinct ſpecies. The ſpecimen which he examined was brought from the Cape of Good Hope by Colonel Prehn; hence the name *prehnite*, by which he diſtinguiſhed it. It was found near Dunbarton by Mr Grotche *; and ſince that time it has been obſerved in other parts of Scotland.

‖ *Miner.* i. 232.
¶ *Cryſtallog.* ii. 275.
* *Ann. de Chim.* 213

It

(υ) This ſeems to be the *carbuncle* (ανθραξ) of Theophraſtus, and the *carbunculus garamanticus* of other ancient writers. See *Hill's Theophraſtus*, περι λιθων, p. 74. and 77.

(χ) Hence, according to many, the name *garnet* (in Latin *granatus*), from the reſemblance of the ſtone in colour to the bloſſoms of the pomegranate.

(ψ) *Kirw.* I. 274.—*Haſſenfratz, Jour. de Phyſ.* XXXII. 81.—*Sage, ibid.* XXXIV. 446.—*Klaproth. Beob. der Berlin, 2 Band.* 211. And *Ann. de Chim.* I. 201.

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It is both amorphous and cryſtallized. The cryſtals are in groups, and confuſed: they ſeem to be four-ſided priſms with dihedral ſummits *. Sometimes they are irregular ſix-ſided plates, and ſometimes flat rhomboidal parallelopipeds.

* *Hauy, Jour. de Min.* N° xxviii. 277.

Its texture is foliated. Fracture uneven. Internal luſtre pearly, ſcarcely 2. Tranſparency 3 to 2. Hardneſs 9 to 10. Brittle. Sp. gr. 2.6969 †. Colour apple green, or greeniſh grey. Before the blow-pipe it froths more violently than zeolite, and melts into a brown enamel. A ſpecimen of prehnite, analyſed by Klaproth, was compoſed of

† *Hauy, ibid*

43.83 ſilica,
30.33 alumina,
18.33 lime,
5.66 oxide of iron,
1.16 air and water.

99.31 ‡

‡ *Ann. de Chim.* i. 208.

Whereas Mr Haſſenfratz found in another ſpecimen

50.0 ſilica,
20.4 alumina,
23.3 lime,
4.9 iron,
.9 water,
.5 magneſia.

100.0 §

§ *Ibid.* and *Jour. de Phyſ.* N° xxxii. 81.

SPECIES 4. Thallite.

73 Thallite.

Green ſhorl of Dauphiné of De Liſle ‖.—*Delphinite* of Sauſſure.

‖ *Cryſtallog.* ii. 401.

This ſtone is found in the fiſſures of mountains; and hitherto only in Dauphiné and on Chamouni in the Alps.

It is ſometimes amorphous, and ſometimes cryſtallized. The primitive form of its cryſtals is a rectangular priſm, whoſe baſes are rhombs with angles of 114° 37′, and 65° 23′ ¶. The moſt uſual variety is an elongated four-ſided priſm (often flattened), terminated by four-ſided incomplete pyramids *; ſometimes it occurs in regular ſix-ſided priſms †. The cryſtals are often very ſlender.

¶ *Hauy, Jour. de Min.* N° xxviii. 271.
* Fig. 22.
† *Romé de Liſle, ibid.* and *Hauy, Jour. de Min.* N° xxx. 415.

Its texture appears fibrous. Luſtre inconſiderable. Tranſparency 2 to 3, ſometimes 4; ſometimes nearly opaque. Cauſes ſingle refraction. Hardneſs 9 to 10. Brittle. Sp. gr. 3.4529 to 3.46. Colour dark green (z). Powder white or yellowiſh green, and feels dry. It does not become electric by heat. Before the blow-pipe, froths and melts into a black ſlag. With borax melts into a green bead ‡.

‡ *Hauy*, and *Deſcotils, ibid.*

A ſpecimen of thallite, analyſed by Mr Deſcotils, contained

37 ſilica,
27 alumina,
17 oxide of iron,
14 lime,
1.5 oxide of manganeſe.

96.5 §

§ *Ibid.* N° xxx. 420.

GENUS XII. 1. AMS.

SPECIES 1. Cyanite *.

Sappare of Sauſſure.

Simple Stones.

74 G. XII. AMS. Cyanite.

This ſtone was firſt deſcribed by Mr Sauſſure the ſon, who gave it the name of *ſappare* †. It is commonly found in granite rocks. The primitive form of its cryſtals is a four-ſided oblique priſm, whoſe ſides are inclined at an angle of 103°. The baſe forms with one ſide of the priſm an angle of 103°; with another an angle of 77°. It is ſometimes cryſtallized in ſix-ſided priſms ‡.

* *Kirw.* i. 209.—*Sage, Jour. de Phyſ.* xxxv. 39.
† *Jour. de Phyſ.* xxxiv. 213.
‡ *Hauy, Jour. de Min.* N° xxviii. 282.

Its texture is foliated. Laminæ long. Fragments long, ſplintery. Luſtre pearly, 2 to 3. Tranſparency of the laminæ 3. Cauſes ſingle refraction §. Hardneſs 6 to 9. Brittle. Sp. gr. from 3.092 to 3.622 ‖. Feels ſomewhat greaſy. Colour milk white, with ſhades of ſky or pruſſian blue (A); ſometimes bluiſh grey; ſometimes partly bluiſh grey, partly yellowiſh or greeniſh grey.

§ *Hauy, ibid.*
‖ *Kirwan.*

Before the blow-pipe it becomes almoſt perfectly white; but does not melt. According to the analyſis of Sauſſure, it is compoſed of

66.92 alumina,
13.25 magneſia,
12.81 ſilica,
5.48 iron,
1.71 lime.

100.17 *

* *Jour. de Phyſ. ibid.*

Cyanite has alſo been analyſed by Struvius and Hermann, who agree with Sauſſure as to the ingredients; but differ widely from him and one another as to the proportions.

Struvius.		Hermann.
5·5	- - -	30 alumina,
30·5	- - -	39 magneſia,
51·5	- - -	23 ſilica,
5.0	- - -	2 iron,
4.0	- - -	3 lime.
96.5 †		97 ‡

† *Crell's Annals*, 1790.
‡ *Ibid.*

GENUS XII. 2. MSA.

SPECIES 2. Serpentine (B).

75 G. XII. 2. MSA. Serpentine.

This ſtone is found in amorphous maſſes. Its fracture is ſplintery. Luſtre 0. Opaque. Hardneſs 6 to 7. Sp. gr. 2.2645 to 2.709. Feels rather ſoft, almoſt greaſy. Generally emits an earthy ſmell when breathed upon. Its colours are various ſhades of green, yellow, red, grey, brown, blue: commonly one or two colours form the ground, and one or more appear in ſpots or veins (c).

Before the blow-pipe it hardens and does not melt.

A ſpecimen of ſerpentine, analyſed by Mr Chenivix, contained

34.5 magneſia,
28.0 ſilica,
23.0 alumina,
4.5 oxide of iron,
0.5 lime,
10.5 water.

101.0 §

§ *Ann. de Chim.* xxviii. 199.

GENUS

(z) Hence the name *thallite* given it by Lametherie, from θαλλος, *a green leaf.*

(A) Hence the name *cyanite*, impoſed by Werner.

(B) *Kirw.* I. 156.—*Margraf, Mem. Berlin*, 1759, p. 3.—*Bayen, Jour. de Phyſ.* XIII. 46.—*Mayer, Crell's Annals*, 1789, II. 416.

(c) Hence the name *ſerpentine*, given to the ſtone from a ſuppoſed reſemblance in colours to the ſkin of a ſerpent.

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Genus XIII. msai.

76 G. XIII. MSAI. Potſtone.

species 1. Potſtone *.

* *Kirw.* i. 155.

This ſtone is found in neſts and beds, and is always amorphous. Its ſtructure is often ſlaty. Texture undulatingly foliated. Luſtre from 1 to 3. Tranſparency from 1 to 0; ſometimes 2. Hardneſs 4 to 6. Brittle. Sp. gr. from 2.8531 to 3.023. Feels greaſy. Sometimes abſorbs water. Colour grey with a ſhade of green, and ſometimes of red or yellow; ſometimes leek green; ſometimes ſpecked with red.

Potſtone is not much affected by fire; and has therefore been made into utenſils for boiling water; hence its name.

According to Wiegleb, the potſtone of Como contains

38	magneſia,
38	ſilica,
7	alumina,
5	iron,
1	carbonat of lime,
1	fluoric acid.
90	

77 Chlorite.

species 2. Chlorite †.

† *Kirw.* i. 147.

This mineral enters as an ingredient into different mountains. It is ſometimes amorphous, and ſometimes cryſtallized in oblong, four-ſided, acuminated cryſtals.

Its texture is foliated. Its luſtre from 0 to 2. Opaque. Hardneſs from 4 to 6; ſometimes in looſe ſcales. Colour green.

Variety 1. Farinaceous chlorite.

Compoſed of ſcales ſcarcely cohering, either heaped together, or inveſting other ſtones. Feels greaſy. Gives an earthy ſmell when breathed on. Difficult to pulveriſe. Colour graſs green; ſometimes greeniſh brown; ſometimes dark green, inclining to black. Streak white. When the powder of chlorite is expoſed to the blow-pipe it becomes brown. Before the blow-pipe, farinaceous chlorite froths and melts into a dark brown glaſs; with borax it forms a greeniſh brown glaſs ‡.

‡ *Vauquelin, Jour. de Min.* N° xxxix. 167.

Variety 2. Indurated chlorite.

This variety is cryſtallized. Luſtre 1. Hardneſs 6. Feel meagre. Colour dark green, almoſt black. Streak mountain green.

Variety 3. Slaty chlorite.

Structure ſlaty. Fragments flatted. Internal luſtre 1 to 2. Hardneſs 5. Colour greeniſh grey, or dark green inclining to black. Streak mountain green.

A ſpecimen of the firſt variety, analyſed by Vauquelin, contained

43.3	oxide of iron,
26.0	ſilica,
15.5	alumina,
8.0	magneſia,
2.0	muriat of potaſs,
4.0	water.
98.8 §	

§ *Ann. de Chim.* xxx. 106.

A ſpecimen of the ſame variety yielded Mr Hæpner

12.92	oxide of iron,
37.50	ſilica,
4.17	alumina,
43.75	magneſia,
1.66	lime.
100.0 *	

Simple Stones.

* *Sauſſure's Voyages*, ii. 133.

A ſpecimen of the ſecond variety, analyſed by the ſame chemiſt, contained

10.15	oxide of iron,
41.15	ſilica,
6.13	alumina,
39.47	magneſia,
1.50	lime,
1.50	air and water.
99.90 †	

† *Crell's Annals*, 1790, p. 56.

On the ſuppoſition that theſe analyſes are accurate, the enormous difference between them is a demonſtration that chlorite is not a chemical combination, but a mechanical mixture.

Genus XIV. slam.

78 G. XIV. SLAM Siliceous ſpar.

species 1. Siliceous ſpar (D).

This ſtone has been found in Tranſylvania. It is cryſtallized in 4 or 6 ſided priſms, channelled tranſverſely, and generally heaped together. Its texture is fibrous. Its luſtre ſilky, 2. Its colours white, yellow, green, light blue. According to Bindheim, it contains

61.1	ſilica,
21.7	lime,
6.6	alumina,
5.0	magneſia,
1.3	oxide of iron,
3.3	water.
99.0 *	

* *Berg.* vi. 104.

Genus XV. samli.

79 G. XV. SAMLI. Argillite.

species 1. Argillite †.

† *Kirw.* i. 234.

Argillaceous ſhiſtus—Common ſlate.

This ſtone conſtitutes a part of many mountains.

Its ſtructure is ſlaty. Its texture foliated. Fracture ſplintery. Fragments often tabular. Luſtre, moſt commonly ſilky, 2; ſometimes 0. Tranſparency from 0 to 1. Hardneſs from 5 to 8. Sp. gr. from 2.67 to 2.88. Does not adhere to the tongue. Gives a clear ſound when ſtruck. Often imbibes water. Streak white or grey. Colour moſt commonly grey, with a ſhade of blue, green, or black; ſometimes purpliſh, yellowiſh mountain green, brown, bluiſh black: ſometimes ſtriped or ſpotted with a darker colour than the ground.

It is compoſed, according to Kirwan, of ſilica, alumina, magneſia, lime, oxide of iron. In ſome varieties the

(D) Is this the *tremolite* of Lowitz from the lake Baikal in Siberia? If ſo, the name of the genus ought to be SLM; for he found it contain no alumina. According to his analyſis, it was compoſed of

52	ſilica,
20	lime,
12	carbonat of lime,
12	magneſia,
96	

The

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the lime is wanting. Several varieties contain a conſiderable quantity of carbonaceous matter.

So G. XVI. SLACMI. Smaragdite.

GENUS XVI. SLACMI.

SPECIES 1. Smaragdite.

This ſtone was called *ſmaragdite* by Mr Sauſſure, from ſome reſemblance which it has to the emerald. Its texture is foliated. The laminæ are inflexible. Fracture even. Hardneſs 7. Colour in ſome caſes fine green, in others it has the grey colour and metallic luſtre of mica: it aſſumes all the ſhades of colour between theſe two extremes *.

* *Hauy, Jour. de Min.* N° xxviii. 272.

According to the analyſis of Vauquelin, it is compoſed of

50.0 ſilica,
13.0 lime,
11.0 alumina,
7.5 oxide of chromum,
6.0 magneſia,
5.5 oxide of iron,
1.5 oxide of copper.

94.5 †

† *Ann. de Chim.* xxx. 206.

GENUS XVII. SM.

SPECIES 1. Kiffekil ‡.

Myrſen—Seafroth.

So G. XVII. SM. Kiffekil.

This mineral is dug up near Konie in Natolia, and is employed in forming the bowls of Turkiſh tobacco pipes. The ſale of it ſupports a large monaſtery of derviſes eſtabliſhed near the place where it is dug. It is found in a large fiſſure ſix feet wide, in grey calcareous earth. The workmen aſſert, that it grows again in the fiſſure §, and puffs itſelf up like froth (E). This mineral, when freſh dug, is of the conſiſtence of wax; it feels ſoft and greaſy; its colour is yellow; its ſp. gr. 1.600 *: when thrown on the fire it ſweats, emits a fetid vapour, becomes hard, and perfectly white.

‡ *Kirwan's Min.* i. 144.

§ *Reignegg. Philoſ. Mag.* iii. 165.

* *Klaproth.*

According to the analyſis of Klaproth, it is compoſed of

50.50 ſilica,
17.25 magneſia,
25.00 water,
5.00 carbonic acid,
.50 lime.

98.25 †

† *Beiträge*, ii. 172.

SPECIES 2. Steatites (F).

So Steatites.

Though this mineral was noticed by the ancients, little attention was paid to it by mineralogiſts, till Mr Pott publiſhed his experiments on it in the Berlin Memoirs for 1747.

It is uſually amorphous, but ſometimes it is cryſtallized in ſix-ſided priſms. Its texture is commonly earthy, but ſometimes foliated. Luſtre from 0 to 2. Tranſparency from 0 to 2. Hardneſs 4 to 7. Sp. gr. from 2.61 to 2.794 ‡. Feels greaſy. Seldom adheres to the tongue. Colour uſually white or grey; often with a tint of other colours; the foliated commonly green. Does not melt *per ſe* before the blow-pipe.

‡ *Briſſon.*

Simple Stones.

Variety 1. Semi-indurated ſteatites.

Texture earthy. Fracture ſometimes coarſe ſplintery. Luſtre 0. Tranſparency 0, or ſcarce 1. Hardneſs 4 to 5. Abſorbs water. Takes a poliſh from the nail. Colour white, with a ſhade of grey, yellow, or green; ſometimes pure white; ſometimes it contains dendritical figures; and ſometimes red veins.

Variety 2. Indurated ſteatites.

Fracture fine ſplintery, often mixed with imperfectly conchoidal. External luſtre 2 to 1, internal 0. Tranſparency 2. Often has the feel of ſoap. Abſorbs water. Colour yellowiſh or greeniſh grey; often veined or ſpotted with deep yellow or red.

Variety 3. Foliated or ſtriated ſteatites.

The texture of this variaty is uſually foliated; ſometimes ſtriated. Fragments cubiform. Luſtre 3. Tranſparency 2 to 1. Hardneſs 6 to 7. Colour leek green, paſſing into mountain green or ſulphur yellow. Streak pale greeniſh grey. When heated to redneſs, it becomes grey; and at 147° Wedgewood, it forms a grey porous porcelain maſs*.

* *Kirwan*, i. 155.

A ſpecimen of ſteatites, analyſed by Klaproth, contained

59.5 ſilica,
30.5 magneſia,
2.5 iron,
5.5 water.

98.0 †

† *Beiträge*, ii. 179.

A ſpecimen of white ſteatites, analyſed by Mr Chenevix, contained

60.00 ſilica,
28.50 magneſia,
3.00 alumina,
2.50 lime,
2.25 iron.

96.25 ‡

‡ *Ann. de Chim.* xxviii. 200.

GENUS XVIII. MSI.

SPECIES 1. Chryſolite (G).

Peridot of the French—*Topaz* of the ancients.

So G. XVIII. MSI. Chryſolite.

The name *chryſolite* was applied, without diſcrimination, to a great variety of ſtones, till Werner defined it accurately, and confined it to that ſtone which the French chemiſts diſtinguiſh by the appellation of *peridot*. This ſtone is the *topaz* of the ancients; their chryſolite is now called *topaz* *.

* *Plinii*, lib. 37. c. 8.

Chryſolite is found ſometimes in unequal fragments, and ſometimes cryſtallized †. The primitive form of its cryſtals is a right angled parallelopiped ‡, whoſe length, breadth, and thickneſs, are as 5, $\sqrt{8}$, $\sqrt{5}$ §.

† Fig. 23.

‡ Fig. 24.

The texture of the chryſolite is foliated. Its fracture conchoidal. Its internal luſtre from 2 to 4. Its tranſparency from 4 to 2. Cauſes double refraction. Hardneſs

§ *Hauy, Jour. de Min.* N° xxviii. 281.

The carbonat of lime was only mechanically interpoſed between the fibres of the ſtone. See *Pallas, Neu. Nord. Beiträge*, 6 *Band*, p. 146.

(E) Hence the name *kiff-kil*, or rather *keff-kelli*, "clay froth," or "light clay."

(F) *Kirw.* I. 151.—*Pott, Mem. Berlin*, 1747, p. 57.—*Wiegleb, Jour. de Phyſ.* XXIX. 60.—*Lavoiſier, Mem. Par.* 1778, 433.

(G) *Kirw.* I. 262.—*Cartheuſer, Min.* 94.—*Dolomieu, Jour. de Min.* N° xxix. 365.—*La Metherie, Nouv. Jour. de Phyſ.* I. 397.

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Hardneſs 9 to 10. Brittle. Sp. gr. from 3.265 to 3.45. Colour green. It is infuſible at 150°, but loſes its tranſparency, and becomes blackiſh grey *. With borax it melts without efferveſcence into a tranſparent glaſs of a light green colour. Infuſible with microcoſmic ſalt † and fixed alkali ‡.

* *Kir. Min.* i. 263.

† *Vauquelin, Ann. de Chim.* xxi. 97.

Variety 1. Common chryſolite.

Found in Ceylon, and South America, and in Bohemia, amidſt ſand and gravel §. Luſtre 3 to 4. Tranſparency 4 to 3. Colour yellowiſh green, ſometimes verging to olive green, ſometimes to pale yellow.

‡ *Kirw. ibid.*

§ *Coquebert, Jour. de Min.* N° xxii. 20.

Variety 2. Olive chryſolite—*Olivine* *.

Found commonly among traps and baſalts; ſometimes in ſmall grains, ſometimes in pretty large pieces; but it has not been obſerved in cryſtals. Luſtre 2 to 3. Tranſparency 3 to 2. Colour olive green.

* *Kirwan's Min.* i. 263—*Le Lievre, Jour. de Phyſ.* xxx. 397.

The firſt variety, according to the analyſis of Klaproth, is compoſed of 41.5 magneſia,
38.5 ſilica,
19.0 oxide of iron.

99.0 †

† *Klaproth's Beiträge*, i. 103.

According to that of Vauquelin, it is compoſed of
51.5 magneſia,
38.0 ſilica,
9.5 oxide of iron.

99.0 ‡

‡ *Ann de Chim. ibid.*

The ſecond variety, according to the analyſis of Klaproth, is compoſed of 37.58 magneſia,
50.00 ſilica,
11.75 oxide of iron,
.21 lime.

99.54 §

§ *Beiträge*, i. 112.

84 Jade.

Species 2. Jade (H).

This ſtone was formerly called *lapis naphriticus*, and was much celebrated for its medical virtues. It is found in Egypt, China, America, and in the Siberian and Hungarian mountains. It is ſometimes adhering to rocks, and ſometimes in detached round pieces.

Its ſurface is ſmooth. Its fracture ſplintery. External luſtre 0, or ſcarce 1; internal waxy, 1. Tranſparency from 2 to 1. Hardneſs 10. Not brittle. Sp. gr. from 2.95 to 2.9829; or, according to Sauſſure, to 3 389. Feels greaſy. Looks as if it had imbibed oil. Colour dark leek green, or verging towards blue; in ſome prominences inclining to greeniſh or bluiſh white. When heated it becomes more tranſparent and brittle, but is infuſible *per ſe*. According to Hoepfner, it is compoſed of
47 ſilica,
38 carbonat of magneſia,
9 iron,
4 alumina,
2 carbonat of lime.

100

This is the ſtone in which the inhabitants of New Zealand make into hatchets and other cutting inſtruments.

Genus XIX. sml.

Species 1. Aſbeſtus (I).

Simple Stones. 85 G. XIX. sml. Aſbeſtus.

This mineral was well known to the ancients. They even made a kind of cloth from one of the varieties, which was famous among them for its incombuſtibility. It is found abundantly in moſt mountainous countries, and no where more abundantly than in Scotland.

It is commonly amorphous. Its texture is fibrous. Its fragments often long ſplintery. Luſtre from 0 to 2; ſometims 3, and then it is metallic. Tranſparency from 0 to 2. Hardneſs from 3 to 7. Sp. gr. from 2.7 to 0.6806. Abſorbs water. Colour uſually white or green. Fuſible *per ſe* by the blow-pipe.

Variety 1. Common aſbeſtus.

Luſtre 2 to 1. Tranſparency 1. Hardneſs 6 to 7. Sp. gr. 2.577 to 2.7. Feels ſomewhat greaſy. Colour leek green; ſometimes olive or mountain green; ſometimes greeniſh or yellowiſh grey. Streak grey. Powder grey.

Variety 2. Flexible aſbeſtus.

Amiantus.

Compoſed of a bundle of threads ſlightly cohering. Fibres flexible. Luſtre 1 to 2, ſometimes 3. Tranſparency 1 to 2, ſometimes 0. Hardneſs 3 to 4. Sp. gr. before it abſorbs water, from 0.9088 to 2.3134; after abſorbing water, from 1.5662 to 2.3803 *. Feels greaſy. Colour greyiſh or greeniſh white; ſometimes yellowiſh or ſilvery white, olive or mountain green, pale fleſh red, and mountain yellow.

* *Briſſon.*

Variety 3. Elaſtic aſbeſtus.

Mountain cork.

This variety has a ſtrong reſemblance to common cork. Its fibres are interwoven. Luſtre commonly 0. Opaque. Hardneſs 4. Sp. gr. before abſorbing water, from 0.6806 to 0.9933; after abſorbing water, from 1.2492 to 1.3492. Feels meagre. Yields to the fingers like cork, and is ſomewhat elaſtic. Colour white; ſometimes with a ſhade of red or yellow; ſometimes yellow or brown.

A ſpecimen of the firſt variety from Dalecarlia, analyſed by Bergman, contained
63.9 ſilica,
16.0 carbonat of lime,
12.8 carbonat of magneſia,
6.0 oxide of iron,
1.1 alumina.

99.8 *

* *Opuſc.* iv. 170.

A ſpecimen of the ſecond variety yielded to the ſame chemiſt
64.0 ſilica,
17.2 carbonat of magneſia,
13.9 carbonat of lime,
2.7 alumina,
2.2 oxide of iron.

100.0 ‡

‡ *Ibid. p.* 163.

A ſpecimen of the third variety contained, according to the ſame analyſis, 56.2 ſilica,
26.1 carbonat of magneſia,
12.7 carbonat of lime,
3.0 iron,
2.0 alumina.

100.0 §

Twelve § *Ibid.* p. 170.

(H) *Kirw.* I. 171.—*Bartolin, De Lapide Nephritico.*—*Lehman, Nov. Comm. Petropol.* X. 381.—*Hoepfner, Hiſt. Nat. de la Suiſſe*, I. 251.

(I) *Kirw.* I. 159.—*Bergman*, IV. 160—*Plot, Phil. Tranſ.* XV. 1051.—*Nebel, Jour. de Phyſ.* II. 62.—*Ibid.* III. 367.

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Twelve different ſpecimens of aſbeſtus, analyſed by Bergman, yielded the ſame ingredients, differing a little in their proportions *.

* *Opuſc.* iv. 175.

86 Aſbeſtinite.

SPECIES 2. Aſbeſtinite (K).

This ſtone is amorphous. Texture foliated or broad ſtriated. Luſtre ſilky, 3. Tranſparency 1 to 2. Hardneſs 5 to 6. Sp. gr. from 2.806 to 2.880. Colour white with ſhades of red, yellow, green or blue. At 150° Wedgewood it melts into a green glaſs.

87 G. XX. 1. SILM. Pyroxen.

GENUS XX. 1. SILM.

SPECIES 1. Pyroxen.

This ſtone is found abundantly in lava and other volcanic productions (L). It is always cryſtallized. The primitive form of its cryſtals is an oblique angled priſm, whoſe baſes are rhombs with angles of 92° 18′, and 37° 42′†. It generally cryſtallizes in eight-ſided priſms, terminated by dihedral ſummits ‡. Its texture is foliated. Hardneſs 9. Colour black; ſometimes green. Powder greeniſh grey §. Commonly attracted by the magnet *. Scarcely fuſible by the blow pipe †. With borax it melts into a yellowiſh glaſs, which appears red while it is hot ‡.

† *Hauy, Jour. de Min.* N° xxviii. 269.
‡ *De Liſle*, ii. 398.
§ *Vauquelin*
* *Ferber.*
† *Le Lievre.*
‡ *Vauquelin.*

According to the analyſis of Vauquelin, it is compoſed of

52.00 ſilica,
14.66 oxide of iron,
13.20 lime,
10.00 magneſia,
3.33 alumina,
2.00 oxide of manganeſe.

95.19 §

§ *Jour de Min.* N° xxxix. 172.

88 Aſbeſtoid.

SPECIES 2. Aſbeſtoid *.

This ſtone has obtained its name from its ſimilarity to common aſbeſtus. It is amorphous. Its texture is foliated or ſtriated. Its luſtre common or glaſſy, from 2 to 3. Tranſparency from 0 to 1. Hardneſs 6 to 7. Sp. gr. from 3 to 3.31. Colour olive or leek green; when decompoſing, brown. Before the blow-pipe it melts *per ſe* into a brown globule. With borax it forms a violet-coloured globule verging towards hyacinth *. According to the analyſis of Mr Macquart, it is compoſed of

* *Kirwan*, i. 166.
* *Macquart, Ann. de Chim.* xxii. 83.

46 ſilica,
20 oxide of iron,
11 lime,
10 oxide of manganeſe,
8 magneſia.

95 †

† *Ibid.*

There is a variety of this ſpecies which Kirwan calls metalliform aſbeſtoid. Its luſtre is ſemimetallic, 3. Opaque. Hardneſs 8 to 9. Sp. gr. 3.356. Colour grey, ſometimes inclining to red ‡.

‡ *Kirwan's Min.* i. 167.

GENUS XX. 2. SMIL.

Simple Stones.

89 G. XX. 2. SMIL. Shorlaceous actinolite.

SPECIES 3. Shorlaceous actinolite (M).

This ſtone cryſtallizes in four or ſix ſided priſms, thicker at one end than the other; hence it has been called by the Germans *ſtrahlſtein*, "arrow-ſtone." The cryſtals ſometimes adhere longitudinally. Fracture hackly. External luſtre glaſſy, 3 to 4; internal, 1 to 2. Tranſparency from 2 to 3; ſometimes 1. Hardneſs from 7 to 10. Sp. gr. 3.023 to 3.45. Colour leek or dark green.

This ſtone is often the matrix of iron, copper, and tin ores.

90 Lamellar actinolite.

SPECIES 5. Lamellar actinolite.

This ſtone reſembles hornblende. It is amorphous. Texture foliated. Luſtre various in different places. Tranſparency 0, or ſcarce 1. Sp. gr. 2.916. Colour dark yellowiſh or greeniſh grey.

91 Glaſſy actinolite.

SPECIES 6. Glaſſy actinolite.

This ſtone is found amorphous, compoſed of fibres adhering longitudinally, or in ſlender four or ſix ſided priſms. Texture fibrous. Fragments long ſplintery, ſo ſharp that they can ſcarcely be handled without injury. External luſtre glaſſy or ſilky, 3 to 4; internal 0. Tranſparency 2. Exceedingly brittle. Sp. gr. 2.95 to 2.493. Colour leek green; ſometimes verging towards greeniſh or ſilver white; ſometimes ſtained with yellowiſh or browniſh red. According to Bergman it is compoſed of 72.0 ſilica,

12.7 carbonat of magneſia,
6.0 carbonat of lime,
7.0 oxide of iron,
2.0 alumina.

99.7 §

§ *Opuſc.* iv. 171.

GENUS XXI. SL.

92 G. XXI. SL. Shiſtoſe hornſtone. * *Kirwan*, i. 305.

SPECIES 1. Shiſtoſe hornſtone *.

The ſtructure of this ſtone is ſlaty. Luſtre from 0 to 1. Commonly opaque. Hardneſs 9 to 10. Sp. gr. from 2.596 to 2.641. Colour dark bluiſh or blackiſh grey. Infuſible *per ſe*.

Variety 1. Siliceous ſhiſtus.

Commonly interſected by reddiſh veins of iron ſtone. Fracture ſplintery. Luſtre 0. Tranſparency from 0 to 1.

Variety 2. Baſanite or Lydian ſtone.

Commonly interſected by veins of quartz. Fracture even; ſometimes inclining to conchoidal. Luſtre ſcarce 1. Hardneſs 10. Sp. gr. 2.596. Powder black. Colour greyiſh black.

This, or a ſtone ſimilar to it, was uſed by the ancients as a touchſtone. They drew the metal to be examined along the ſtone, and judged of its purity by the

(K) *Kirw. Min.* I. 165. Is this the *tremolite* of Werner? It certainly is not the *tremolite* of the French mineralogiſts.

(L) Hence the name *pyroxen* given it by Hauy; from πυρ *fire*, and ξενος, *a ſtranger*. It means, as he himſelf explains it, *a ſtranger in the regions of fire*. By this he means to indicate, that pyroxen, though preſent in lava, is not a volcanic production.

(M) In this and the following ſpecies we have followed Mr. Kirwan's new arrangement exactly, without even venturing to give the ſynonimes of other authors. The deſcriptions which have been given are ſo many and incomplete, and the minerals themſelves are ſtill ſo imperfectly known, and have got ſo many names, that no part of mineralogy is in a ſtate of greater confuſion.

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the colour of the metallic ſtreak. On this account they called it βασανος, *the trier*. They called it alſo *Lydian ſtone*, becauſe, as Theophraſtus informs us, it was found moſt abundantly in the river Tmolus in Lydia *.

* *Hill's Theophraſtus*, περι λιθων, p. 190.

A ſpecimen of the firſt variety, analyſed by Wiegleb, contained

75.0	ſilica,
10.0	lime,
4.6	magneſia,
3.5	iron,
5.2	carbon.
98.3	

This ſpecies is rather a mechanical mixture than a chemical combination.

93 G. XXII. zs. Zircon.

GENUS XXII. ZS.

SPECIES I. Zircon †.

Jargon—Hyacinth.

† *Kirwan*, i. 257. and 333.

This ſtone is brought from Ceylon, and found alſo in France, Spain, and other parts of Europe. It is commonly cryſtallized. The primitive form of its cryſtals is an octahedron ‡, compoſed of two four-ſided pyramids applied baſe to baſe, whoſe ſides are iſoſceles triangles (N). The inclination of the ſides of the ſame pyramid to each other is 124° 12′; the inclination of the ſides of one pyramid to thoſe of another 82° 50′. The ſolid angle at the apex is 73° 44′ §. The varieties of the cryſtalline forms of zircon amount to ſeven. In ſome caſes there is a four-ſided priſm interpoſed between the pyramids of the primitive form; ſometimes all the angles of this priſm are wanting, and two ſmall triangular faces in place of each; ſometimes the cryſtals are dodecahedrons, compoſed of a flat four-ſided priſm with hexagonal faces, terminated by four-ſided ſummits with rhomboidal faces ‖; ſometimes the edges of this priſm, ſometimes the edges where the priſm and ſummit join, and ſometimes both together, are wanting, and we find ſmall faces in their place. For an accurate deſcription and figure of theſe varieties, we refer to *Mr Hauy* ¶.

‡ Fig. 25.

§ *Hauy*, *Jour. de Min.* N° xxvi. 91.

‖ Fig. 26.

¶ *Ibid.*

The texture of the zircon is foliated. Internal luſtre 3. Tranſparency from 4 to 2. Cauſes a very great double refraction. Hardneſs from 10 to 16. Sp. gr. from 4.2 to 4.165 *. Colour commonly reddiſh or yellowiſh; ſometimes it is limpid.

* *Ibid.*

Before the blow-pipe it loſes its colour, but not its tranſparency. With borax it melts into a tranſparent glaſs. Infuſible with fixed alkali and microcoſmic ſalt.

1. The variety formerly called *hyacinth* is of a yellowiſh red colour, mixed with brown. Its ſurface is ſmooth. Its luſtre 3. Its tranſparency 3 to 4.

2 The variety formerly called *jargon of Ceylon*, is either grey, greeniſh, yellowiſh brown, reddiſh brown, or violet. It has little external luſtre. Is ſometimes nearly opaque.

The firſt variety, according to the analyſis of Vauquelin, is compoſed of

64.5	zirconia,
32.0	ſilica,
2.0	oxide of iron.
98.5 †	

† *Ibid.* p. 106.

A ſpecimen analyſed by Klaproth contained

70.0	zirconia,
25.0	ſilica,
0.5	oxide of iron.
95.5 *	

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* *Beiträge*, i. 231.

The ſecond variety, according to Klaproth, who diſcovered the component parts of both theſe ſtones, contains

60.0	zirconia,
31.5	ſilica,
0.5	nickel and iron.
100.0 ‡	

‡ *Ibid.* i. 219.

ORDER II. SALINE STONES.

94 Genera.

UNDER this order we comprehend all the minerals which conſiſt of an earthy baſis combined with an acid. They naturally divide themſelves into five genera. We ſhall deſcribe them in the following order.

I. CALCAREOUS SALTS.
- Carbonat of lime,
- Sulphat of lime,
- Phoſphat of lime,
- Fluat of lime,
- Borat of lime.

II. BARYTIC SALTS.
- Carbonat of barytes,
- Sulphat of barytes.

III. STRONTITIC SALTS.
- Carbonat of ſtrontites,
- Sulphat of ſtrontites.

IV. MAGNESIAN SALTS.
- Sulphat of magneſia.

V. ALUMINOUS SALTS.
- Alum.

95 G. I. Calcareous ſalts.

GENUS I. CALCAREOUS SALTS.

This genus comprehends all the combinations of lime and acids which form a part of the mineral kingdom.

96 Carbonat of lime.

SPECIES I. Carbonat of lime.

No other mineral can be compared with carbonat of lime in the abundance with which it is ſcattered over the earth. Many mountains conſiſt of it entirely, and hardly a country is to be found on the face of the globe where, under the names of limeſtone, chalk, marble, ſpar, it does not conſtitute a greater or ſmaller part of the mineral riches.

It is often amorphous, often ſtalactitical, and often cryſtallized. The primitive form of its cryſtals is a parallelopiped, whoſe ſides are rhombs, with angles of 77° 30′ and 102° 30′ ‡. Its integrant molecules have the ſame form. The varieties of its cryſtals amount to more than 40; for a deſcription and figure of which we refer to *Romé de Liſle* * and *Hauy* (O).

‡ Fig. 28.

* *Cryſtal.* i. 497.

When cryſtallized, its texture is foliated; when amorphous, its ſtructure is ſometimes foliated, ſometimes ſtriated, ſometimes granular, and ſometimes earthy. Its

(N) Let ABC (fig. 27.) be one of the ſides. Draw the perpendicular BD; then AB = 5, BD = 4, AD = 3.

(O) *Eſſai d'une Theorie*, &c. p. 75.—*Jour. de Phyſ.* 1793, Auguſt, p. 114.—*Jour. d'Hiſt. Nat.* 1792, February, p. 148.—*Ann. de Chim.* XVII. 249. &c.—*Jour. de Min.* N° XXVIII. 304.

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luſtre varies from 0 to 3. Tranſparency from 0 to 4. It cauſes double refraction; and it is the only mineral which cauſes double refraction through two parallel faces of the cryſtal. Hardneſs from 3 to 9. Sp. gr. from 2.315 to 2.78. Colour, when pure, white. Effervefces violently with muriatic acid, and diſſolves completely, or leaves but a ſmall reſiduum. The ſolution is colourleſs.

This ſpecies occurs in a great variety of forms; and therefore has been ſubdivided into numerous varieties. All theſe may be conveniently arranged under two general diviſions.

I. Soft carbonat of lime.

Variety 1. Agaric mineral.

Mountain milk, or *mountain meal* of the Germans.

This variety is found in the clefts of rocks, or the bottom of lakes. It is nearly in the ſtate of powder; of a white colour, ſometimes with a ſhade of yellow; and ſo light that it almoſt floats on water.

Variety 2. Chalk.

The colour of chalk is white, ſometimes with a ſhade of yellow. Luſtre 0. Opaque. Hardneſs 3 to 4. Sp. gr. from 2.315 to 2.657. Texture earthy. Adheres ſlightly to the tongue. Feels dry. Stains the fingers, and marks. Falls to powder in water. It generally contains about $\frac{2}{100}$ of alumina, and $\frac{1}{100}$ of water; the reſt is carbonat of lime.

Variety 3. Arenaceous limeſtone.

Colour yelloviſh white. Luſtre 1. Tranſparency 1. So brittle that ſmall pieces crumble to powder between the fingers. Sp. gr. 2.742. Phoſphoreſces in the dark when ſcraped with a knife, but not when heated. It conſiſts almoſt entirely of pure carbonat of lime.

Variety 4. Teſtaceous tufa.

The colour of this variety is yelloviſh or greyiſh white. It is exceedingly porous and brittle; and is either compoſed of broken ſhells, or reſembles mortar containing ſhells; or it conſiſts of fiſtulous concretions variouſly ramified, and reſembling moſs.

II. Indurated carbonat of lime.

Variety 1. Compact limeſtone.

The texture of this variety is compact. It has little luſtre; and is moſt commonly opaque. Hardneſs 5 to 8. Sp. gr. 1.3864 to 2.72. Colour grey, with various ſhades of other colours. It moſt commonly contains about $\frac{1}{10}$th of alumina, oxide of iron, &c.; the reſt is carbonat of lime. This variety is uſually burnt as lime.

Variety 2. Granularly foliated limeſtone.

Structure ſometimes ſlaty. Texture foliated and granular. Luſtre 2 to 1. Tranſparency 2 to 1. Hardneſs 7 to 8. Sp. gr. 2.71 to 2.8376. Colour white, of various ſhades from other colours.

Variety 3. Sparry limeſtone.

Structure ſparry. Texture foliated. Fragments rhomboidal. Luſtre 2 to 3. Tranſparency from 2 to 4; ſometimes 1. Hardneſs 5 to 6. Sp. gr. from 2.693 to 2.718. Colour white; often with various ſhades of other colours. To this variety belong all the cryſtals of carbonat of lime.

Variety 4. Striated limeſtone.

Texture ſtriated or fibrous. Luſtre 1 to 0. Tranſparency 2 to 1. Hardneſs 5 to 7. Sp. gr. commonly from 2.6 to 2.77. Colours various.

Variety 5. Swine ſtone.

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Texture often earthy. Fracture often ſplintery. Luſtre 1 to 0. Tranſparency 0 to 1. Hardneſs 6 to 7. Sp. gr. 2.701 to 2.7121. Colour dark grey, of various ſhades. When ſcraped or pounded it emits an urinous or garlic ſmell.

Variety 6. Oviform.

This variety conſiſts of a number of ſmall round bodies, cloſely compacted together. Luſtre 0. Tranſparency 0 or 1. Hardneſs 6 to 7.

97

SPECIES 2. Sulphat of lime. Sulphat of lime.

Gypſum—Selenite.

This mineral is found abundantly in Germany, France, England, Italy, &c.

It is found ſometimes in amorphous maſſes, ſometimes in powder, and ſometimes cryſtallized. The primitive form of its cryſtals, according to Romé de Liſle, is a decahedron *, which may be conceived as two four-ſided pyramids applied baſe to baſe, and which, inſtead of terminating in pointed ſummits, are truncated near their baſes; ſo that the ſides of the pyramids are trapeziums, and they terminate each in a rhomb. Theſe rhombs are the largeſt faces of the cryſtal. The angles of the rhombs are 52° and 128°. The inclination of two oppoſite faces of one pyramid to the two ſimilar faces of the other pyramid is 145°, that of the other faces 110†. Sometimes ſome of the faces are elongated; ſometimes it cryſtallizes in ſix-ſided priſms, terminated by three or four-ſided ſummits, or by an indeterminate number of curvilinear faces. For a deſcription and figure of theſe varieties, we refer to *Romé de Liſle* ‡.

* Fig. 29.

† *Cryſtal.* i. 144.

‡ *Ibid.*

The texture of ſulphat of lime is moſt commonly foliated. Luſtre from 0 to 4. Tranſparency from 0 to 4. It cauſes double refraction. Its hardneſs does not exceed 4. Its ſp. gr. from 1.872 to 2.311. Colour commonly white or grey.

Before the blow-pipe, it melts into a white enamel, provided the blue flame be made to play upon the edges of its laminæ. When the flame is directed againſt its faces, the mineral falls into powder §.

§ *Le Lievre, Jour. de Min.* N° xxviii. 315.

It does not effervefce with muriatic acid, except it be impure; and it does not diſſolve in it.

The following varieties of this mineral are deſerving of attention.

Variety 1. Broad foliated ſulphat.

Texture broad foliated. Luſtre glaſſy, from 4 to 2. Tranſparency from 4 to 3. Hardneſs 4. Sp. gr. 2.311. Colour grey, often with a ſhade of yellow.

Variety 2. Grano-foliated ſulphat.

Texture foliated, and at the ſame time granular; ſo that it eaſily crumbles into powder. Luſtre 2 to 3. Tranſparency 2 to 3. Hardneſs 4 to 3. Sp. gr. from 2.274 to 2.310. Feels ſoft. Colour white or grey, often with a tinge of yellow, blue, or green; ſometimes fleſh red, brown, or olive green.

Variety 3. Fibrous ſulphat.

Texture fibrous. Fragments long ſplintery. Luſtre 2 to 3. Tranſparency 2 to 1; ſometimes 3. Hardneſs 4. Brittle. Sp. gr. 2.300. Colour white, often with a ſhade of grey, yellow, or red; ſometimes fleſh red, and ſometimes honey yellow; ſometimes ſeveral of theſe colours meet in ſtripes.

Variety 4. Compact ſulphur.

Texture compact. Luſtre 1 or 0. Tranſparency 2 to

1,

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1, ſometimes 0. Hardneſs 4. Sp. gr. from 1.872 to 2.288. Feels dry, but not harſh. Colour white, with a ſhade of grey, yellow, blue, or green; ſometimes yellow; ſometimes red; ſometimes ſpotted, ſtriped, or veined.

Variety 5. Farinaceous ſulphat.

Of the conſiſtence of meal. Luſtre 0. Opaque. Scarcely ſinks in water. Is not gritty between the teeth. Feels dry and meagre. Colour white. When heated below redneſs, it becomes of a dazzling white.

98 Phoſpat of lime.

SPECIES 3. Phoſphat of lime.

Apatite—Phoſphorite—Chryſolite—of the French.

This ſubſtance is found in Spain, where it forms whole mountains, and in different parts of Germany. It is ſometimes amorphous, and ſometimes cryſtallized. The primitive form of its cryſtals is a regular ſix-ſided priſm *. Its integrant molecule is a regular triangular priſm, whoſe height is to a ſide of its baſe as 1 to $\sqrt{2}$ †. Sometimes the edges of the primitive hexagonal priſm are wanting, and ſmall faces in their place; ſometimes there are ſmall faces inſtead of the edges which terminate the priſm; ſometimes theſe two varieties are united; ſometimes the terminating edges and the angles of the priſm are replaced by ſmall faces ‡; and ſometimes the priſm is terminated by four ſided pyramids §.

* Fig. 30.
† *Hauy, Jour. de Min.* N° xxviii. p. 310.
‡ Fig. 31.
§ *Hauy, ibid.*

Its texture is foliated. Its fracture uneven, tending to conchoidal. External luſtre from 2 to 3, internal 3 to 2. Tranſparency from 4 to 2. Cauſes ſingle refraction. Hardneſs 6 to 7. Brittle. Sp. gr. from 2.8249 to 3.218. Colour commonly green or grey; ſometimes brown, red, blue, and even purple.

It is infuſible by the blow-pipe. When its powder is thrown upon burning coals, it emits a yellowiſh green phoſphoreſcent light. It is ſoluble in muriatic acid without efferveſcence or decompoſition, and the ſolution often bomes gelatinous.

99 Fluat of lime.

SPECIES 4. Fluat of lime.

Fluor.

This mineral is found abundantly in different countries, particularly in Derbyſhire. It is both amorphous and cryſtallized.

The primitive form of its cryſtals is the regular octohedron; that of its integrant molecules the regular tetrahedron ||. The varieties of its cryſtals hitherto obſerved amount to 7. Theſe are the primitive octohedron; the cube; the rhomboidal dodecahedron; the cubo octohedron ¶, which has both the faces of the cube and of the octohedron; the octohedron wanting the edges; the cube wanting the edges, and either one face *, or two faces in place of each. For a deſcription and figure of theſe we refer to *Mr Hauy* †.

|| *Hauy, ibid.* p. 325.
¶ Fig. 32.
* Fig. 33.
† *Ibid.*

The texture of fluat of lime is foliated. Luſtre from 2 to 3, ſometimes 0. Tranſparency from 2 to 4, ſometimes 1. Cauſes ſingle refraction. Hardneſs 8. Very brittle. Sp. gr. from 3.0943 to 3.1911. Colours numerous, red, violet, green, red, yellow, blackiſh purple. Its powder thrown upon hot coals emits a bluiſh or greeniſh light. Two pieces of it rubbed in the dark phoſphoreſce. It decrepitates when heated. Before the blow-pipe it melts into a tranſparent glaſs §.

§ *Ibid.*

It admits of a poliſh, and is often formed into vaſes and other ornaments.

100 Borat of lime.

SPECIES 5. Borat of lime.

Boracite.

This mineral has been found at Ka lkberg near Luneburg, ſeated in a bed of ſulphat of lime. It is cryſtallized. The primitive form of its cryſtals is the cube *. In general, all the edges and angles of the cube are truncated; ſometimes, however, only the alternate angles are truncated †. The ſize of the cryſtals does not exceed half an inch.

Saline Stones.

* *Hauy, Jour. de Min.* N° xxvii. p. 325.

The texture of this mineral is compact. Its fracture is flat conchoidal. External luſte 3; internal, greaſy, 2. Tranſparency from 2 to 3. Hardneſs 9 to 10. Sp. gr. 2.566. Colour greyiſh white, ſometimes paſſing into greeniſh white or purpliſh.

† *Hauy*, and *Weſtrum.*

When heated it becomes electric; and the angles of the cube are alternately poſitive and negative ‡.

‡ *Hauy, ibid.* and *Ann. de Chim.* ix. 59.

Before the blow-pipe it froths, emits a greeniſh light, and is converted into a yellowiſh enamel, garniſhed with ſmall points, which, if the heat be continued, dart out in ſparks §.

§ *Le Lievre, Jour. de Min. ibid.*

According to Weſtrum, who diſcovered its component parts, it contains

68	boracic acid,
13.5	magneſia,
11	lime,
1	alumina,
2	ſilica,
1	iron.
96 ¶	

¶ *Ann. de Chim.* ii. 116.

SPECIES 6. Nitrat of lime.

101 Nitrat of lime.

Found abundantly mixed with native nitre. For a deſcription ſee the article CHEMISTRY in this *Supplement*, n° 672.

102 G. II. Barytic ſalts.

GENUS II. BARYTIC SALTS.

This genus comprehends the combinations of barytes with acids.

103 Carbonat of barytes.

SPECIES 1. Carbonat of barytes.

Witherite.

This mineral was diſcovered by Dr Withering; hence Werner has given it the name of *witherite*. It is found both amorphous and cryſtallized. The cryſtals are octohedrons or dodecahedrons, conſiſting of four or ſix ſided pyramids applied baſe to baſe; ſometimes the ſix-ſided pyramids are ſeparated by a priſm; ſometimes ſeveral of theſe priſms are joined together in the form of a ſtar.

Its texture is fibrous. Its fracture conchoidal. Its fragments long ſplintery. Luſtre 2. Tranſparency 2 to 3. Hardneſs 5 to 6. Brittle. Sp. gr. 4.3 to 4.338. Colour greeniſh white. When heated it becomes opaque. Its powder phoſphoreſces when thrown on burning coals *.

* *Hauy.*

It is ſoluble with efferveſcence in muriatic acid. The ſolution is colourleſs.

According to Pelletier it contains

62	barytes,
22	carbonic acid,
16	water.
100 †	

† *Jour. de Min.* N° xxi. p. 46.

104 Sulphat of barytes.

SPECIES 2. Sulphat of barytes.

Boroſelenite.

This mineral is found abundantly in many countries, particularly in Britain. It is ſometimes in powder, often in amorphous maſſes, and often cryſtallized. The primitive form of its cryſtals is a rectangular priſm, whoſe

Earths and Stones.

whose bases are rhombs, with angles of 101° 30′ and 78° 30′ *. The varieties of its crystals are very numerous. For a description and figure of them we refer to *Romé de Lisle* † and *Hauy* ‡. The most common varieties are the octohedron with cuneiform summits, the six or four sided prism, the hexangular table with bevelled edges. Sometimes these crystals are needle form.

* *Hauy, Essai d'une Theorie, &c.* p. 119.
† *Crystal.* i. 588.
‡ *Ibid.* and *Ann. de Chim.* xii. 3.

Its texture is commonly foliated. Lustre from 0 to 2. Transparency from 2 to 0; in some cases 3 or 4. Hardness from 5 to 6. Sp. gr. from 4.4 to 4.44. Colour commonly white, with a shade of yellow, red, blue, or brown.

When heated it decrepitates. It is fusible *per se* by the blue flame of the blow-pipe, and is converted into sulphurat of barytes. Soluble in no acid except the sulphuric; and precipitated from it by water.

Variety 1. Foliated sulphat.

Lustre 3 to 3. Transparency from 4 to 2, sometimes 1. Colours white, reddish, bluish, yellowish, blackish, greenish. Mr Werner subdivides this variety into three, according to the nature of the texture. These three subdivisions are *granularly foliated, straight foliated, curve foliated.*

Variety 2. Fibrous sulphat.

Texture fibrous; fibres converging to a common centre. Lustre silky or waxy, 2. Transparency 2 to 1. Hardness 5. Colours yellowish, bluish, reddish.

Variety 3. Compact sulphat.

Texture compact. Lustre 0 to 1. Transparency 1 to 0. Feels meagre. Almost constantly impure. Colours light yellow, red, or blue.

Variety 4. Earthy sulphat.

In the form of coarse dusty particles, slightly cohering. Colour reddish or yellowish white.

105 G. III. Strontitic salts.

Genus III. Strontitic Salts.

This genus comprehends all the combinations of strontites and acids which form a part of the mineral kingdom.

Species 1. Carbonat of strontites

106 Carbonat of strontites.

This mineral was first discovered in the lead mine of Srontion in Argyleshire; and since that time it is said to have been discovered, though not in great abundance, in other countries. It is found amorphous, and also crystallized in needles, which, according to Hauy, are regular six-sided prisms.

Its texture is fibrous; the fibres converge. Fracture uneven. Lustre 2. Transparency 2. Hardness 5. Sp. gr. from 3.4 to 3.66. Colour light green. Does not decrepitate when heated. Before the blow-pipe becomes opaque and white, but does not melt. With borax it effervesces, and melts into a transparent colourless glass. Effervesces with muriatic acid, and is totally dissolved. The solution tinges flame purple.

Species 2. Sulphat of strontites.

Celestine.

107 Sulphat of strontites.

This mineral has been found in Pennsylvania, in Germany, in France, in Sicily, and Britain. It was first discovered near Bristol by Mr Clayfield. There it is found in such abundance, that it has been employed in mending the roads.

It occurs both amorphous and crystallized. The crystals are most commonly bevelled tables, sometimes rhomboidal cubes. Its texture is foliated. More or less transparent. Hardness 5. Sp. gr. from 3.51 to 3.96. Colour most commonly a fine sky blue; sometimes reddish; sometimes white, or nearly colourless §.

§ *Clayfield, Nicholson's Jour.* iii. 36.

Klaproth found a specimen of this mineral from Pennsylvania composed of 58 strontites,
42 sulphuric acid.

100 ‖.

‖ *Beiträge*, ii. 97.

According to the analysis of Mr Clayfield, the sulphat strontites found near Bristol is composed of
58.25 strontites,
41.75 sulphuric acid of 2.24, and a little iron ¶.

¶ *Ibid. Nicholson's Journal.*

100.00

According to the analysis of Vauquelin, the sulphat of strontites found at Bouvron in France, which was contaminated with .1 of carbonat of lime, is composed of
54 strontites,
45 sulphuric acid.

99 *

* *Jour. de Min.* N° xxxvii. 6.

Genus IV. Magnesian Salts.

108 G. IV. Magnesian Salts.

This genus comprehends the combinations of magnesia and acids which occur in the mineral kingdom. Only two species have hitherto been found; namely,

Species 1. Sulphat of magnesia.

109 Sulphat of magnesia.

It is found in Spain, Bohemia, Britain, &c.; and enters into the composition of many mineral waters.

For a description of it, we refer to Chemistry, n° 633. in this *Suppl.*

Species 2. Nitrat of magnesia.

110 Nitrat of magnesia.

Found sometimes associated with nitre. For a description see Chemistry, n° 674,

Genus V. Aluminous salts.

111 G. V. Aluminous salts.

This genus comprehends those combinations of alumina and acids which occur in the mineral kingdom.

Species 1. Alum.

112 Alum.

This salt is found in crystals, in soft masses, in flakes, and invisibly mixed with the soil. For a description, we refer to Chemistry, n° 636.

Order III. AGGREGATES.

This order comprehends all mechanical mixtures of earths and stones found in the mineral kingdom. These are exceedingly numerous: the mountains and hills, the mould on which vegetables grow, and indeed the greater part of the globe, may be considered as composed of them. A complete description of aggregates belongs rather to geology than mineralogy. It would be improper, therefore, to treat of them fully here. But they cannot be altogether omitted; because aggregates are the first substances which present themselves to the view of the practical mineralogist, and because, without being acquainted with the names and component parts of many of them, the most valuable mineralogical works could not be understood.

Aggregates

113 Division of aggregates.

Aggregates may be comprehended under four divisions: 1. Mixtures of earths; 2. Amorphous fragments of stones agglutinated together; 3. Crystallized stones, either agglutinated together or with amorphous stones; 4. Aggregates formed by fire. It will be exceedingly convenient

Earths and Stones. convenient to treat each of these separately. We shall therefore divide this order into four sections.

SECT. I. *Aggregates of Earths.*

THE most common earthy aggregates may be comprehended under the following genera:

1. Clay,
2. Colorific earths,
3. Marl,
4. Mould.

114 Clay.

GENUS I. CLAY.

Clay is a mixture of alumina and silica in various proportions. The alumina is in a state of an impalpable powder; but the silica is almost always in small stones, large enough to be distinguished by the eye. Clay, therefore, exhibits the character of alumina, and not of silica, even when this last ingredient predominates. The particles of silica are already combined with each other; and they have so strong an affinity for each other that few bodies can separate them; whereas the alumina, not being combined, readily displays the characters which distinguish it from other bodies. Besides alumina and silica, clay often contains carbonat of lime, of magnesia, barytes, oxide of iron, &c. And as clay is merely a mechanical mixture, the proportion of its ingredients is exceedingly various.

Clay has been divided into the following species:

115 Porcelain clay.

SPECIES 1. Porcelain clay.

Its texture is earthy. Its lustre 0. Opaque. Hardness 4. Sp. gr. from 2.23 to 2.4. Colour white, sometimes with a shade of yellow or red. Adheres slightly to the tongue. Feels soft. Falls to powder in water.

A specimen, analysed by Hassenfratz, contained

62 silica,
19 alumina,
12 magnesia,
7 sulphat of barytes.

100 *

* *Ann. de Chim.* xiv. 144.

A specimen, analysed by Mr Wedgewood, contained

60 alumina,
20 silica,
12 air of water.

92

116 Common clay.

SPECIES 2. Common clay.

Its texture is earthy. Lustre 0. Opaque. Hardness 3 to 6. Sp. gr. 1.8 to 2.68. Adheres slightly to the tongue. Often feels greasy. Falls to powder in water. Colour, when pure, white; often tinged blue or yellow.

Variety 1. Potter's clay.

Hardness 3 to 4. Sp. gr. 1.8 to 2. Stains the fingers slightly. Acquires some polish by friction. Colour white; often with a tinge of yellow or blue; sometimes brownish, greenish, reddish. Totally diffusible in water; and, when duly moistened, very ductile.

Variety 2. Indurated clay.

Hardness 5 to 6. Does not diffuse itself in water, but falls to powder. Discovers but little ductility. Colours grey, yellowish, bluish, greenish, reddish, brownish.

Variety 3. Shistose clay. Aggregates

Structure slaty. Sp. gr. from 2.6 to 2.68. Feels smooth. Streak white or grey. Colour commonly bluish, or yellowish grey; sometimes blackish, reddish, greenish. Found in strata, usually in coal mines.

This variety is sometimes impregnated with bitumen. It is then called bituminous *shale.*

SPECIES 3. Lithomarga. 117 Lithomarga.

Texture earthy. Fracture conchoidal. Lustre from 0 to 2. Opaque. Hardness 3 to 7. Sp. gr. when pretty hard, 2.815. Surface smooth, and feels soapy, Adheres strongly to the tongue. Falls to pieces, and then to powder, in water; but does not diffuse itself through that liquid. Fusible *per se* into a frothy mass.

Variety 1. Friable lithomarga.

Formed of scaly particles slightly cohering. Lustre 1 to 0. Hardness 3 to 4. Exceedingly light. Feels very smooth, and assumes a polish from the nail. Colour white; sometimes tinged yellow or red.

Variety 2. Indurated lithomarga.

Hardness 4 to 7. The softer sorts adhere very strongly to the tongue when newly broken; the harder very moderately. Colours grey, yellow, red, brown, blue.

A specimen of lithomarga from Osmund, analysed by Bergman, contained

60.0 silica,
11.0 alumina,
5.7 carbonat of lime,
4.7 oxide of iron,
0.5 carbonat of magnesia,
18.0 water and air.

99.9 *

* *Opusc.* iv. 118

SPECIES 4. Bole. Bole.

Texture earthy. Fracture conchoidal. Lustre 0. Transparency scarce 1. Hardness 4. Sp. gr. from 1.4 to 2. Acquires a polish by friction. Scarcely adheres to the tongue. Feels greasy. Colour yellow or brown; sometimes red; sometimes spotted.

The lemnian earth which belongs to this species, according to the analysis of Bergman, contains

47,0 silica,
19,0 alumina,
6.0 carbonat of magnesia,
5.4 carbonat of lime,
5.4 oxide of iron,
17.0 water and air.

99.8 †

† *Ibid.* p. 157.

SPECIES 5. Fullers earth. 119 Fullers earth.

Texture earthy. Structure sometimes slaty. Fracture imperfectly conchoidal. Lustre 0. Opaque. Hardness 4. Receives a polish from friction. Does not adhere to the tongue. Feels greasy. Colour usually light green.

A specimen from Hampshire, analysed by Bergman, contained

51.8 silica,
25.0 alumina,
3.3 carbonat of lime,
3.7 oxide of iron,
0.7 carbonat of magnesia.
15.5 moisture.

100.0 ‡

‡ *Ibid.* 159.

This

Earths and Stones.

This earth is uſed by fullers to take the greaſe out of their cloth before they apply ſoap. It is eſſential to fullers earth that the particles of ſilica be very fine, otherwiſe they would cut the cloth. Any clay, poſſeſſed of this laſt property, may be conſidered as *fullers earth*; for it is the alumina alone which acts upon the cloth, on account of its ſtrong affinity for greaſy ſubſtances.

120 G. II. Colorific earths.

Genus II. Colorific Earths.

The minerals belonging to this genus conſiſt of clay, mixed with ſo large a quantity of ſome colouring ingredient as to render them uſeful as paints. The colouring matter is commonly oxide of iron, and ſometimes charcoal.

121 Red chalk.

Species 1. Red chalk.

Reddle.

Texture earthy. Fracture conchoidal. Luſtre 0. Opaque. Hardneſs 4. Sp. gr. inconſiderable. Colour dark red.

Feels rough. Stains the fingers. Adheres to the tongue. Falls to powder in water. Does not become ductile. When heated it becomes black, and at 159° Wedgewood melts into a greeniſh yellow frothy enamel.

Compoſed of clay and oxide of iron.

122 Yellow chalk.

Species 2. Yellow chalk.

Texture earthy. Fracture conchoidal. Hardneſs 3. Sp. gr. inconſiderable. Colour ochre yellow.

Feels ſmooth or greaſy. Stains the fingers. Adheres to the tongue. Falls to pieces in water. When heated becomes red; and at 156° Wedgewood melts into a brown porous porcelain.

According to Sage, it contains

50 alumina,
40 oxide of iron,
10 water, with ſome ſulphuric acid.

100 *

* *Mem. Par.* 1779, 313.

Species 3. Black chalk.

123 Black chalk.

Structure ſlaty. Texture earthy. Fragments ſplintery. Luſtre 0. Opaque. Hardneſs 5. Sp. gr. 2.144 to 2.277. Colour black. Streak black.

Feels ſmooth. Adheres ſlightly to the tongue. Does not moulder in water. When heated to redneſs it becomes reddiſh grey.

According to Wiegleb, it is compoſed of

64.50 ſilica,
11.25 alumina,
11.00 charcoal,
2.75 oxide of iron,
7.50 water.

97.00 †

† *Ann. de Chim.* xxx. 13.

Species 4. Green earth.

124 Green earth.

Texture earthy. Luſtre 0. Opaque. Hardneſs 6 to 7. Sp. gr. 2.637. Colour green.

Commonly feels ſmooth. Does not ſtain the fingers. Often falls to powder in water. When heated it becomes reddiſh brown; and at 147° Wedgewood melts into a compact glaſs.

Compoſed of clay, oxides of iron, and nickel.

125 G. III. Marl.

Genus III. Marl.

A mixture of carbonat of lime and clay, in which the carbonat conſiderably exceeds the other ingredient, is called *marl*. Aggregates

Its texture is earthy. Luſtre 0. Opaque. Hardneſs from 4 to 8; ſometimes in powder. Sp. gr. from 1.6 to 2.877. Colour uſually grey, often tinged with other colours. Effervеſces with acids.

Some marls crumble into powder when expoſed to the air; others retain their hardneſs for many years.

Marls may be divided into two ſpecies: 1. Thoſe which contain more ſilica than alumina; 2. Thoſe which contain more alumina than ſilica. Mr Kirwan has called the firſt of theſe *ſiliceous*, the ſecond *argillaceous*, marls. Attention ſhould be paid to this diſtinction when marls are uſed as a manure.

126 G. IV. Mould.

Genus IV. Mould.

By *mould* is meant the ſoil on which vegetables grow. It contains the following ingredients: ſilica, alumina, lime, magneſia (ſometimes), iron, carbon derived from decayed vegetable and animal ſubſtances, carbonic acid, and water. And the good or bad qualities of *ſoils* depends upon a proper mixture of theſe ingredients. The ſilica is ſeldom in the ſtate of an impalpable powder, but in grains of a greater or ſmaller ſize: Its chief uſe ſeems to be to keep the ſoil open and pervious to moiſture. If we paſs over the carbon, the iron, and the carbonic acid, the goodneſs of a ſoil depends upon its being able to retain the quantity of moiſture which is proper for the nouriſhment of vegetables, and no more. Now the retentive power of a ſoil increaſes with the proportion of its alumina, lime, or magneſia, and diminiſhes as the proportion of its ſilica increaſes. Hence it follows, that in a dry country, a fertile ſoil ſhould contain leſs ſilica, and more of the other earths, than in a wet country.

Giobert found a fertile ſoil near Turin, where it rains annually 30 inches, to contain

From 77 to 79 ſilica,
9 — 14 alumina,
5 — 12 lime.

Near Paris, where it rains about 20 inches annually, Mr Tillet found a fertile ſoil to contain

Coarſe ſand 25
Fine ſand 21
— 46.0 ſilica,
16.5 alumina,
37.5 lime.

100.0 *

* *Kirwan on Manures.*

The varieties of mould are too numerous to admit an accurate deſcription: we ſhall content ourſelves, therefore, with mentioning the moſt remarkable.

127 Sand.

Species 1. Sand.

This conſiſts of ſmall grains of ſiliceous ſtones not cohering together, nor ſoftened by water. When the grains are of a large ſize, the ſoil is called *gravel*.

128 Clay.

Species 2. Clay.

This conſiſts of common clay mixed with decayed vegetable and animal ſubſtances.

129 Loam.

Species 3. Loam.

Any ſoil which does not cohere ſo ſtrongly as clay, but more ſtrongly than chalk, is called *loam*. There are many varieties of it. The following are the moſt common.

Variety

Earths and Stones.

Variety 1. Clayey loam; called alſo *ſtrong*, *ſtiff*, *cold*, and *heavy*, loam.

It conſiſts of a mixture of clay and coarſe ſand.

Variety 2. Chalky loam.

A mixture of clay, chalk, and coarſe ſand; the chalk predominating.

Variety 3. Sandy loam.

A mixture of the ſame ingredients; the ſand amounting to .8 or .9 of the whole.

130 Till.

SPECIES 4. Till.

Till is a mixture of clay and oxide of iron. It is of a red colour, very hard and heavy.

SECT II. *Aggregates of Amorphous Stones.*

THE aggregates which belong to this ſection conſiſt of amorphous fragments of ſtones cemented together. They may be reduced to the following genera:

1. Sandſtone,
2. Puddingſtone,
3. Amygdaloid,
4. Breccia.

131 G. I. Sandſtone.

GENUS I. SANDSTONE.

Small grains of ſand, conſiſting of quartz, flint, hornſtone, ſiliceous ſhiſtus, or felſpar, and ſometimes of mica, cemented together, are denominated ſandſtones. They feel rough and ſandy; and, when not very hard, eaſily crumble into ſand. The cement or baſis by which the grains of ſand are united to each other is of four kinds; namely, lime, alumina, ſilica, iron. Sandſtones, therefore, may be divided into four ſpecies.

132 Calcareous.

SPECIES 1. Calcareous ſandſtones.

Calcareous ſandſtones are merely carbonat of lime or marl, with a quantity of ſand interpoſed between its particles. Though the quantity of ſand, in many caſes, far exceeds the lime, calcareous ſandſtones are ſometimes found cryſtallized; and, in ſome caſes, the cryſtals, as might be expected, have ſome of the forms which diſtinguiſh carbonat of lime. Thus the calcareous ſandſtone of Fountainbleau is cryſtallized in rhomboidal tables. It contains, according to the analyſis of Laſſone

62.5 ſiliceous ſand,
37.5 carbonat of lime.

100

Calcareous ſandſtones have commonly an earthy texture. Their ſurface is rough. Their hardneſs from 6 to 7. Their ſpecific gravity about 2.5 or 2.6. Their colour grey; ſometimes yelloviſh or brown. They are ſometimes burned for lime.

133 Aluminous.

SPECIES 2. Aluminous ſandſtones.

The baſis of argillaceous ſandſtones is alumina, or rather clay. Their ſtructure is often ſlaty. Their texture is compact, and either fine or coarſe grained, according to the ſize of the ſand of which they are chiefly compoſed. Their hardneſs is from 6 to 8, or even 9. Their colour is uſually grey, yellow, or brown.

They are often formed into mill-ſtones, filtering-ſtones, and coarſe whet-ſtones.

134 Siliceous.

SPECIES 3. Siliceous ſandſtones.

Siliceous ſandſtones conſiſt of grains of ſand cemented together by ſilica, or ſome ſubſtance which conſiſts chiefly of ſilica or flint. They are much harder than any of the other ſpecies.

Aggregates

Sometimes ſtones occur, conſiſting of grains of lime cemented together with ſilica. Theſe ſtones are alſo denominated ſiliceous ſandſtones.

135 Ferruginous.

SPECIES 4. Ferruginous ſandſtones.

The iron which acts as a cement in ferruginous ſandſtones is not far from a metallic ſtate. When iron is completely oxidated, it loſes the property of acting as a cement. This is the reaſon that ferruginous ſandſtones, when expoſed to the air, almoſt always crumble into powder.

The colour of ferruginous ſandſtones is uſually dark red, yellow, or brown. The grains of ſand which compoſe them are often pretty large. Their hardneſs is commonly inconſiderable.

136 G. II. Pudding ſtone.

GENUS II. PUDDING STONE.

Pebbles of quartz, flint, or other ſimilar ſtones of a round or eliptical form, from the ſize of rape ſeed to that of an egg, cemented together by a ſiliceous cement, often mixed with iron, have been denominated *pudding ſtones*.

Pudding ſtones, of courſe, are not inferior in hardneſs to quartz, flint, chalcedony, &c. of which the pebbles may conſiſt. The colour of the cement is uſually yellow, brown, or red. Its fracture is conchoidal.

The finer ſorts of pudding ſtones are capable of a fine poliſh; the coarſe are uſed for mill-ſtones.

137 G. III. Amygdaloid.

GENUS III. AMYGDALOID.

Rounded or eliptical maſſes of chalcedony, zeolite, limeſtone, lithomarga, ſteatites, green earth, garnets, hornblende, or opal, cemented together by a baſis of indurated clay, trap, mullen, walken or kragg, conſtitute an *amygdaloid*.

Amygdaloids are opaque. They have no luſtre. Their fracture is uneven or conchoidal. Hardneſs 6 to 9. Their colours are as various as the ingredients of which they are compoſed.

138 G. IV. Breccia.

GENUS IV. BRECCIA.

Angular fragments of the ſame *ſpecies* of ſtone, agglutinated together, conſtitute a *breccia*. This *calcareous* breccia conſiſts of fragments of marble cemented together by means of lime.

SECT. III. *Aggregates of Cryſtals.*

THE minerals belonging to this ſection conſiſt either of cryſtals of different kinds cemented together, or of cryſtals and amorphous ſtones cemented together.

They may be reduced under the following genera.

1. Granite,
2. Sienite,
3. Granatine,
4. Granitell,
5. Granilite,
6. Trap,
7. Porphyry.

139 G. I. Granite.

GENUS I. GRANITE.

An aggregate of felſpath, quartz, and mica, whatever be the ſize or the figure of the ingredients, is denominated *granite*. This aggregate may be divided into two ſpecies, namely, *common* granite, and *ſhiſtoſe* granite or gneiſs.

140 Common.

SPECIES 1. Common granite.

Its ſtructure is always granular. The felſpar is often amor-

Earths and Stones.

amorphous, and conſtitutes moſt frequently the greateſt part of the aggregate.

Common granites differ much in their appearance, according to the ſize, proportion, colour, and figure of their component parts. They are commonly very hard: Their ſpecific gravity varies from 2.5388 to 2.9564.

141 Gneiſs.

SPECIES 2. Shiſtoſe granite or gneiſs.

The ſtructure of gneiſs is always ſlaty, and this conſtitutes its ſpecific character. In gneiſs, the proportion of quartz and felſpar is nearly equal: the proportion of mica is ſmalleſt. It is evidently ſubject to the ſame varieties with common granite.

142 G II. Sienite.

GENUS II. Sienite.

Mr Werner has given the name of *ſienite* to aggregates compoſed of felſpar, hornblende, and quartz; or of felſpar, hornblende, quartz, and mica. Theſe aggregates were formerly confounded with quartz.

Sienite is found both of a granular and ſlaty ſtructure: it might, therefore, like granite, be divided into two ſpecies. In ſienite the quartz is commonly in by far the ſmalleſt proportion.

143 G. III. Granatine.

GENUS III. GRANATINE.

Mr Kirwan has applied the name *granatine* to the following aggregates.

Quartz, Felſpar, Shorl.	Quartz, Mica, Garnet.	Quartz, Hornblende, Jade.	Felſpar, Mica, Shor
Quartz, Felſpar, Jade.	Quartz, Shorl, Hornblende.	Quartz, Hornblende, Garnet.	Felſpar, Mica, Hornblende.
Quartz, Felſpar, Garnet.	Quartz, Shorl, Jade.	Quartz, Jade, Garnet.	Felſpar, Quartz, Serpentine.
Quartz, Mica, Shorl.	Quartz, Shorl, Garnet.	Quartz, Hornblende, Hornſtone,	Felſpar, Quartz, Steatites.
Quartz, Mica, Jade.			

One of theſe aggregates, namely, *quartz*, *mica*, *garnet*, was called by Cronſtedt *morka* or *murkſten*.

144 G. IV. Granitell.

GENUS IV. GRANITELL.

Mr Kirwan gives the name of *granitell* to all aggregates compoſed of any two of the following ingredients: quartz, felſpath, mica, ſhorl, hornblende, jade, garnet, ſteatites. The moſt remarkable of theſe are:

Quartz, Felſpar.	Quartz, Hornblende.	Quartz, Steatites.	Felſpar, Hornblende.
Quartz, Mica.	Quartz, Jade.	Felſpar, Mica.	Felſpar, Jade.
Quartz, Shorl.	Quartz, Garnet.	Felſpar, Shorl.	Felſpar, Garnet.
Mica, Shorl.	Mica, Jade.	Hornblende, Jade.	Jade, Garnet.
Mica, Hornblende,	Mica, Garnet.	Hornblende, Garnet.	Steatites, Shorl.

Aggregates

Some of theſe aggregates have received particular names. The aggregate of *quartz* and *mica*, when its ſtructure is ſlaty, is called by Werner *ſhiſtoſe mica*: by the Swedes, it is denominated *ſtellſten*, whatever be its ſtructure.

The aggregate of hornblende and mica is called *grunſtein*, from the dark green colour which it uſually has.

145 G.V. Granilite.

GENUS V. GRANILITE.

Under the name of *granilite*, Mr Kirwan comprehends all aggregates containing more than three ingredients. Of theſe the following are the moſt remarkable.

Quartz, Felſpar, Mica, Shorl.	Quartz, Mica, Shorl, Garnet.	Quartz, Sulph. of barytes, Mica, Shorl.
Quartz, Felſpar, Mica, Steatites.	Quartz, Felſpar, Mica, Garnet.	Quartz, Sulph. of barytes, Mica, Hornblende.

146 G. VI. Trap.

GENUS VI. TRAP (p).

Under this genus we claſs not only what has commonly been called *trap*, but alſo wacken, and mullen, and kragſtone of Kirwan.

147 Common.

SPECIES 1. Common trap.

This ſtone is very common in Scotland, and is known by the name of *whinſtone*. Whole hills are formed of it; and it occurs very frequently in large rounded detached fragments. Sometimes it aſſumes the form of immenſe columns, and is then called *baſalt*. The Giants Cauſeway in Ireland, the iſland of Staffa, and the ſouth ſide of Arthur's Seat in Scotland, are well known inſtances of this figure.

Its texture is earthy or compact. Its fracture uneven. Its luſtre commonly 0. Opaque. Hardneſs 8 to 9. Not brittle. Sp. gr. from 2.78 to 3.021 * Colour black, with a ſhade of grey, blue, or purple; ſometimes blackiſh or reddiſh brown; in ſome caſes greeniſh grey. By expoſure to the atmoſphere, it often becomes inveſted winh a browniſh rind. Before the blow-pipe, it melts *per ſe* into a more or leſs black glaſs.

* Kirwan.

Trap conſiſts of ſmall cryſtals of hornblende, felſpar, olivine, &c. uſually ſet in a ground compoſed apparently of clay and oxide of iron. A ſpecimen, in the form of baſaltes, from Staffa, analyſed by Dr Kennedy of Edinburgh, contained

48	ſilica,
16	alumina,
16	oxide of iron,
9	lime,
5	moiſture,
4	ſoda,
1	muriatic acid.
99 †	

† *Edin. Tranſ.* v. 89.

(p) *Kirw.* I. 231 and 431.—*Faujas de St Fond. Eſſai ſur l'Hiſt. Nat. des Roches de Trap.*—*Phil. Tranſ.* paſſim. See alſo a very ingenious ſet of experiments on the fuſion of trap, by Sir James Hall in *Tranſ. Edin.* V. 43.

Earths and Stones. A ſpecimen from Saliſbury rock, near Edinburgh, contained, according to the analyſis of the ſame gentleman,

46.0 ſilica,
19.0 alumina,
17.0 oxide of iron,
8.0 lime,
4.0 moiſture,
3.5 ſoda,
1.0 muriatic acid.

98.5 *

* *Edin. Tranſ.* v. 90.

Dr Kennedy conducted theſe analyſes with great ingenuity and judgment; and the diſcovery in which they terminated, that trap contains ſoda, is certainly of importance, and may lead to valuable conſequences both in a geological and mineralogical view.

148 Wacken.

SPECIES 2. Wacken †.

† *Kirwan*, i. 223.

This ſtone often forms conſiderable parts of hills, and, like trap, is amorphous. Its texture is earthy. Its fracture uſually even. Luſtre 0. Opaque. Hardneſs 6 to 9. Sp gr. from 2.535 to 2.893 ‡. Colour grey, with a ſhade of green, black, red, brown. When expoſed to the atmoſphere, it withers and becomes more grey.

‡ *Kirwan.*

It melts into a grey porous ſlag.

149 Mullen.

SPECIES 3. Mullen *.

* *Kirwan*, i. 225.

This ſtone is alſo found in conſiderable maſſes, and ſometimes has a tendency to a columnar form like baſalt. Texture earthy. Fracture uneven, and fine ſplintery. Luſtre 0, except from ſome ſhining particles of baſaltine. Opaque. Hardneſs from 7 to 9. Sp. gr. from 2.6 to 2.738. Colour aſh or bluiſh grey; ſometimes mixed with ochre yellow, in conſequence of the decompoſition of the ſtone. At 130° Wedgewood it melts into a black compact glaſs.

When mullen is expoſed to the air, its ſurface becomes covered with a greyiſh white rind ſometimes ſlightly ochry.

150 Kragſtone.

SPECIES 4. Kragſtone *.

* *Kirw.* i. 226.

This ſtone, which, like the others, forms conſiderable parts of rocks, was formed into a diſtinct ſpecies by Mr Kirwan. Its texture is earthy. It is exceedingly porous, and the pores are often filled with the cryſtals of other minerals. Fracture uneven. Luſtre 0. Opaque. Hardneſs 5 to 7. Sp. gr. 2.314. Feels rough and harſh. Colour reddiſh grey. Streak yelloviſh grey. At 138° Wedgewood it melts into a reddiſh brown porcelain maſs.

151 G. VII. Porphyry.

GENUS VII. PORPHYRY.

Any ſtone which contains ſcattered cryſtals or grains of felſpar, viſible to the naked eye, is denominated a *porphyry*. Beſides felſpar, porphyries generally contain ſmall cryſtals of quartz, hornblende, and mica. Theſe cryſtals are uſually of a different colour from the ſtone in which they are found, and they are ſtuck in it as in a cement. It is evident from this definition, that the number of porphyries muſt be great. Each ſpecies receives its name from the ſtone which forms its baſis. To deſcribe them would be unneceſſary. We ſhall only give a catalogue of the principal ſpecies.

1. Hornſtone porphyry.
2. Pitchſtone porphyry.
3. Hornſlate porphyry.
4. Felſpar or petunſe porphyry.
5. Clay porphyry.
6. Hornblende porphyry.
7. Trap porphyry.
8. Wacken porphyry.
9. Mullen porphyry.
10. Krag porphyry.
11. Argillitic porphyry.
12. Potſtone porphyry.
13. Serpentine porphyry.
14. Sandſtone porphyry.

Aggregate.

The aggregates belonging to this ſection compoſe moſt of the mountains of the globe. In giving an account of them, we have adhered implicitly to the arrangement moſt generally received by mineralogiſts. It muſt be acknowledged, that this arrangement is by no means complete, and that ſome of the genera are too vague to be of much uſe. The number of aggregates already diſcovered is too great for giving to each a particular name. Perhaps it would be better henceforth to adopt the method propoſed by Mr Hauy, namely, to conſtitute the genera from that ingredient which enters moſt abundantly into the aggregate, and which forms as it were its baſis, and to diſtinguiſh the ſpecies according to the nature and proportion of the other ingredients. According to this plan, the aggregates hitherto diſcovered have been divided by Hauy into the following genera:

1. Felſpathic rock.
2. Quartzous rock.
3. Micaceous rock.
4. Chloritous rock.
5. Serpentine rock.
6. Trappean rock.
7. Hornblendean rock.
8. Petro ſiliceous rock.
9. Garnetic rock.
10. Calcareous rock.
11. Argillaceous rock.
12. Corneous rock.

SECT. IV. *Volcanic Aggregates.*

AGGREGATES formed by volcanoes may be reduced to the following genera.

1. Lava.
2. Tufa.
3. Pumice.
4. Aſhes.

152 G. I. Lava.

GENUS I. LAVA.

All ſubſtances which have iſſued out of a volcano in a ſtate of fuſion are called *lavas*. They have been divided into three ſpecies.

153 Vitreous.

SPECIES 1. Vitreous lava.

Found in ſmall pieces.

Texture gloſſy. Fracture concholdal. Luſtre 3. Tranſparency from 3 to 1. Hardneſs 9 to 10. Sp. gr. from 2 to 3. Colour blackiſh, greeniſh, or whitiſh. Commonly ſomewhat porous.

154 Cellular.

SPECIES 2. Cellular lava.

This ſpecies is full of cells. Surface rough and full of cavities. Texture earthy. Luſtre 0. Opaque. Hardneſs 7 to 9. Sp. gr. varies, but does not exceed 2.8. Colour brown or greyiſh black. Commonly ſomewhat magnetic.

155 Compact.

SPECIES 3. Compact lava.

This ſpecies is the moſt common of all; it runs into

Combuſtibles.

the ſecond by inſenſible degrees; and indeed is ſeldom found of any conſiderable ſize without ſome pores. It bears in general a very ſtrong reſemblance to trap.

A ſpecimen of the lava of Catania in Sicily, analyſed by Dr Kennedy, contained

51.0 ſilica,
19.0 alumina,
14.5 oxide of iron,
9.5 lime,
4.0 ſoda,
1.0 muriatic acid.

99.0 *

* *Tranſ. Edin.* v. 93.

A ſpecimen of the lava of Sta. Venere in Sicily he found to contain 50.75 ſilica,
17.50 alumina,
14.25 oxide of iron,
10.00 lime,
4.00 ſoda,
1.00 muriatic acid.

97.5 †

† *Ibid.* 94.

Thus we ſee, that the reſemblance between trap and lava holds not only in their external appearance, but alſo in their component parts.

Genus II. PUZZOLANA.

Combuſtible. 156 G. II. Puzzolana.

Found in ſmall pieces. Surface rough. Texture earthy and porous. Fracture uneven. Luſtre 0. Opaque. Hardneſs 3. Very brittle. Sp. gr. from 2.57 to 2.8. Colour brown or dark grey. Magnetic. Eaſily melts into a black ſlag.

When mixed with lime into a mortar, it poſſeſſes the property of hardening even under water. This property it owes moſt probably, as Mr Kirwan ſuppoſes, to the iron which it contains. The iron decompoſes the water of the mortar, and by this means it becomes too hard to be acted upon by water in a very ſhort time.

Genus III. PUMICE.

157 G. III. Pumice.

This is a very light ſubſtance ejected from volcanoes. It is porous. Hardneſs 3. Brittle. Sp. gr. below 1. Colour grey or brown.

In ſome varieties the luſtre and tranſparency are 0: in others, the luſtre is glaſſy, 2. Tranſparency from 1 to 2.

Genus IV. VOLCANIC ASHES.

158 G IV. Volcanic aſhes.

Theſe are analogous to the aſhes of common pit coal. Looſe and ſmooth, very light and fine. Slowly diffuſible in water, and when wet ſomewhat ductile.

Class II. SALTS.

UNDER this claſs we comprehend all the combinations of alkalies with acids which exiſt in the mineral kingdom. As they have been already deſcribed in the article CHEMISTRY, *Suppl.* we ſhall here only give a liſt of their names.

159 Genera.

Genus I. POTASS.
Sp. 1. Sulphat of potaſs.
2. Nitrat of potaſs.

Genus II. SODA.
Sp. 1. Carbonat of ſoda.
2. Sulphat of ſoda.
3. Muriat of ſoda.
4. Borax.

Genus III. AMMONIA.
Sp. 1. Sulphat of ammonia.
2. Muriat of ammonia.

Class III. COMBUSTIBLES.

THE combuſtible ſubſtances belonging to the mineral kingdom, excluding the metals, may be comprehended under the following genera.

160 Genera.

1. Sulphur.
2. Carbon.
3. Bitumen.
4. Coal.
5. Amber.

Genus I. SULPHUR.

161 G. I. Sulphur.

SPECIES 1. Native ſulphur.

This ſubſtance is found abundantly in many parts of the world, eſpecially near Volcanoes, as Hecla, Ætna, Veſuvius, the Lipari iſlands, &c. It is either in the ſtate of powder, or maſſive, or cryſtallized. The primitive form of its cryſtals is an octohedron, compoſed of two four-ſided pyramids, joined baſe to baſe ‡. The ſides of theſe pyramids are ſcalene triangles, and ſo inclined that the plane where the baſes of the pyramids join in a rhomb, whoſe long diagonal is to its ſhort as 5 to 4 §. Sometimes the apices of the pyramids, to uſe the language of De Liſle, are truncated; ſometimes they are ſeparated from each other by a priſm; ſometimes they are truncated near their baſes, and a low four-ſided pyramid riſes from the truncature: this pyramid is alſo ſometimes truncated near its apex ¶. Finally, one of the edges of the pyramids is ſometimes truncated. For figures of theſe varieties and for the laws of their formation, we refer to *Mr Lefroy* *.

‡ Fig. 34.

§ *Romé de Liſle*, i. 292. *Hauy* and *Lefroy*, *Jour. de Min.* N° xxix. 337.

¶ Fig. 35.

* *Jour. de Min.* N° xxix. 337.

Colour yellow, with a ſhade of green; ſometimes reddiſh (ϙ). Luſtre greaſy, 2. Tranſparency varies from 0 to 4. Cauſes double refraction †. Texture compact. Hardneſs 4 to 5. Brittle.—For its other properties, we refer to CHEMISTRY in this *Suppl.*

† *Hauy.*

Sometimes ſulphur is mixed with different proportions of earths. Theſe combinations are hardly ſuſceptible of accurate deſcription.

Sulphur combines alſo with metals. Theſe combinations ſhall be deſcribed in the fourth claſs.

Genus II. CARBON.

162 G. II. Carbon.

This genus comprehends all minerals compoſed of pure carbon, or of carbon combined with a little earth.

SPECIES 1. Diamond.

163 Diamond.

This mineral, which was well known to the ancients, is

(ϙ) It then contains arſenic.

Combuſtibles.

is found in different parts of Aſia, particularly in the kingdoms of Golconda and Viſapour; it is found alſo in Brazil.

It is always cryſtallized; but ſometimes ſo imperfectly, that at the firſt ſight it might paſs for amorphous. Its primitive form is a regular octogon †; but it more commonly aſſumes a ſpheroidal form, and then has uſually 36 curvilinear triangular faces, ſix of which are raiſed upon each of the faces of the primitive octogon ‡. Its integrant molecule, according to Hauy, is a regular tetrahedron.—For a more particular account of the cryſtals of this mineral, we refer the reader to *Mr Romé de Liſle* * and *Mr Hauy* †.

† Fig. 36.

‡ Fig. 37.

* *Cryſtal.* ii. 191.

† *Jour. de Min.* N° xxix 343.

Texture foliated. Luſtre 4. Tranſparency from 2 to 4. Cauſes ſingle refraction. Hardneſs 20. Sp. gr. 3.5185 to 3.5310 ‡. Colour various; ſometimes limpid, ſometimes red, orange, yellow, green, blue, and even blackiſh.

‡ *Hauy, ibid.*

When rubebd it becomes poſitively electric, even before it has been cut by the lapidary, which is not the caſe with any other gem ‖.

‖ *Id. ibid.*

It is compoſed of pure carbon §.

§ *Morveau, Ann. de Chim.* xxxi. 72.

SPECIES 2. Mineral charcoal.

Kilkenny coal—Wales culm.

164 Mineral charcoal.

This mineral has been found in Hungary, Italy, France, Ireland, and Wales. It occurs in ſtratified maſſes, or in lumps neſted in clay.

Colour black. Luſtre 4, metallic. Opaque. Texture foliated. Hardneſs 5 to 7. Sp. gr. 1.4 to 1.526, Often ſtains the fingers. Inſoluble in acids. Deflagrates with nitre. Does not burn till wholly ignited, and then conſumes ſlowly without emitting flame or ſmoke.

It conſiſts almoſt entirely of *charcoal*, which, as Morveau has proved, is an oxide of carbon *.

* *Ibid.*

165 Anthracite.

SPECIES 3. Anthracite (R).

Anthracolite.

This ſubſtance, as Dolomieu informs us, is found excluſively in the primitive mountains. It is always amorphous. Colour black or browniſh black. Luſtre 3 to 4. Structure ſlaty. Fragments rhomboidal. Hardneſs 6 to 7. Sp. gr. greater than that of coal. Often ſtains the fingers.

Burns preciſely like the laſt ſpecies, and leaves .40 of white aſhes. According to Dolomieu, it is compoſed of about

64.0	charcoal,
32.5	ſilica,
3.5	iron,
100.0 †	

† *Jour. de Min.* N° xxix. 338.

It is probable that the charcoal in the two laſt ſubſtances is in the ſame ſtate in which it exiſts in plumbago, combined with oxygen, but not containing ſo much as charcoal does ‡.

‡ *Morveau, ibid.*

GENUS III. BITUMEN.

166 G. III. Bitumen.

By bitumen we underſtand, with mineralogiſts in general, an oil, which is found in different parts of the earth, in various ſtates of conſiſtence. Theſe different ſtates form diſtinct ſpecies; in our arrangement of which we ſhall be guided by the obſervations which Mr Hatchett has made in his valuable paper on bituminous ſubſtances *.

* *Nicholſon's Journal*, ii. 201, 248.

SPECIES 1. Naphtha.

Combuſtibles.

This ſubſtance is found ſometimes on the ſurface of the water of ſprings, and ſometimes iſſuing from certain ſtrata. It is found in great abundance in Perſia.

167 Naphtha.

It is as fluid and tranſparent as water. Colour white or yellowiſh white. Smell ſtrong, but not diſagreeable. Sp. gr. when white, .708 * or .729 †; when yellowiſh, .8475 ‡. Feels greaſy. Catches fire on the approach of flame, burns with a white flame, and leaves ſcarce any reſiduum.

* *Muſchenbroek.*

† *Boulduc.*

‡ *Briſſon.*

Inſoluble in alcohol. Does not freeze at 0° Fahrenheit. When pure naphtha is expoſed to the air, it becomes yellow and then brown; its conſiſtence is increaſed, and it paſſes into *petroleum* *.

* *Hatchett.*

SPECIES 2. Petroleum.

168 Petroleum.

This ſubſtance is alſo found in Perſia, and likewiſe in many countries in Europe, particularly Italy, France, Switzerland, Germany, Sweden, England, and Scotland.

Not ſo fluid nor tranſparent as water. Colour yellow, either pale or with a ſhade of red or green; reddiſh brown and reddiſh black. Smell that of naphtha, but leſs pleaſant. Sp. gr. 8783 *. When burned it yields a ſoot, and leaves a ſmall quantity of coally reſiduum.

* *Briſſon.*

By expoſure to the air it becomes like tar, and is then called *mineral tar* †.

† *Hatchett, ibid.*

SPECIES 3. Mineral tar.

169 Mineral tar.

This ſubſtance is found in many parts of Aſia, America, and Europe. It is viſcid, and of a black, browniſh black, or reddiſh colour. Smell ſometimes ſtrong, but often faint. Sp. gr. 1.1. When burned, emits a diſagreeable bituminous ſmell. By expoſure to the air it paſſes into *mineral pitch* and *maltha* *.

* *Hatchett, ibid.*

SPECIES 4. Mineral pitch and maltha.

170 Mineral pitch and maltha.

This ſubſtance has a ſtrong reſemblance to common pitch. When the weather is warm it is ſoft, and has ſome tenacity; it is then called *adheſive mineral pitch*: when the weather is cold, it is brittle; its hardneſs is 5; and its fracture has a glaſſy luſtre. In this ſtate it is called *maltha*. Colour black, dark brown, or reddiſh. Luſtre 0. Opaque. Sp. gr. from 1.45 to 2.07. Does not ſtain the fingers. On a white hot iron it flames with a ſtrong ſmell, and leaves a quantity of grey aſhes. It it is to the preſence of the earths which compoſe theſe aſhes that the great ſpecific gravity of this bitumen is to be aſcribed. By farther induration, it paſſes into *aſphalt*.

SPECIES 5. Aſphalt.

171 Aſphalt.

This ſubſtance is found abundantly in many parts of Europe, Aſia, and America, eſpecially in the iſland of Trinidad.

Colour black or browniſh black. Luſtre greaſy 2. Opaque. Fracture conchoidal, of a glaſſy luſtre. Hardneſs from 7 to 8. Very brittle. Sp. gr. 1.07 to 1.165 *. Feel ſmooth, but not greaſy. Does not ſtain the fingers. Has little or no ſmell, unleſs when rubbed or heated. When heated melts, ſwells, and inflames; and when pure, burns without leaving any aſhes.

* *Kirwan.*

SPECIES 6. Elaſtic bitumen.

Mineral caoutchouc.

172 Elaſtic bitumen.

This ſubſtance was found about the year 1786 in the lead

(R) This name was given by Hauy from ανθραξ, *a coal*.

Combuſtibles.

lead mine of Odin, near Caſtletown, Derbyſhire. It was firſt mentioned by Mr De Born.

Colour yellowiſh or reddiſh brown, ſometimes blackiſh brown. In its appearance it has a ſtrong reſemblance to caoutchouc or Indian rubber; hence its name. Conſiſtency various: ſometimes ſo ſoft as to adhere to the fingers; ſometimes nearly as hard as aſphalt. When ſoft it is elaſtic; when hard brittle. Sp. gr. 0.9053 to 1.0233*.

* *Hatchett, ibid.*

Inſoluble in alcohol, ether, and oil of turpentine, but ſoluble in oil of olives. Not affected by nitric acid. When diſtilled, it yields a bituminous oil inſoluble in alcohol; the reſiduum is carbonaceous†.

† *Lamethrie, Jour. de Phyſ.* xxxi. 312.

There is a variety of this ſubſtance found in a rivulet near the mine of Odin, which, when freſh cut, exactly reſembles fine cork in colour and texture; but in a few days after being expoſed to the air, becomes of a pale reddiſh brown. This ſubſtance contains within it a nucleus of elaſtic bitumen. It ſeems to be the elaſtic bitumen altered in its texture by the water‡.

‡ *Hatchett, ibid.*

173 G. IV. Coal.

Genus IV. coal.

The ſubſtances belonging to this genus are compoſed of carbon, or rather charcoal, and bitumen.

174 Jet.

Species 1. Jet (s).

This ſubſtance is found in France, Spain, Germany, Britain, and other countries. It is found in detached kidneyform maſſes, of various ſizes, from an inch to ſeven or eight feet in length.

Colour full black. Luſtre 3 to 4; internal glaſſy. Opaque. Hardneſs 7 to 8. Not near ſo brittle as aſphalt. Texture ſtriated. Fracture conchoidal. Sp. gr. 1.259*. It has no odour except when heated, and then it reſembles the odour of aſphaltum. Melts in a ſtrong heat, burns with a greeniſh flame, and leaves an earthy reſiduum†.

* *Briſſon.*

† *Hatchett.*

‡ *Kirwan.*

§ *Vauquelin.*

Becomes ſomewhat electric by friction‡. When diſtilled yields a peculiar acid §.

This mineral is formed into buttons, beads, and other trinkets. The manufacture has been almoſt confined to France‖.

‖ *Jour. de Min.* N° iv. 41.

175 Cannel coal.

Species 2. Cannel coal.

This mineral is found in Lancaſhire, and in different parts of Scotland, where it is known by the name of *parrot coal.*

Colour black. Luſtre common, 2. Opaque. Structure ſometimes ſlaty. Texture compact. Fracture conchoidal. Hardneſs 5 to 8. Brittle. Sp. gr. 1.232 to 1.426. Does not ſtain the fingers.

Kindles eaſily, and burns with a bright white flame like a candle (t), which laſts but a ſhort time. It does not cake. It leaves a ſtony or ſooty reſiduum.

A ſpecimen of Lancaſhire cannel coal, analyſed by Mr Kirwan, contained 75.20 charcoal,
21.68 maltha,
3.10 alumina and ſilica.

99.98¶

¶ *Mineral.* ii. 523.

A ſpecimen of the ſlaty kind from Airſhire, called *ſplent coal*, was compoſed of

47.62 charcoal,
32.52 maltha,
20.00 earths.

100.14*

* *Ibid.* 524

Combuſtibles.

Cannel coal is ſuſceptible of poliſh, and, like jet, is often wrought into trinkets.

176 Common coal.

Species 3. Common coal.

This very uſeful combuſtible is never found in the primitive mountains, but only in the ſecondary mountains, or in plains formed of the ſame materials with them. It is always in ſtrata, and generally alternates with clay, ſandſtone, or limeſtone.

Colour black, more or leſs perfect. Luſtre uſually greaſy or metallic, 2 to 4. Opaque. Structure generally ſlaty. Texture often foliated. Fracture various. Hardneſs 4 to 6. Sp. gr. 1.25 to 1.37. Uſually ſtains the fingers. Takes fire more ſlowly, and burns longer, than the laſt ſpecies. Cakes more or leſs during combuſtion.

Of this ſpecies there are many varieties, diſtinguiſhed in Britain by the names of caking coal, rock coal, &c. Theſe are too well known to require any deſcription.

Mr Kirwan analyſed a variety of different kinds of coal: The reſult of his experiments may be ſeen by the following table.

Whitehaven coal.	Wigan.	Swanſey.	Leeirem.	
57.0	61.73	73.53	71.43	charcoal.
41.3	36.7	23.14	23.37	maltha & aſph.
1.7	1.57	3.33	5.20	earths†.
100.0	100.00	100.00	100.00	

† *Mineral.* ii. 525.

177 Spurious coal.

Species 4. Spurious coal.

This mineral is generally found amidſt ſtrata of genuine coal. It is alſo called *parrot-coal* in Scotland.

Colour greyiſh black. Luſtre 0 to 1. Structure uſually ſlaty. Texture earthy. Hardneſs 7 to 8. Sp. gr. 1.5 to 1.6. Generally explodes, and burſts when heated.

Compoſed of charcoal, maltha, and aſphalt, and above .20 of ſtony matter.

178 G. V. Amber.

Genus V. amber.

Species 1. Common amber.

This ſubſtance, called *electrum* by the ancients, is found in different countries; but moſt abundantly in Pruſſia, either on the ſea-ſhore, or under-ground at the depth of about 100 feet, repoſing on *wood-coal*‡. It is in lumps of different ſizes.

‡ *Kirw. Min.* ii. 66.

Colour yellow. Luſtre 3 to 2. Tranſparency 2 to 4. Fracture conchoidal. Hardneſs 5 to 6. Sp. gr. 1.078 to 1.085. Becomes electric by friction.

If a piece of amber be fixed upon the point of a knife, and then kindled, it burns to the end without melting¶.

¶ *Hauy.*

By diſtillation it yields ſuccinic acid.

Class

(s) It was called *gagathes* by the ancients, from the river Gages in Licia, near which it was found; *jayet* in French, *ozabache* in Spaniſh, *gagath* in German.

(t) Hence it has been called *cannel coal. Candle*, in the Lancaſhire and Scotch dialect, is pronounced *cannel.*

Class IV. METALLIC ORES.

THIS class comprehends all the mineral bodies, composed either entirely of metals, or of which metals constitute the most considerable and important part. It is from the minerals belonging to this class that all metals are extracted; for this reason they have obtained the name of *ores*.

179 Orders. The metals hitherto discovered amount to 21; we shall therefore divide this class into 21 orders, allotting a distinct order for the ores of every particular metal.

Metals exist in ores in one or other of the four following states: 1. In a metallic state, and either solitary or combined with each other. 2. Combined with sulphur. 3. In the state of oxides. 4. Combined with acids. Each order therefore may be divided into the four following genera.

180 Genera.

1. Alloys,	3. Oxides,
2. Sulphurets,	4. Salts.

It must be observed, however, that every metal has not hitherto been found in all these four states, and that some of them are hardly susceptible of them all. Some of the orders therefore want one or more genera, as may be seen from the following table.

Order I. *Gold ores.*
1. Alloys.

Order II. *Silver ores.*
1. Alloys.
2. Sulphurets.
3. Oxides.
4. Salts.

Order III. *Platinum ores.*
1. Alloys.

Order IV. *Ores of mercury.*
1. Alloys.
2. Sulphurets.
3. Oxides.
4. Salts.

Order V. *Copper ores.*
1. Alloys.
2. Sulphurets.
3. Oxides.
4. Salts.

Order VI. *Iron ores.*
1. Alloys.
2. Sulphurets.
3. Carburets.
4. Silicated iron.
5. Oxides.
6. Salts.

Order VII. *Tin ores.*
1. Sulphurets.
2. Oxides.

Order VIII. *Lead ores.*
1. Sulphurets.
2. Oxides.
3. Salts.

Order IX. *Zinc ores.*
1. Sulphurets.
2. Oxides.
3. Salts.

Order X. *Antimonial ores.*
1. Alloys.
2. Sulphurets.
3. Oxides.
4. Salts.

Order XI. *Bismuth ores.*
1. Alloys.
2. Sulphurets.
3. Oxides.

Order XII. *Arsenic ores.*
1. Alloys.
2. Sulphurets.
3. Oxides.

Order XIII. *Cobalt ores.*
1. Alloys.
2. Sulphurets.
3. Oxides.
4. Salts.

Order XIV. *Nickel ores.*
1. Sulphurets.
2. Oxides.
3. Salts.

Order XV. *Manganese ores.*
1. Oxides.
2. Salts.

Order XVI. *Tungsten ores.*
1. Oxides.
2. Salts.

Order XVII. *Ores of molybdenum.*
1. Sulphurets.

Order XVIII. *Ores of uranium.*
1. Oxides.
2. Salts.

Order XIX. *Ores of titanium.*
1. Oxides.

Order XX. *Ores of tellurium.*
1. Alloys.

Order XXI. *Ores of chromum.*
1. Oxides.

Order I. GOLD ORES.

181 Where found. No metal perhaps, if we except iron, is more widely scattered through the mineral kingdom than gold *. Hitherto it has been found only in a metallic state; most commonly in grains, ramifications, leaves, or rhomboidal, octahedral, or pyramidal crystals. It is generally mixed with quartz, though there are instances of its having occurred in calcareous rocks. It is not uncommon also to find it disseminated through the ores of other metals; especially iron, mercury, copper, and zinc. The greatest quantity of gold is found in the warmer regions of the earth. It abounds in the sands of many African rivers, and is very common in South America and India. Europe, however, is not destitute of this metal. Spain was famous in ancient times for its gold mines, and several of the rivers in France contain it in their sands †. But the principal gold mines in Europe are those of Hungary, and next to them those of Salzburg. Gold also has been discovered in Sweden and Norway, and more lately in the county of Wicklow in Ireland ‡.

* *Bergman.*

† *Reaumur, Mem. Par.* 1718, p. 68.

‡ *Lloyd, Phil. Trans.* 1796, p. 36. *Mills, ibid.* p. 38.—*Nicholson's Journ.* ii. 224.

Genus I. Alloys of gold.

Species 1. Native gold.

182 G. I. Native gold. Native gold is never completely pure; it is alloyed with some silver or copper, and sometimes with iron. In the native gold found in Ireland, indeed, the quantity of alloy appears to have been exceedingly small.

Its colour is yellow. Lustre metallic. Fracture hackly. Hardness 5. Sp. gr. from 12 to 9.

Order II. SILVER ORES.

183 Where found. Silver is found most commonly in quartz, limestone, hornstone; or combined with the ores of other metals, most commonly with copper, antimony, zinc, cobalt, and lead. This last metal indeed is seldom totally destitute of silver.

Genus I. Alloys of silver.

Species 1. Native silver *.

184 G. I. Native silver. Native silver, so called because the silver is nearly in a state of purity, forms the principal part of some of the richest silver mines in the world. It is sometimes in small lumps; sometimes crystallized in cubes, hexahedrons, octahedrons, or dodecahedrons; sometimes in leaves, or threads, often so connected with each other as to resemble branches of trees, and therefore called *dendrites*. The silver in the famous mines of Potosi has this last form. When newly extracted, it is not unlike small branches of fir †.

* *Kirw.* ii. 108.—*Cal. Ling. Act. Liter. Sveciæ*, 1738, p. 420.

† *Bergman's Phys. Geogr. Jour. de Min.* N° xvi p. 26.

The colour of native silver is white; often tarnished. Lustre metallic. Fracture hackly. Hardness 6. Malleable. Sp. gr. from 10 to 10.338.

The silver in this species is almost constantly alloyed with from .03 to .05 of some other metal, frequently gold or arsenic.

SPECIES

Silver.

SPECIES 2. Alloy of silver and gold.
Auriferous native silver.

185 Alloy of silver and gold.

This alloy is not uncommon in silver mines. Its colour is yellowish white. Its lustre metallic. Hardness 5. Malleable. Sp. gr. above 10.6. Dr. Fordyce found a specimen from Norway composed of

72 silver,
28 gold.

100 *

* *Phil. Transf.* 1776, p. 532.

SPECIES 3. Alloy of silver and antimony †.
Antimoniated silver ore.

186 Alloy of silver and antimony.

This alloy, which is found in the silver mines of Spain and Germany, is sometimes in grains or lumps, and sometimes crystallized in six-sided prisms, whose sides are longitudinally channelled ‡.

Its colour is white. Its lustre metallic. Hardness 10. Brittle. Sp. gr. from 9.4406 § to 10.* Texture foliated. Fracture conchoidal. Before the blow-pipe the antimony evaporates in a grey smoke, and leaves a brownish slag, which tinges borax green. If borax be used at first, a silver bead may be obtained.

This alloy was long supposed to contain arsenic. Bergman examined it, and found only silver and antimony †. His analysis has been confirmed by the experiments of Vauquelin and Selb ‡. According to Selb, it is composed of 89 silver,
11 antimony.

100

A specimen analysed by Klaproth, contained
84 silver,
16 antimony.

100

Another specimen contained
76 silver,
24 antimony.

100 ‡

† *Opusc.* ii. 415.
‡ *Jour. de Min. ibid*
‡ *Beiträge*, ii. 301.

GENUS II. SULPHURETS OF SILVER.

187 G. II. Sulphurets.

SPECIES 1. Common sulphuret of silver *.
Vitreous silver ore.

Common sulphuret of silver.

This ore occurs in the silver mines of Germany and Hungary. It is sometimes in masses, sometimes in threads, and sometimes crystallized. Its crystals are either cubes or regular octohedrons, whose angles and edges are often variously truncated. For a description of the varieties produced by these truncatures, we refer the reader to *Romé de Lisle* †.

Its colour is dark bluish grey, inclining to black; often tarnished. Internal lustre metallic. Texture foliated. Fracture uneven. Hardness 4 to 5. May be cut with a knife like lead. Flexible and malleable. Sp. gr. 6.909 ‡ to 7.215 ‖ In a gentle heat the sulphur evaporates. Melts when heated to redness.

A specimen of this ore, analysed by Klaproth, contained 85 silver,
15 sulphur.

100 *

* *Kirwan*, ii. 115.
† *Crystal.* iii. 441.
‡ *Brisson.*
‖ *Gellert.*
* *Beiträge*, i. 162.

Metallic ores.

SPECIES 2. Antimoniated silver ore *.
Sulphuret of silver with antimony and iron.

188 Antimoniated silver ore.

This ore, which occurs in Saxony and Hungary, seems to be sulphuret of silver contaminated with antimony and iron, and ought therefore, in all probability, to be considered merely as a variety of the last species. It is sometimes in masses, but more frequently crystallized in six-sided prisms, tables, or rhomboids; generally indistinct and accumulated together.

Its colour is iron grey; often tarnished. Its lustre metallic. Fracture uneven. Hardness 4 to 5. Brittle. Sp. gr. 7.208 †. Before the blow-pipe the sulphur and antimony exhale, leaving a bead, which may be freed from iron by fusion with nitre and borax.

A specimen of this ore, analysed by Klaproth, contained 66.5 silver,
12.0 sulphur,
10.0 antimony,
5.0 iron,
1.0 silica,
0.5 arsenic and copper.

95.0 ‡

* *Kirwan*, ii. 118.
† *Gellert.*
‡ *Beiträge*, i. 166.

SPECIES 3. Sulphuret of silver and copper ‖
Cupriferous sulphurated silver ore.

189 Sulphuret of silver and copper.

This ore, which is found in the Korbolokinsk mountains in Siberia, was first described by Mr Renovantz. It is in amorphous masses, varying in size from that of the thumb to that of the fist.

Its colour is bluish grey like lead. Lustre metallic. Hardness 5 to 6. Brittle. Its powder, when rubbed on the skin, gives it a black colour and a leaden gloss. Before the blow-pipe the sulphuret of silver melts readily; that of copper with difficulty. This ore is composed of about 42 silver,
21 copper,
35 sulphur.

98

‖ *Kirwan*, ii. 121.

190 G. III. Oxides.

GENUS III. OXIDES OF SILVER.

SPECIES 1. Calciform silver ore *.

Calciform silver ore.

This ore was first described by Mr Widenman. It is sometimes in masses, sometimes disseminated through other minerals.

Its colour is greyish black. Its streak bright. Its lustre metallic. Its fracture uneven. Hardness 4 to 5. Brittle. Sp. gr. considerable. Effervesces with acids. Melts easily before the blow pipe. Froths with borax.

According to Selb, it contains 72.5 silver,
15.5 copper,
12.0 carbonic acid.

100.0

* *Kirwan*, ii. 112.

SPECIES 2. Red silver ore (u).

191 Red silver ore.

This ore is very common in several German silver mines. It occurs in masses, disseminated and crystallized. The primitive form of its crystals is a dodecahedron ‡, whose sides are equal rhombs, and which may be con-

† Fig. 38.

(u) *Kirw.* II. 122.—*Scopoli de Minera Argenti, Rubra.*—*Sage, Jour. de Phys.* XXXIV. 331. *and* XLI. 370; and *Nouv. Jour. de Phys.* II. 284.—*Westrum, Jour. de Phys.* XLIII. 291.—*Klaproth, Beiträge*, I. 141.

Silver.

considered as a ſix-ſided rhomboidal priſm, terminated by three-ſided ſummits*. Sometimes the priſm is lengthened, and ſometimes its edges, or thoſe of the terminating ſummits, or both, are wanting. For a deſcription and figure of theſe varieties, we refer to *De Liſle* † and *Hauy* ‡.

Its colour is commonly red. Streak red. External luſtre metallic, internal common. Tranſparency from 3 to 1; ſometimes opaque. Fracture flat conchoidal. Hardneſs 5 to 7. Brittle. Sp. gr. from 5.44 ‖ to 5.592 *. Becomes electric by friction, but only when inſulated †. Soluble in nitric acid without effervescence ‡. Before the blow-pipe melts, blackens, burns with a blue flame, gives out a white ſmoke with a ſlight garlic ſmell, and leaves a ſilver bead ‖.

Variety 1. Light red.

Colour intermediate between blood and cochineal red; ſometimes variegated. Streak orange red. Powder black.

Variety 2. Dark red.

Colour commonly between dark cochineal red and lead grey; ſometimes nearly black, and without any ſhade of red. Streak dark crimſon red.

This ore was long ſuppoſed to contain arſenic. Klaproth firſt aſcertained its real compoſition *; and his analyſis has been confirmed by Vauquelin, who found a ſpecimen compoſed of 56.6748 ſilver,
16.1300 antimony,
15.0666 ſulphur,
12.1286 oxygen.

100.

Klaproth proved, that the ſilver and antimony are in the ſtate of oxides; and Vauquelin, that the ſulphur is combined partly with the oxide of ſilver and partly with the oxide of antimony. Klaproth obtained a little ſulphuric acid; but this acid, as Vauquelin, with his uſual ingenuity, demonſtrated, was formed during the analyſis.

This ore ſometimes contains a minute portion of arſenic, but never more than .02 †.

192 G. IV. Salts. Muriat of ſilver.

GENUS IV. SALTS OF SILVER.

SPECIES 1. Muriat of ſilver (x).

Corneous ſilver ore.

This ore occurs at Johanngeorgenſtadt in Saxony, in South America, &c. It is often amorphous, ſometimes nearly in powder, and ſometimes cryſtallized in cubes or parallelopipeds.

Its colours are various: when expoſed to the light it becomes brown. Internal luſtre greaſy, 2; external, 2 to 1. Acquires a gloſs when ſcraped with a knife. Tranſparency 2 to 1. Texture foliated. Hardneſs 4 to 5. Sp. gr. 4 745 ‡ to 4.804 ‖. Before the blow-pipe it inſtantly melts, and gradually evaporates, but may be reduced by adding an alkali.

Metallic ores.

That this ore contains muriatic acid, has been long known. Mr Woulfe firſt ſhewed that it contained alſo ſulphuric acid *: and this diſcovery has been confirmed by Klaproth, according to whoſe analyſis this ore is compoſed of
67.75 oxide of ſilver,
6.00 oxide of iron,
21.00 muriatic acid,
.25 ſulphuric acid,
1.75 alumina.
96.75 †

The alumina can only be conſidered as mixed with the ore. Sometimes its quantity amounts to .67 of the whole ‡.

* *Romé de Liſle*, iii. 447.
† *Ibid.*
‡ *Jour. d'Hiſt. Naturelle*, N° 18. p. 216.
‖ *Kirwan.*
* *Vauquelin, Jour. de Min.* N° xvii. p. 2.
† *Hauy, ibid.* N° xxx. p. 476.
‡ *Hauy, ibid.* N° xxxi. p. 518.
‖ *Vauquelin, ibid.*
* *Ann. de Chim.* xviii 81.
† *Vauquelin, ibid.* p. 8.
‡ *Briſſon.*
‖ *Gellert.*
* *Phil. Tranſ.* 1770.
† *Beiträge*, i. 134.
‡ *Ibid.* p. 137.

ORDER III. ORES OF PLATINUM (y).

193 Mines.

HITHERTO no mine of platinum has been diſcovered. It is found in ſmall ſcales or grains on the ſands of the river Pinto, and near Carthagena in South America. It is always in a metallic ſtate, and always combined with iron.

GENUS I. ALLOYS OF PLATINUM.

SPECIES 1. Native platinum.

194 G. I. Alloys. Native platinum.

Its colour is whitiſh iron grey. Magnetic. Sp. gr. from 12 to 16. Soluble in nitro-muriatic and oxy-muriatic acids.

ORDER IV. ORES OF MERCURY.

MERCURY is employed in medicine; it ſerves to ſeparate ſilver and gold from their ores; the ſilvering of looking-glaſſes, gilding, &c. are performed by means of it; and its ſulphuret forms a beautiful paint.

195 Mines.

Mercury abounds in Europe, particularly in Spain, Germany, and Hungary: it is found alſo in China (z), the Phillipines ‖, and in Peru, and perhaps Chili (a) in South America. The moſt productive mines of mercury are thoſe of Idria *; of Almaden, near Cordova in Spain, which were wrought by the Romans (b); of the Palatinate †; and of Guanca Velica in Peru (c).

Mercury has never been found in Britain, nor has any mine worth working been diſcovered in France. It occurs moſt commonly in argillaceous ſhiſtus, limeſtones, and ſandſtones.

‖ *Carreri's Voyage.*
* *Scopoli.*
† *Jour. de Min.* N° xxxvi. p. 915. *Jour. de Min.* N° vi. and vii.

GENUS I. ALLOYS OF MERCURY.

SPECIES 1. Native mercury.

196. G. I. Alloys Native mercury.

Native mercury is found in moſt mercurial mines: it is in ſmall globules, ſcattered through different kinds of ſtones, clays, and ores.

Fluid. Colour white. Sp. gr. about 13.6.

(x) *Kirw.* II. 113.—*Laxman. Nov. Comm. Petropol.* XIX. 482.—*Monnet, Mem. Sçav. Etang.* IX. 717.

(y) See *Brownrigg, Phil. Tranſ.* XLVI. 584.—*Lewis, ibid.* XLVIII. 638. and L. 148.—*Margraf, Mem. Berlin*, 1757, p. 314.—*Macquer, Mem. Par.* 1758, p. 119.—*Buffon, Jour. de Phyſ.* III. 324.—*Morveau, ibid.* VI. 193.—*Bergman, Opuſc.* II. 166.—*Tillet, Mem. Par.* 1779, p. 373, and 385, and 545.—*Crell, Crell's Annals*, 1784. 1 *Band.* 328.—*Willis, Mancheſter Memoirs*, III. 467.—*Muſſin Puſchkin, Ann. de Chim.* XXIV. 205.—*Morveau, ibid.* XXV. 3.

(z) See *Entrecolle's Lettres Edificantes.*

(a) See *Molina's Natural Hiſtory of Chili.*

(b) See *Bowle's Natural Hiſtory of Spain*, and *Jour. de Min.* N° xxxi. p. 555.

(c) See *Ulloa's Memoirs concerning America.*

Ores of Mercury.

197 Amalgam of silver.

SPECIES 2. Amalgam of silver *.

Native amalgam.

This mineral has been found in the silver mine of Sahlberg †, in the province of Dalecarlia, in Sweden; in the mines of Deux Ponts ‡, in the Palatinate; and in other places. It is in thin plates, or grains, or crystallized in cubes, parallelopipeds, or pyramids.

Its colour is silvery white or grey. Lustre metallic. Creaks when cut. Sp. gr. above 10. Tinges gold white. Before the blow-pipe the mercury evaporates and leaves the silver.

A specimen of this amalgam, analysed by Klaproth, contained 64 mercury, 36 silver.

100 §

Sometimes it contains a mixture of alumina, and sometimes the proportion of mercury is so great that the amalgam is nearly as soft as paste.

198 G. II. Sulphurets

GENUS II. SULPHURETS OF MERCURY.

SPECIES 1. Common sulphuret ‖.

Native cinnabar.

This ore, which is found in almost all mercurial mines, is sometimes in veins, sometimes disseminated, sometimes in grains, and sometimes crystallized. The form of its crystals is a tetrahedron or three-sided pyramid, most commonly wanting the summit; sometimes two of these pyramids are joined base to base; and sometimes there is a three sided prism interposed between them ¶.

Its colour is red. Its streak red and metallic. Lustre when crystallized 2 to 3; when amorphous, often 0. Transparency, when crystallized, from 1 to 3; when amorphous, often 0. Texture generally foliated. Hardness from 3 to 8. Sp. gr. from 5.419 to 10.1285.

Before the blow-pipe evaporates with a blue flame and sulphureous smell. Insoluble in nitric acid *.

Variety 1. Dark red.

Colour cochineal red. Hardness 6 to 7. Sp. gr. when pure, 10.1285 †; sometimes only 7.2, or even 6.188 ‡.

Variety 2. Bright red.

Colour commonly scarlet. Sp. gr. 6.9022 § to 5.419 ‖.

199 G. III. Oxides.

GENUS III. OXIDES OF MERCURY.

SPECIES 1. Hepatic mercurial ore ¶.

This ore, which is the most common in the mines of Idria, is always amorphous, and is often mixed with native mercury and cinnabar.

Its colour is somewhat red. Its streak dark red and brighter. Lustre commonly metallic. Hardness from 6 to 8. Sp. gr. from 9.2301 * to 7.186 †. When heated the mercury evaporates.

Though this ore has never been accurately analysed, chemists have concluded that the mercury which it contains is in the state of a red oxide, because it is insoluble in nitric and soluble in muriatic acid ‡. When purest, it contains about .77 of mercury §. It contains also some sulphur and iron.

Werner has divided this species into two varieties, the *compact* and the *slaty*. The second is often nothing more than bituminous shale impregnated with oxide of mercury ‖.

Metallic Ores.

200 Mercurial Salts. Muriat of mercury.

GENUS IV. MERCURIAL SALTS.

SPECIES 1. Muriat of mercury *.

Corneous mercury.

This ore, which occurs in the Palatinate, is sometimes in scales, sometimes in grains, and sometimes crystallized. Its crystals are either small four or six sided prisms whose sides are rhombs †, or cubes, or four-sided pyramids wanting their angles. They are always very small and generally confused.

Its colours are various; but it is most frequently white. Its lustre, when white, is pearly. Sometimes opaque, and sometimes semitransparent. Evaporates before the blow-pipe.

Mr Woulfe discovered that this ore generally contains some sulphuric acid ‡. Specimens have been found in which the quantity of sulphuric acid exceeds that of the muriatic §.

ORDER V. COPPER ORES.

MANY of the most useful utensils are formed of copper: it enters largely into the composition of brass, bronze, and bell metal; not to mention the dyes and paints of which it is the basis.

201 Mines.

Copper mines abound in most countries. They are wrought in China, Japan, Sumatra; the north of Africa; in Chili and Mexico; and in most parts of Europe; especially Britain, Germany, Russia, Hungary.

Copper is found most commonly in rocks of hornblende, shistus, and quartz.

202 G. I. Alloys. Native copper.

GENUS I. ALLOYS OF COPPER.

SPECIES 1. Native copper ‖.

Native copper occurs now and then in the greater number of copper mines: Sometimes it is in masses, sometimes in plates and threads, which assume a variety of forms; and sometimes, as in Siberia, it is crystallized in cubes, or other forms nearly resembling cubes §.

Colour commonly that of copper, but sometimes dark brown. Lustre metallic. Streak brighter. Fracture hackly. Flexible and malleable. Hardness 6 to 7. Sp. gr. from 7.6 * to 8.5844 †.

SPECIES 2. White copper ore ‡.

Alloy of copper, iron, and arsenic.

This ore, which is said to be uncommon, occurs in masses. Colour white. Lustre metallic. Fracture uneven. Hardness 8 to 9. Brittle. Sp. gr. considerable.

Before the blow-pipe gives out a white arsenical smoke, and melts into a greyish black slag §.

204 G. II. Sulphurets. Copper. Common sulphuret of copper.

GENUS II. SULPHURETS OF COPPER.

SPECIES 1. Common sulphuret of copper ‖.

Vitreous copper ore.

This ore, which is found in Cornwall, Hungary, and Siberia, occurs in masses, plates, threads, and crystallized in six-sided prisms, or four-sided pyramids, joined base to base.

Colour bluish grey. Streak brighter grey. Lustre metallic. Hardness 4 to 7. Sp. gr. 5.452 ¶ to 5.565 *; sometimes so low as 4.129 †. Detonates with nitre.

Before the blow-pipe it melts easily; and while the fusion exhibits a green pearl, which, on cooling, is covered with a brown crust. Tinges borax green.

Werner makes two varieties of this ore: the first he calls

§ *Beiträge*, i. 183.

¶ *Romé de Lisle*, iii. 154.

* *Hauy, Jour. de Min.* N° xxxi. p. 518.
† *Brisson.*
‡ *Muschenbroek.*
§ *Brisson.*
‖ *Gellert.*

¶ *Kirwan*, ii. 224
* *Brisson.*
† *Kirwan.*

‡ *Sage, Jour. de Phys.* xxiv. 61.
§ *Scopoli, Jour. de Min.* N° xxxvi. p. 919.
‖ *Kirwan*, ii. 226.

* *Kirwan*, ii. 223.
† *Cronstedt's Min.*
‡ *Heyer, Crell's Annals*, 1790.

‡ *Phil. Trans.* lxvi. 618.
§ *Suckow.*

§ *Hauy, Jour. de Min.* N° xxxi. 509.

* *Kirwan, Min.* ii. 128.
† *Hauy, ibid.* p. 509.

‡ *Kir. Min.* ii. 152.
§ *Widenman.*

¶ *Kirwan*, ii. 144.
* *Gellert.*
† *Kirwan.*

* *Kirwan*, ii. 226.
† *Romé de Lisle*, iii. 161.

‖ *Kirwan*, ii. 127.—*Carthcuser.*

Copper Ores.

calls *compact*, from its fracture; and the second, for the same reason, he calls *foliated*. This last is somewhat darker coloured than the first, but in other respects they agree.

205 Copper pyrites. * *Kirwan*, ii. 140.

SPECIES 2. Copper pyrites *.
Yellow copper ore.

This ore, which is probably nothing else than sulphuret of iron combined with copper, and which, therefore, would be more properly placed among iron ores, is found frequently in copper mines, and mixed with common pyrites or sulphuret of iron. It is sometimes amorphous, and sometimes crystallized. Its crystals are either three or four sided pyramids applied base to base, or six-sided plates.

Its colour is yellow; often tarnished. Its internal lustre metallic. Hardness 6 to 7; sometimes 9. Brittle. Sp. gr. 4.314 † to 4.08 ‡. Deflagrates; but does not detonate with nitre §.

† *Brisson.* ‡ *Kirwan*, § *Id. Min.* ii. 141.

Before the blow-pipe decrepitates, gives a greenish sulphureous smoke, and melts into a black mass, which tinges borax green. Does not effervesce with nitric acid.

206 Purple copper ore. ‖ *Kirwan*, ii. 142.

SPECIES 3. Purple copper ore ‖.

This ore is found in masses, or plates, or disseminated; sometimes, also, it is crystallized in octahedrons. Colour various, but most commonly purple; internally reddish. Streak reddish and bright. Lustre metallic. Hardness 6 to 7. Brittle. Sp. gr. 4.956 to 4.983 ¶.

¶ *Ibid.* ii. 143.

Effervesces with nitric acid, and tinges it green. Deflagrates with nitre. Before the blow-pipe melts readily, without smoke, vapour, or smell; but is not reduced. Tinges borax a bright green.

A specimen of this ore, analysed by Klaproth, contained
58 copper,
18 iron,
19 sulphur,
5 oxygen.

100 †

† *Beiträge*, ii. 186.

207 Grey copper ore. ‡ *Kirwan*, ii. 146.

SPECIES 4. Grey copper ore ‡.

This ore is found in Cornwall, Saxony, Hungary, &c. It is often amorphous, but often also crystallized. The primitive form of its crystals is the regular tetrahedron; but, in general, either the angles or the edges, or both, are truncated or bevelled §.

§ *Romé de Lisle*, iii. 345.

Colour steel grey; often tarnished, and then dark grey. Streak dark grey; sometimes reddish brown. Powder blackish; sometimes with a tint of red. Lustre metallic. Hardness 7 or 8. Very brittle. Sp. gr. 4.8648 ‖. Deflagrates with nitre. Before the blow-pipe crackles, but at last melts, especially if assisted by borax. The bead gives a white smoke, without any particular smell; tinges borax yellow or brownish red, but does not unite with it.

‖ *Hauy. Jour. de Min.* N° xxxi. 512.

A specimen of this ore from Cremnitz, analysed by Klaproth, contained
31 copper,
14 silver,
34 antimony,
3 iron,
11 sulphur.
—
93

Napion, in an ore from the valley of Lanzo, found copper, silver, and antimony, nearly in the same proportions, but more iron, and some arsenic *. Savoresi, as Baron Born informs us, besides the ingredients of Klaproth's analysis, found some gold and mercury in grey copper ore †: and Klaproth himself found lead in most of the other specimens which he examined.

Metallic Ores.

* *Mem. Turin*, v. 173.

† *Catal.* ii. 498.

GENUS III. OXIDES OF COPPER.

208 G. III. Oxides. Red oxide of copper. ‡ *Kirwan*, ii. 135.

SPECIES 1. Red oxide of copper ‡.
Florid red copper ore—Red copper glass.

This ore is found in Cornwall, and many other countries. It occurs in masses, disseminated, in scales, and crystallized. The figure of its crystals is most commonly the octahedron §.

§ *Hauy, Jour. de Min.* N° xxxi. 517.

Colour commonly cochineal red. Streak brick red. Lustre semimetallic. Transparency, when amorphous, generally 0; when crystallized, 3 or 4. Hardness from 4 to 7. Soluble with effervescence in nitric acid. Before the blow-pipe melts easily, and is reduced.

This ore was supposed to be composed of carbonic acid and red oxide of copper; but a specimen, examined by Vauquelin, which consisted of pure crystals, contained no acid ‖. It must therefore be considered as an oxide of copper.

‖ *Ibid.*

Werner has made three varieties of this ore, which, from their texture, he has denominated *compact*, *foliated*, and *fibrous*. The first is seldom or never found crystallized, and is opaque; the second occurs amorphous, crystallized, and in scales; the third is carmine, ruby, or scarlet red; and occurs always in short capillary crystals, or delicate flakes.

This ore sometimes contains a mixture of red oxide of iron; it is then called *brick red copper ore*, *copper malm*, or *copper ochre*.

This ore is sometimes mixed with bitumen. Its colour is then brownish black, and it is called *pitch ore*.

209 Green oxide of copper. * *Kirwan*, ii. 149.

SPECIES 3. Green oxide of copper *.
Green sand of Peru.

This ore, which was brought from Peru by Dombey, is a grass green powder, mixed with grains of quartz. When thrown on burning coals, it communicates a green colour to the flame. It is soluble both in nitric and muriatic acids without effervescence. The solution is green. It was supposed to contain muriatic acid †; but Vauquelin has discovered that the appearance of this acid was owing to the presence of some common salt, which is accidently mixed with the sand ‡.

† *Berthollet, Mem. Par.* 1786, 462.

‡ *Jour. de Min.* N° xxxi. 519.

GENUS IV. SALTS OF COPPER.

210 G. IV. Salts. Blue carbonat of copper.

SPECIES 1. Blue carbonat of copper (D).
Mountain blue—Azure de cuivre—Blue calx of copper—Kupfer lazur.

This ore, which occurs in the copper mines of Siberia, Sweden, Germany, Hungary, Cornwal, &c. is either amorphous or crystallized. The crystals are small, and difficult to examine. According to Romé de Lisle, their primitive form is an octahedron, the sides of which are isosceles triangles, and two of them more inclined than the others §. Be that as it may, the crystals of blue carbonat of copper are often rhomboidal prisms, either regular, or terminated by dihedral summits ‖.

§ *Crystal.* iii. 343.

‖ *Ibid.* p. 345.

Its colour is azure or smalt blue. Streak blue. Hard-

(D) *Kirwn.* II. 129.—*Morveau, Mem. Dijon*, 1782. 1 *Semestre*, p. 100.

Copper Ores.

neſs 4 to 6. Brittle. Sp. gr. 3.608 ‡. It effervesces with nitric acid, and gives it a blue colour. Before the blow-pipe it blackens, but does not melt. Tinges borax green with effervescence.

‡ *Briſſon.*

The cryſtals, according to Pelletier, are compoſed of

66 to 70 copper,
18 — 20 carbonic acid,
8 — 10 oxygen,
2 — 2 water.

Fontana firſt diſcovered that this ore contained carbonic acid gas.

Variety 1. Earthy blue carbonat.

Mountain blue.

This variety generally contains a mixture of lime. It is never cryſtallized; and ſometimes is almoſt in the ſtate of powder. Luſtre 0. Texture earthy.

Variety 2. Striated blue carbonat of copper.

Luſtre glaſſy. Tranſparency, when cryſtallized, 2; when amorphous, 1. Texture ſtriated; ſometimes approaching to the foliated.

211 Green carbonat of copper.

SPECIES 2. Green carbonat of copper (E).

Oxygenated carbonat of copper—Malachite.

This ore is generally amorphous, but ſometimes it is cryſtallized in four-ſided priſms, terminated by four-ſided pyramids.

Colour green. Luſtre ſilky. Hardneſs 5 to 7. Brittle. Sp. gr. 3.571 * to 3.653 ‡. Effervesces with nitric acid, and gives a blue colour to ammonia. Before the blow-pipe it decrepitates and blackens, but does not melt. Tinges borax yellowiſh green. It is compoſed of carbonic acid and green oxide of iron.

* *Briſſon.* ‡ *Kirwan.*

Variety 1. Fibrous malachite.

Texture fibrous. Opaque when amorphous; when cryſtallized its tranſparency is 2. Colour generally graſs green.

Variety 2. Compact malachite.

Texture compact. Opaque. Colour varies from the dark emerald green to blackiſh green.

A ſpecimen of malachite from Siberia, analyſed by Klaproth, contained

58.0 copper,
18.0 carbonic acid,
12.5 oxygen,
11.5 water.

100 *

* *Beiträge*, ii. 290.

This ſpecies is ſometimes mixed with clay, chalk, and gypſum, in various proportions; it is then known by the name of

Common mountain green.

Its colour is verdigris green. Luſtre 0. Tranſparency 0 to 1. Hardneſs 3 to 4. Brittle. Texture earthy. Effervesces feebly with acids. Before the blow-pipe it exhibits the ſame phenomena with malachite.

212 Sulphat of copper.

SPECIES 3. Sulphat of copper.

For a deſcription of this ſalt, ſee CHEMISTRY, n° 648. in this *Supplement*.

213 Arſeniat of copper.

SPECIES 4. Arſeniat of copper ‡.

Olive copper ore.

‡ *Kirwan*, ii. 151.

This ore is found at Cararach in Cornwal. It is generally cryſtallized in ſix-ſided compreſſed priſms. Its colour is olive green. Streak ſometimes ſtraw coloured, ſometimes olive green. Luſtre glaſſy. Tranſparency from 4 to 2. Fracture conchoidal. Hardneſs 4 to 7. Before the blow-pipe deflagrates with an arſenical ſmoke, and melts into a grey coloured bead. This bead, fuſed with borax, leaves a button of pure copper ‖.

Metallic Ores.

‖ *Klaproth's Obſervations on Cornwal*, p. 29.

Klaproth diſcovered that it was compoſed of oxide of copper and arſenic acid.

Sometimes this ore is combined with iron. It then cryſtallizes in cubes. Theſe cubes are of a dark green colour; before the blow-pipe they frothe, give out an arſenical ſmoke, and do not ſo quickly form a grey bead as the arſeniat of copper *.

* *Ibid.* p. 29.

ORDER VI. IRON ORES.

To deſcribe the uſes of iron, would be to write the hiſtory of every art and manufacture, ſince there is not one which is not more or leſs dependent upon this uſeful metal. Nor is its abundance inferior to its utility. It exiſts almoſt everywhere, and ſeems, as it were, the bond which connects the mineral kingdom together.

214. Mines.

GENUS I. ALLOYS OF IRON.

215 G. I. Alloys.

SPECIES 1. Native iron (F).

Native iron.

Native iron has been found in Siberia and in Peru in immenſe maſſes, which ſeemed as if they had been fuſed. Theſe maſſes evidently did not originate in the place where they were found. See *FIRE-balls, Suppl.*

Colour bluiſh white. Fracture hackly. Luſtre metallic. Malleable. Magnetic. Hardneſs 8 to 9. Sp. gr. 7.8. Prouſt has diſcovered, that the native iron found in Peru is alloyed with nickel ¶.

¶ *Nicholſon's Jour.* iii. 374.

GENUS II. SULPHURETS OF IRON.

SPECIES 1. Common ſulphuret of iron *.

Pyrites.

216. G. III. Sulphurets. Common ſulphuret of iron.

This mineral occurs very frequently both in ores and mixed with other bodies, for inſtance in ſlates. It is often amorphous, and often alſo cryſtallized. The primitive form of its cryſtals is either a regular cube or an octohedron. The varieties of its form hitherto deſcribed amount to 30; for a deſcription of which we refer the reader to *Romé de Liſle* †.

* *Kirwan*, ii. 76.—*Henkel's Pyritologia.*

† *Cryſtal.* iii. 208.

Its colour is yellow. Its luſtre metallic. Hardneſs 8 to 10. Brittle. Sp. gr. 3.44 to 4.6. Soluble in nitric acid with effervescence. Scarce ſoluble in ſulphuric acid. Before the blow-pipe burns with a blue flame and a ſulphureous ſmell, and leaves a browniſh bead, which tinges borax of a ſmutty green.

Variety 1. Common pyrites.

Fracture uneven. Hardneſs 10. Decrepitates when heated. Emits a ſulphureous ſmell when rubbed. Not magnetic. It occurs often in coal mines and in ſlates.

Variety 2. Striated Pyrites.

Texture ſtriated. Hardneſs 10. Not magnetic.

Variety 3. Capillary.

Colour often ſteel grey. Found in needle-form cryſtals. Uncommon. Not magnetic.

Variety 4. Magnetic pyrites.

Found in maſſes. Texture compact. Hardneſs 8, 9. Slightly magnetic. Seems to contain leſs ſulphur than the other varieties.

In pyrites the proportion of the ſulphur to the iron is variable; and this explains the variety of its cryſtalline forms.

GENUS

(E) *Kirw.* II. 131.—*Fontana, Jour. de Phyſ.* XI. 509.—*Klaproth, Beiträge*, II. 287.

(F) *Pallas, Phil. Tranſ.* LXVI. 523.—*Rubin de Celis, ibid.* LXVIII. 37.—See alſo *Schreiber, Jour. de Phiſ.* XLI. 3.; and *Stelin, Phil. Tranſ.* LXIV. 461.

Iron Ores.

Metallic Ores.

Genus III. Carburet of iron.

Species 1. Plumbago *.

Graphite of Werner.

217 G. III. Plumbago.

This mineral is found in England, Germany, France, Spain, America, &c. It occurs in kidney-form lumps of various sizes. Its colour is dark iron grey or brownish black; when cut, bluish grey. Lustre metallic, from 3 to 4. Opaque. Structure slaty. Texture fine grained. Hardness 4 to 5. Brittle. Sp. gr. from 1.987 to 2.089; after being soaked in water 2.15; after being heated 2.3, and when heated after that 2.41 †. Feels somewhat greasy. Stains the fingers, and marks strongly. The use of this mineral when manufactured into pencils is known to every person.

* *Kirwan*, ii. 58.

† *Brisson.*

Its composition was discovered by Scheele. When pure it contains

90 carbon,
10 iron.

100

But it is often exceedingly impure: A specimen, for instance, from the mine of Pluffier, in France, analysed by Vauquelin, contained 23 carbon,

2 iron,
38 silica,
37 alumina.

100 ‡

‡ *Jour. de Min.* N° xii. p. 16.

Genus IV. Iron combined with silica.

Species 1. Emery *.

218. G. IV. Emery.

This mineral is commonly disseminated through other fossils, but sometimes in the East Indies it occurs in large masses.

* *Kirwan*, ii. 193.

Its colour is bluish grey, greyish brown, or bluish black, often covered with a yellowish rind; internally it discovers red or purple spots. Lustre 1 or 0; in some parts 2, and metallic. Opaque. Hardness 14. Brittle. Sp. gr. 3.92 †. Before the blow-pipe it blackens and gives a smutty yellow tinge to borax.

† *Brisson.*

According to Wiegleb it contains

95.6 silica,
4.3 iron.

99.9

Genus V. Oxides of iron.

219 G. V. Oxides.

This genus is very extensive; for iron is much more frequently found in the state of an oxide than in any other.

Species 1. Black oxide of iron ‡.

220 Black oxide of iron.

Common magnetic iron stone—Blackish octohedral iron ore.

‡ *Kirwan*, ii. 158.

This species of ore is very common in Sweden; it is found also in Switzerland, Norway, Russia, &c. It occurs in masses, plates, grains, and crystallized. The primitive form of its crystals is a regular octohedron †. Sometimes two opposite sides of the pyramids are trapeziums, which renders the apex of the pyramids cuneiform. Sometimes the crystals pass into rhomboidal parallelopipeds, and into dodecahedrons with rhomboidal faces §.

† *Rome de Lisle*, iii. 178.

§ *Ibid.*

* *Hauy*, *Jour. de Min.* N° xxxiii. 659.

† *Kirwan's Min.* ii. 159.

‡ *Hauy*, *Jour. de Min.* N° xxxi. 527.

Its surface is brownish black; internally bluish grey. Powder black *. Streak blackish grey, brighter. Lustre metallic. Hardness 9 to 10. Brittle. Sp. gr. from 4.094 to 4.688 †. Attracted by the magnet, and generally possessed of more or less magnetic virtue ‡. To this species belongs the magnet. Before the blow-pipe it becomes browner, but does not melt. Tinges borax dark green.

When pure it consists entirely of oxide of iron; and this oxide appears to contain from .15 to .24 oxygen, and from .76 to .85 iron §. Undoubtedly it consists of a mixture of iron in two different states of oxidation. It is often also mixed and contaminated with foreign ingredients.

§ *Kirwan. Min.* ii. 159.

There are two varieties of this ore. The first is what we have just described; the second is in the form of sand, and has therefore been called

Magnetic sand *.

* *Kirwan*, ii.—*Dupuget, Jour. de Min.* N° xxi. p. 75.

This substance is found in Italy, Virginia, St. Domingo, the East Indies, and in the sand of the river Don at Aberdeen in Scotland. It is black, very hard, magnetic. Sp. gr. about 4.6 Not altered by the blow-pipe *per se*; melts into a black glass with potass, and into a green glass with microcosmic salt, both opaque †. It probably contains some silica, as Kirwan has supposed ‡.

† *Fourcroy*, *Ann. de Chim.* ii. 127.

‡ *Min.* ii. 161.

Species 2. Specular iron ore ¶.

Fer oligiste.

221 Specular iron ore.

This ore is found abundantly in the isle of Elba near Tuscany. It is either in masses or crystallized. The primitive form of its crystals, and of its integrant molecules, is the cube *. The varieties hitherto observed amount to 7. These are the rhomboidal parallelopiped; the cube, with three triangular faces instead of two of its angles diagonally opposite; two six-sided pyramids, applied base to base, wanting the summits ‡, and sometimes the angles at the bases, and sometimes the alternate edges of the pyramid; a polyhedron of 24 sides, resembling a cube with three triangular faces for two angles diagonally opposite, and two triangles for the rest of its angles. For a description and figure of these varieties, we refer to *Romé de Lisle* † and *Hauy* ‡.

¶ *Kirw.* ii. 162.—*Coudrai, Jour. de Phys.* iv. 52.

* *Hauy*, *Jour. de Min.* N° xxxiii. 660.

‡ *Fig.* 39.

† *Cryst.* iii. 189.

‡ *Ibid.* 660.

Colour steel grey; often tarnished, and beautifully iridescent, reflecting yellow, blue, red. Streak red. Powder dark red. Lustre metallic. Hardness 9 to 10. Not brittle. Sp. gr. 5.0116† to 5.218‡. Slightly magnetic. Little altered by the blow-pipe. Tinges borax an obscure yellow.

† *Hauy*, ‡ *Brisson.*

This ore, according to Mr Mushet, is composed of

66.1 iron,
21.2 oxygen,
10.7 water and carbonic acid,
2.0 lime.

100.0 †

† *Philos. Mag.* iii. 354.

The quantity of oxygen here stated is probably too small, owing to the unavoidable inaccuracy which results from the *dry way* of analysis which Mr Mushet followed.

Micaceous iron ore

Is generally considered as a variety of this species. Kirwan, however, supposes it to contain carbon, and to be a distinct species.

It is found in Saxony, and in the isle of Elba, &c. generally in amorphous masses, composed of thin six-sided laminæ. Colour iron grey. Streak bluish grey. Lustre metallic. Opaque. Feels greesy. Hardness 5 to 7. Brittle. Sp. gr. from 4.5 to 5.07. Slightly magnetic.

Iron Ores. magnetic. Infusible by the blow-pipe. Tinges borax greenish brown.

Metallic Ores.

222 Laminated specular iron ore.

SPECIES 3. Laminated specular iron ore.

Fer pyroceti of Hauy.

This ore, which is found at Montd'or in Auvergn, was usually arranged under the last species; but has been separated from it, we think properly, by Mr Hauy, because the form of its crystals is incompatible with the supposition that their primitive nucleus is a cube, as we have seen is the case with common specular iron ore. Its crystals are thin octagonal plates, bounded by six linear trapeziums, alternately inclined different ways *.

* *De Lisle*, iii. 188.

Colour steel grey. Powder reddish black. Lustre metallic; surface polished. Fracture glassy. Very brittle †. Hauy supposes that this ore has been produced by fire, and accordingly has given it a name which denotes its origin.

† *Hauy, Jour. de Min.* N° xxxi. 33.

223 Brown iron ore.

SPECIES 4. Brown iron ore ‡.

‡ *Kirw.* ii. 163.

This species of ore is found abundantly in Britain, particularly in Cumberland and Lancashire; and it is also very common in other counties. It consists of the brown oxide of iron, more or less contaminated with other ingredients.

Its colour is brown. Its streak reddish brown. Sp. gr. from 3.4771 to 3.951. Before the blow-pipe blackens, but does not melt. Tinges borax greenish yellow.

Variety 1. Brown hæmatites.

The name hæmatites (bloodstone) was probably applied by the ancients only to those ores which are of a red colour, and have some resemblance to clotted blood; but by the moderns it is applied to all the ores of iron which give a reddish coloured powder, provided they be of a fibrous texture.

Brown hæmatites occurs in masses of various shapes, and it is said also to have been found crystallized in five or six sided acute angled pyramids. Colour of the surface brown or black, sometimes irridescent; internally nut brown. Powder red. Texture fibrous. Hardness 8 to 10. Brittle. Sp. gr. 3.789 § to 3.951 ‖. Not magnetic.

§ *Gellert.*
‖ *Kirwan.*

This variety has not been analysed, but it seems to consist of brown oxide of iron, oxide of manganese, and alumina ¶.

¶ *Kirwan's Min.* ii. 164.

Variety 2. Compact brown iron stone.

This variety occurs in masses of very various and often fantastical shapes.

Colour brown. Internal lustre metallic. Texture compact. Hardness 6 to 9. Brittle. Sp. gr. 3.4771 * to 3.551 †.

* *Brisson.*
† *Kirwan.*

Variety 3. Brown scaly iron ore.

This variety is generally incumbent on other minerals. Colour brown. Lustre metallic. Stains the fingers, marks strongly. Feels unctuous. Texture foliated. Hardness 3 to 5. Brittle. So light as often to float on water.

Variety 4. Brown iron ochre.

This variety occurs both massive and disseminated. Colour from nut brown to orange. Lustre 0. Strongly stains the fingers. Texture earthy. Hardness 3 to 4. When slightly heated reddens.

224 Red iron ore.

SPECIES 5. Red iron ore ‡.

‡ *Kirw.* ii. 168.

Colour red. Streak blood red. Sp. gr. from 3.423 to 5.005. Before the blow-pipe blackens, but does not melt. Tinges borax yellowish olive green. When digested in ammonia, it becomes black and often magnetic.

Variety 1. Red hæmatites.

Found in masses, and all the variety of forms of stalactites. Colour between brownish red and steel grey. Powder red. Internal lustre metallic. Texture fibrous. Hardness 9 to 10. Brittle. Sp. gr. 4.74 * to 5.005 †.

* *Gellert.*
† *Kirwan.*

When pure it consists of red oxide of iron, but it often contains manganese and alumina ‡.

‡ *Kirwan's Min.* ii. 169.

Variety 2. Compact red iron ore.

Found massive and stalactitic; sometimes in crystals of various forms, but they seem to be only secondary; sometimes in columns like basalt.

Colour between brown red and steel grey. Stains the fingers. Lustre 1 to 0; often semimetallic. Texture compact. Hardness 7 to 9. Brittle. Sp. gr. 3.423 to 3.76 §. Sometimes invested with a rosy red ochre.

§ *Kirwan.*

Variety 3. Red ochre.

Found sometimes in powder, sometimes indurated. Colour blood red. Stains the fingers. Lustre 0. Texture earthy. Hardness 3 to 5. Brittle.

Variety 4. Red scaly iron ore.

This variety is generally found incumbent upon other iron ores. Colour between cherry red and steel grey. Stains the fingers. Lustre silky, inclining to metallic. Texture foliated. Feels unctuous. Hardness 3 to 4. Brittle. Heavy.

225 Argillaceous iron ore.

SPECIES 6. Argillaceous iron ore ‖.

Oxid of iron combined or mixed with clay.

‖ *Kirw.* ii. 173.

This ore is exceedingly common; and though it contains less iron than the species already described, it is, in this country at least, preferred to them, because the method of extracting pure iron from it is easier, or rather because it is better understood.

Colour most commonly dark brown. Streak red or yellowish brown. Sp. gr. from 2.673 to 3.471 *. Before the blow-pipe blackens, and tinges borax olive green and blackish. It is composed of oxide of iron, alumina, lime, silica in various proportions. It generally yields from 30 to 40 *per cent.* of iron.

* *Kirwan.*

Variety 1. Common argillaceous iron ore.

The minerals arranged under this variety differ considerably from each other in their external characters. They are found in masses of various shapes, and often form large strata.

Colour various shades of grey, brown, yellow, and red. Streak reddish yellow or dark red. Lustre 0. Hardness from 3 to 8. Smell earthy when breathed upon.

Variety 2. Columnar or scapiform iron ore.

This variety is found in columns, adhering to each other, but easily separable: They are commonly incurvated, and their surface is rough. Colour brownish red. Streak dark red. Slightly stains the fingers. Lustre 0. Adheres strongly to the tongue. Sound hollow. Feel dry. Texture earthy.

Variety 3. Acinose iron ore.

This variety is found in masses, and is commonly lenticular. Colour generally brownish red. Lustre metallic, nearly. Texture granular. Hardness 5 to 9. Brittle.

Variety

Iron Ores.

Variety 4. Nodular, or kidney-form iron ore.
Ætites or *Eagleſtone.*

This variety, which was mentioned by the ancients, is generally found under the form of a rounded knob, more or leſs reſembling a kidney, though ſometimes it is quadrangular; and it contains within it a kernel, which is ſometimes looſe, and ſometimes adheres to the outſide rind. Colour of the ſtone yelloviſh brown; of the kernel ochre yellow. Surface generally fouled with earth. Luſtre of the rind metallic; of the kernel 0. Hardneſs from 4 to 7. Brittle.

Variety 5. Piſiform or granular iron ore.

This variety occurs in rounded maſſes, from the ſize of a pea to that of a nut. Surface rough. Colour commonly dark brown. Streak yelloviſh brown. Hardneſs 5 to 6. Brittle.

The oolitic ore found at Creuſot, near mount Cenis, belongs to this variety. It is compoſed of

50 lime,
30 iron,
20 alumina.

100

226 Lowland iron ore. * *Kirw.* ii. 179.

SPECIES 7. Lowland iron ore *.

This ſpecies of ore is ſuppoſed to conſiſt of oxide of iron, mixed with clay and phoſphuret or phoſphat of iron. It is called lowland ore, becauſe it is found only in low grounds; whereas the laſt ſpecies is more commonly in high grounds; and is therefore cally *highland ore.*

This ore occurs in amorphous maſſes, and alſo in grains or powder. Its colour is brown. Streak yelloviſh brown. Luſtre 0, or common. Texture earthy. Hardneſs 3 to 5.

Variety 1. Meadow lowland ore.

Colour blackiſh or yelloviſh brown: Both colours often meet in the ſame ſpecimen. Found in lumps of various ſizes, often perforated. Fracture compact. Moderately heavy.

Frequently yields from 32 to 38 *per cent.* of iron.

Variety 2. Swampy iron ore.

This variety is generally found under water. It is in lumps, which are commonly perforated or corroded, and mixed with ſand. Colour dark yelloviſh brown, or dark nut brown. Hardneſs 3 to 4. Brittle. Sp. gr. 2.944. It often contains .36 of iron.

Variety 3. Moraſſy iron ore.

This variety is found either in a looſe form or in perforated lumps. Colour light yelloviſh brown. Stains the fingers. Hardneſs 3. Friable.

227 G. VI. Salts. Sparry iron ore.

GENUS VI. SALTS OF IRON.

SPECIES 1. Sparry iron ore (G).

This ore is common in Germany, France, and Spain. It is found ſometimes in amorphous maſſes, and ſometimes cryſtallized.

Metallic Ores.

Its colour is white; but it becomes tarniſhed by expoſure to the air, and then aſſumes various colours. Streak grey or white. External luſtre often metallic; internal common or glaſſy. Tranſparency 1 or 2; ſometimes 0. Texture foliated. Fragments rhomboidal. Hardneſs 5 to 7. Brittle. Sp. gr. 3.6 to 3.810. Not magnetic. Soluble in acids with very little effervescence. Before the blow-pipe decrepitates, becomes browniſh black, and magnetic; but is ſcarcely fuſible. Tinges borax ſmutty yellow, with ſome effervescence.

This ore, as Bergman aſcertained, conſiſts of iron, manganeſe, lime, and carbonic acid.

One ſpecimen, according to his analyſis, contained

38 iron,
24 manganeſe,
38 carbonat of lime.

100

Another contained 22 iron,
28 manganeſe,
50 carbonat of lime.

100

Whether the iron be combined with the carbonic acid is ſtill a diſputed point. The cryſtals of this ore are rhomboidal parallelopipeds; which is preciſely the form of carbonat of lime. This amounts nearly to a demonſtration, that the carbonic acid is combined with the lime; and that, as Cronſtedt and Hauy have ſuppoſed, this ore is merely carbonat of lime, contaminated with a quantity of the oxids of iron and manganeſe.

228 Arſeniat of iron.

SPECIES 2. Arſeniat of iron.

Mr Prouſt has diſcovered this ore in Spain. Its colour is greeniſh white. Its texture granular. Inſoluble in water and nitric acid. When melted on charcoal, the arſenical acid eſcapes with effervescence *.

* *Ann. de Chim.* i. 195.

229 Sulphat of iron.

SPECIES 3. Sulphat of iron.

For a deſcription of this ſalt, ſee CHEMISTRY, n° 631. in this *Suppl.*

ORDER VII. TIN ORES (H).

TIN is employed to cover plates of iron and copper, and to ſilver the backs of looking glaſſes: It enters into the compoſition of pewter; and forms a very important article in dyeing.

230 Mines.

Tin ores are by no means ſo common as the ores of the metals which we have already deſcribed. They are found only in the *primitive mountains* (1). Hence Werner ſuppoſes them to be the moſt ancient of all metallic ores. They occur moſt frequently in granite, ſometimes in porphyry, but never in limeſtone.

Almoſt

(G) *Kirw.* II. 190.—*Bergman*, II. 184.—*Bayen. Jour. de Phyſ.* VII. 213.— *Razowmowſki, Mem. Lauſanne*, 1783, p. 149.

(H) *Geoffroy, Mem. Par.* 1738, p. 103. —*Morveau, Ann. de Chim.* XXIV. 127.

(1) Geologiſts have divided mountains into three claſſes; *primitive, ſecondary*, and *tertiary*. The *primitive* occupy the centre of all extenſive chains; they are the higheſt, the moſt rugged, and exhibit the moſt pointed tops. They are conſidered as the moſt ancient mountains of the globe.

The *ſecondary* mountains occupy the outſide of extenſive ranges. They are uſually compoſed of ſtrata, more or leſs inclined, and commonly reſt againſt the ſides of the primitive mountains.—The *tertiary* mountains are much ſmaller than the others, and are often ſolitary. We uſe the terms *primitive, ſecondary*, &c. merely as proper

Tin Ores.

Almoſt the only tin mines known to Europeans are thoſe of Cornwal, Devonſhire, Saxony, Bohemia, Sileſia, Hungary, Gallicia; thoſe of the iſland of Banca and the peninſula of Malacca in India; and thoſe of Chili and Mexico and America.

231 G. I. Sulphurets. Sulphuret of tin and copper * *Kirw.* ii. 200.

GENUS I. SULPHURETS OF TIN.

SPECIES 1. Sulphuret of tin and copper *.

Tin pyrites.

Hitherto this ore has only been found in Cornwal. There is a vein of it in that county, in the pariſh of St Agnes, nine feet wide, and twenty yards beneath the ſurface †.

† *Klaproth's Cornwal*, p. 21.

‡ *Klaproth.*

Its colour is yellowiſh grey, paſſing into the ſteel grey. Not unlike grey copper ore. Luſtre metallic. Hardneſs 5 to 6. Very brittle. Sp. gr. 4.35 ‡. Before the blow-pipe it melts eaſily, with a ſulphureous ſmell, into a black bead, and depoſits a bluiſh oxide on the charcoal.

The compoſition of this ore, as Klaproth informs us, was firſt diſcovered by Mr Raſpe. According to Klaproth's analyſis, it is compoſed of

34 tin,
36 copper,
25 ſulphur,
3 iron,
2 earth.

100 §

§ *Id.* 58.

232 G. II. Oxides. Brown oxide of tin * *Kirw.* ii. 197.

GENUS II. OXIDES OF TIN.

SPECIES 1. Brown oxide of tin *.

Tinſtone—Woodtin.

This ore, which may be conſidered as almoſt the only ore of tin, occurs in maſſes, in rounded pieces, and cryſtallized. Theſe cryſtals are very irregular. Hauy ſuppoſes, that their primitive form is a cube †; but Romé de Liſle, with more probability, makes it an octohedron ‡; and in this opinion Mr Day agrees with him ||. The octohedron is compoſed of two four-ſided pyramids, applied baſe to baſe. The ſides of the pyramids are iſoſceles triangles, the angle at the vertex of which is 70°, and each of the other angles 55°. The ſides of the two pyramids are inclined to each other at an angle of 90° §. The primitive form, however, never occurs, but cryſtals of tinſtone are ſometimes found, in which the two pyramids are ſeparated by a priſm. For a complete deſcription of the varieties of the cryſtals of tinſtone, we refer the reader to *Romé de Liſle* and *Mr Day* *.

† *Jour. de Min.* N° xxxii. 576.

‡ *Cryſtallog.* iii. 413.

|| *Philoſ. Mag.* iv. 152.

§ *Romé de Liſle, ibid.*

Metalic Ores.

* *Philoſ. Mag. ibid.*

Its colour is commonly brown. Streak grey. Hardneſs 9 to 10. Sp. gr. 6.9 to 7.0. Brittle.

Variety 1. Common tinſtone.

Colour dark brown; ſometims yellowiſh grey, and ſometimes nearly white. Streak light grey. Somewhat tranſparent when cryſtallized. Hardneſs 10. Sp. gr. 6.9 to 6.97. Before the blow-pipe it decrepitates, and on charcoal is partly reduced. Tinges borax white.

According to Klaproth, it is compoſed of

77.50 tin,
21.50 oxygen,
.25 iron,
.75 ſilica.

100.00 †

† *Beiträge*, ii. 256.

Variety 2. Woodtin.

This variety has hitherto been found only in Cornwal. It occurs always in fragments, which are generally rounded. Colour brown; ſometimes inclining to yellow. Streak yellowiſh grey. Opaque. Texture fibrous. Hardneſs 9. Sp. gr. 7.0. Before the blow-pipe becomes browniſh red; decrepitates when red hot, but is not reduced.

Klaproth obtained from it .63 of tin; and, in all probability, it is an oxide of tin nearly pure.

ORDER VIII. ORES OF LEAD.

The uſeful purpoſes to which lead in its metallic ſtate is applied, are too well known to require deſcription. Its oxides are employed in painting, in dyeing, and ſometimes alſo in medicine.

Ores of lead occur in great abundance in almoſt every part of the world. They are generally in veins; ſometimes in ſiliceous rocks, ſometimes in calcareous rocks.

233 G. I. Sulphurets. Galena, or pure ſulphuret of lead. ‡ *Kirw.* ii. 216. || *Romé de Liſle*, iii. 364.

GENUS I. SULPHURETS OF LEAD.

SPECIES 1. Galena, or pure ſulphuret of lead ‡.

This ore, which is very common, is found both in maſſes and cryſtallized. The primitive form of its cryſtals is a cube. The moſt common varieties are the cube, ſometimes with its angles wanting, and the octohedron, compoſed of two four-ſided pyramids applied baſe to baſe: The ſummits of theſe pyramids are ſometimes cuneiform, and ſometimes their ſolid angles are wanting ||.

Its colour is commonly bluiſh grey, like lead. Streak bluiſh grey and metallic. Luſtre metallic. Sometimes ſtains

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proper names, without affirming or denying the truth or falſehood of the theory on which theſe names are founded. That the reader may have a more accurate idea of the compoſition of theſe different claſſes of mountains, we have ſubjoined a liſt of the ſubſtances which, according to Werner, enter into the compoſition of each.

I. PRIMARY MOUNTAINS.

1. Granite,
2. Gneiſs,
3. Micaceous ſhiſtus,
4. Argillaceous ſhiſtus,
5. Syenite,
6. Porphyry,
7. Shiſtoſe porphyry,
8. Quartz,
9. Primitive limeſtone,
10. Serpentine,
11. Topaz rock.

II. SECONDARY MOUNTAINS.

1. Argillaceous ſhiſtus,
2. Rubble ſtone,
3. Secondary limeſtone,
4. Shiſtoſe hornblende,
5. Grunſtein,
6. Amygdaloid.

III. TERTIARY MOUNTAINS.

1. Trap,
2. Argillaceous ſhiſtus,
3. Stratified limeſtone,
4. Sandſtone,
5. Breccia,
6. Coal,
7. Chalk,
8. Sulphat of lime,
9. Rock ſalt,
10. Ferruginous clay,
11. Potters earth.

Ores of Lead.

§ *Watſon.*

ſtains the fingers. Texture foliated. Fragments cubical. Hardneſs 5 to 7; ſometimes even 9. Brittle. Sp. gr. 6.884 to 7.786 §. Effervesces with nitric and muriatic acids. Before the blow-pipe decrepitates, and melts with a ſulphureous ſmell; part ſinks into the charcoal.

It is compoſed of from .45 to .83 lead, and from .086 to .16 of ſulphur. It generally contains ſome ſilver, and ſometimes alſo antimony and zinc.

Variety 1. Common galena.

This variety corresponds nearly with the above deſcription. Sp. gr. 7.051 to 7.786. Sometimes ſtains the fingers.

Compact galena.

Found only in amorphous maſſes. Texture compact, inclining to foliated. Hardneſs 6 to 8. Sp. gr. 6.886 to 7.444. Luſtre common. Streak lead grey, brighter and metallic. Often feels greaſy, and ſtains the fingers.

234 Sulphuret of lead, with ſilver and antimony. * *Kirw.* ii. 219.

SPECIES 2. Sulphuret of lead, with ſilver and antimony*.

Plumbiferous antimoniated ſilver ore.

Found in amorphous maſſes. Colour grey. Hardneſs 5 to 6. Brittle. Sp. gr. from 5.2 to 8.

Variety 1. Light grey ſilver ore.

Colour light bluiſh grey. Streak light bluiſh grey, and brighter. Luſtre metallic. Texture compact. Before the blow-pipe partly evaporates, and leaves a ſilver bead on the charcoal, ſurrounded by yellow duſt.

According to Klaproth, it contains

48.06 lead,
20.40 ſilver,
7.88 antimony,
12.35 ſulphur,
2.25 iron,
7.00 alumina,
.25 ſilica.

98.09 †

† *Beiträge*, ii. 172.

Variety 2. Dark grey ſilver ore.

Colour iron grey, verging on black. Powder black, and ſtains the fingers. Luſtre 0, Texture earthy.

According to Klaproth, it contains

41.00 lead,
21.50 antimony,
29.25 ſilver,
22.00 ſulphur,
1.75 iron,
1.00 alumina,
.75 ſilica.

97.25 ‡

‡ *Ibid.* 175.

235 Blue lead ore. * *Kirw.* ii. 220.

SPECIES 3. Blue lead ore *.

This ore, which is found in Siberia, Germany, and Hungary, and is very rare, occurs ſometimes in maſſes, and ſometimes cryſtallized in ſix-ſided priſms.

Colour between indigo blue and lead grey; ſometimes inclining to black. Internal luſtre metallic. Streak brighter. Texture compact. Hardneſs 6. Sp. gr. 5.461 †. Before the blow-pipe melts with a low blue flame and a ſulphureous ſmell, and is eaſily reduced.

† *Gellert.*

236 Black lead ore. ‡ *Kirw.* 221.

SPECIES 4. Black lead ore ‡.

This ore, which is found in Germany and Brittanny, and which is ſuppoſed to be common galena decayed, is ſometimes in ſtalactites of various forms, and ſometimes cryſtallized in ſix-ſided priſms, which are generally truncated and confuſed.

Metallic Ores.

Colour black, often with ſome ſtreaks of red. Streak light bluiſh grey. Internal luſtre metallic. Hardneſs 5 to 6. Brittle. Sp. gr. from 5.744 ‖ to 5.77*. Before the blow-pipe decrepitates, melts eaſily, and is reduced.

‖ *Briſſon.* * *Gellert.*

According to the experiments of Laumont, this ore is a ſulphuret of lead (or rather ſulphuret of oxide of lead), mixed with ſome phoſphat of lead.

237 Sulphuret of lead, biſmuth, and ſilver.

SPECIES 5. Sulphuret of lead, biſmuth, and ſilver.

This ore, which occurs in the valley of Schapbach in Saxony, was firſt taken notice of by Selb, and afterwards deſcribed by Weidenmann and Emerling.

Its colour is light bluiſh grey. Its luſtre metallic Its fracture uneven. Hardneſs 5. Melts eaſily before the blow-pipe, emitting ſome ſmoke, and leaves a ſilver bead.

A ſpecimen, analyſed by Mr Klaproth, contained

33.0 lead,
27.0 biſmuth,
15.0 ſilver,
16.3 ſulphur,
4.3 iron,
0.9 copper.

96.5 †

† *Beiträge*, ii. 297.

GENUS II. OXIDES OF LEAD.

238 G. II. Oxides. Lead ochre. ‡ *Kirw.* ii. 205.

SPECIES 1. Lead ochre ‡.

This ore, which is a mixture of the oxide of lead with various earths, is found maſſive, and various degrees of hardneſs.

Its colour is either yellow, grey, or red. Luſtre 0. Tranſparency 0 to 1. Hardneſs 6 to 8; ſometimes in powder. Sp. gr. from 4.165 to 5.545 §. Texture compact. Effervesces with nitric and muriatic acids. Eaſily reduced by the blow-pipe, leaving a black ſlag, unleſs the lead be mixed with too great a proportion of earth.

§ *Kirwan.*

GENUS III. SALTS OF LEAD.

239 G. III. Salts. Carbonat of lead. ‡ *Kirw.* ii. 203.

SPECIES 1. Carbonat of lead ‡.

White lead ſpar.

This ore of lead, which is very common, is ſometimes in maſſes, and ſometimes cryſtallized. But the cryſtallization is in general ſo confuſed, that the primitive form of the cryſtals has not yet been aſcertained (K).

Its colour is white. External luſtre, waxy or ſilky, from 3 to 1; internal 1 to 2. Generally ſomewhat tranſparent. Hardneſs 5 to 6. Brittle. Sp. gr. from 5.349 ‖ to 6.92 §. Effervesces with nitric and muriatic acids when they are heated. Soluble in fat oils. Blackened by ſulphuret of ammonia *. Decrepitates when heated. Before the blow-pipe, in a ſilver ſpoon, it becomes red by the yellow cone of the flame, while the blue cone renders it yellow †. On charcoal it is immediately reduced.

‖ *Kirwan.* § *Gellert.* * *Pelletier, Ann. de Chim.* ix. 56. † *Ribbentropp, Ann. de Chim.* xxv. 189.

It contains from .60 to .85 of lead, and from .18 to .24 of carbonic acid. It is generally contaminated with carbonat of lime and oxide of iron.

(K) See *Hauy, Jour. de Min.* N° XXXI. 502. and *Romé de Liſle*, III. 380.

Ores of Lead.

SPECIES 2. Phosphat of lead *.

240 Phosphat of lead. * *Kirw.* ii. 207.

This ore, which is found in Siberia, Scotland, England, Germany, Carinthia, Brittany, &c. is sometimes amorphous, and sometimes crystallized. The primitive form of its crystals, according to Romé de Lisle, is a dodecahedron, consisting of a six-sided rectangular prism, terminated by six-sided pyramids, the sides of which are isosceles triangles (L). Sometimes the pyramids are truncated, and even altogether wanting. The crystals of this ore are often acicular.

Its colour is commonly green; sometimes yellowish or brownish, or greyish white. Streak commonly greenish white. Powder yellowish. External lustre, waxy, 2 to 3. Somewhat transparent, except when its colour is greyish white. Hardness 5 to 6. Brittle. Sp. gr. from 5.86* to 6.27†. Insoluble in water and sulphuric acid, and nearly insoluble in nitric acid; soluble in hot muriatic acid, with a slight effervescence ‡. Before the blow-pipe it easily melts on charcoal, and crystallizes on cooling: with soda the lead is in some measure reduced.

* *Brisson.* † *Klaproth.* ‡ *Fourcroy, Ann. de Chim.* ii. 207.

The composition of this ore was first discovered by Gahn.

According to Fourcroy's analysis, a specimen from Erlenbach in Alsace consists of

96 phosphat of lead,
2 phosphat of iron,
2 water.

100

Or it contains 79 oxide of lead,
1 oxide of iron,
18 phosphoric acid,
2 water.

100¶

¶ *Ibid.*

241 Arseniat of lead. § *Kirw.* ii. 209.

SPECIES 3. Arseniat of lead §.

This ore, which has hitherto been found only in Andalusia in Spain, and always in quartz or feldspar, is in small masses. Colour meadow green, often passing into wax yellow. Lustre waxy, 2. Transparency 2. Before the blow-pipe it melts, and retains its colour, and does not crystallize on cooling. When heated to whiteness, the arsenic acid escapes, and the lead is reduced*.

* *Proust, Jour. de Phys.* xxx. 394.

242 Phosphat and arseniat of lead. † *Kirw.* ii. 210.

SPECIES 4. Phosphat and arseniat of lead.

Aesenio phosphat of lead †.

This ore, which has been found in Auvergne in France, is either in masses, or crystallized in small six-sided prisms, with curvilineal faces.

Colour yellowish green, or shews alternate layers of pale and light green. Powder yellowish. The crystals are somewhat transparent; but when massive, this ore is opaque. Hardness 5 to 7. Brittle. Sp. gr. 6.8465 ‡. Soluble in hot muriatic acid, but not in nitric. When heated it decrepitates. Before the blow-pipe melts easily, effervesces, emits a white smoke, with an arsenical smell. Some particles of lead are reduced, a brown fluid remains, which crystallizes on cooling like phosphat of lead.

‡ *Brisson.*

According to Fourcroy, from whom the whole of this description has been taken, it is composed of

65 arseniat of lead,
27 phosphat of lead,
5 phosphat of iron,
3 water.

100*

Metallic Ores.

* *Ann. de Chim.* ii. 23.

243 Molybdat of lead.

SPECIES 5. Molybdat of lead (M).

This ore, which is found in Carinthia and at Lead-hills in Scotland, was first mentioned in 1781 by Mr Jacquin (N). It occurs either in masses, or crystallized in cubic, or rhomboidal, or octohedral plates.

Its colour is yellow. Streak white. Lustre waxy. Generally somewhat transparent. Texture foliated. Fracture conchoidal. Hardness 5 to 6. Sp. gr. 5.486†; when purified from its gangue by nitric acid, 5.706‡.

† *Macquart.* ‡ *Hatchett.*

Soluble in fixed alkalies and in nitric acid. Communicates a blue colour to hot sulphuric acid. Soluble in muriatic acid, and decomposed by it. Before the blow-pipe decrepitates, melts into a yellowish grey mass, and globules of lead are reduced ‖.

‖ *Macquart.*

Klaproth first proved that this ore was molybdat of lead.

A very pure specimen, analysed by him, contained

64.42 oxide of lead,
34.25 molybdic acid,

98.67¶

¶ *Beiträge*, ii. 275.

According to the analysis of Mr Hatchett, it is composed of

58.40 oxide of lead,
38.00 molybdic acid,
2.10 oxide of iron,
.28 silica.

98.78*

* *Phil. Trans.* lxxxvi. 323.

Macquart found a specimen to contain

58.74 lead,
4.76 oxygen,
28.00 molybdic acid,
4.50 carbonat of lime,
4.00 silica.

100.00†

† *Jour. de Min.* N° xvii. 32.

Its gangue is carbonat of lime.

244 Sulphat of lead. * *Kirw. Min.* ii. 211. † *Hauy, Jour. de Min.* N° xxxi. 508.

SPECIES 6. Sulphat of lead *.

This ore, which is found in Anglesey and in Andalusia, is generally crystallized. The crystals are regular octahedrons †, and very minute.

Colour white. Lustre 4. Transparency 4. Before the blow-pipe it is immediately reduced.

The composition of this ore was first ascertained by Dr Withering.

ORDER IX. ORES OF ZINC.

HITHERTO zinc has not been applied to a great variety of uses. It enters into the composition of brass; it is used in medicine; and Morveau has shewn that its oxide

(L) *Crystal.* III. 391. See also *Hauy's* remarks on the same subject in the *Jour. de Min.* N° XXXI. 506.
(M) *Kirw.* II. 212.—*Klaproth, Ann. de Chim.* VIII. 103.—*Hatchett, Phil. Trans.* 1796, p. 285.
(N) In his *Miscellanea Austriaca*, Vol. II. p. 139.

Ores of Zinc.

oxide might be employed with advantage as a white paint.

Ores of zinc are very abundant; they generally accompany lead ores, particularly galena. Calamine, or oxide of zinc, has never been discovered in the primitive mountains.

245 G. I. Sulphurets. Common sulphuret of zinc.

GENUS I. SULPHURETS OF ZINC.

SPECIES 1. Common sulphuret of zinc *.

Blende.

This ore very commonly accompanies sulphuret of lead. It occurs both in amorphous masses and crystallized. The primitive form of its crystals is a rhomboidal dodecahedron, consisting of a six-sided prism, terminated by three-sided pyramids. All the faces of the crystals are equal rhombs. This dodecahedron may be mechanically divided into four equal rhomboidal parallelopipeds, and each of these into six tetrahedrons, whose faces are equal isosceles triangles. The figure of its integrant particles is the tetrahedron, similar to these†.

The principal varieties of its crystals are the tetrahedron; the octohedron; the octohedron with its edges wanting‡; a 24-sided crystal, 12 of whose faces are trapezoids, and 12 elongated triangles§; and, lastly, a 28-sided figure, which is the last variety, augmented by four equilateral triangles‖.

Colour yellow, brown, or black. Streak reddish, brownish, or grey. Lustre commonly metallic. Generally somewhat transparent. Texture foliated. Hardness 6 to 8. Sp. gr. 3.93* to 4.1665†. Before the blow-pipe decrepitates, and gives out white flowers of zinc, but does not melt. Borax does not affect it. When breathed upon, loses its lustre, and recovers it very slowly ‡.

Variety 1. Yellow blende.

Colour commonly sulphur yellow, often passing into olive green or brownish red. Powder pale yellow. Streak yellowish or reddish grey, not metallic. Lustre metallic. Transparency 2 to 4. Often phosphoresces when scraped or rubbed §.

According to Bergman, it is composed of

64 zinc,
20 sulphur,
5 iron,
4 fluor acid,
1 silica,
6 water.

100‖

Variety 2. Brown blende.

Colour different shades of brown. Surface often tarnished. Powder brownish grey. Streak reddish or yellowish grey, not metallic. Lustre commonly metallic. Transparency 0 to 2.

A specimen of this variety, analysed by Bergman, contained

44 zinc,
17 sulphur,
24 silica,
5 iron,
5 alumina,
5 water.

100¶

Variety 3. Black blende.

Colour black, or brownish black; surface often tarnished blue; tips of the crystals often blood red. Powder brownish black. Streak reddish, brownish, or grey. Lustre common or metallic. Transparency 0 to 1; the red parts 2. Hardness 8.

Metallic Ores.

A specimen of this variety, analysed by Bergman, contained

52 zinc,
26 sulphur,
4 copper,
8 iron,
6 silica,
4 water.

100*

246 G. II. Oxides. White oxide of zinc.

GENUS II. OXIDES OF ZINC.

SPECIES 1. White oxide of zinc †.

Calamine.

This ore is either found loose, or in masses, or crystallized. The primitive form of its crystals appears, from the mechanical division of one of them by Mr Hauy, to be an octohedron composed of two four-sided pyramids, whose sides are equilateral triangles ‡. But the crystals are minute, and their figure not very distinct. They are either four or six-sided tables with bevelled edges, six-sided prisms, or three-sided pyramids.

Colour commonly white, grey, or yellow. Lustre often 0, sometimes 2 or 1. Opaque. The crystals are somewhat transparent. Hardness from 4 to 9, sometimes in powder. Sp. gr. from 2.585 to 3.674 §. When heated, becomes electric, without friction, like the tourmaline ‖. Not blackened by sulphuret of ammonia. Soluble in sulphuric acid. Before the blow-pipe decrepitates, and does not melt.

This ore consists of oxide of zinc more or less contaminated with iron, silica, lime, and other foreign ingredients. In one specimen Bergman found the following ingredients:

84 oxide of zinc,
3 oxide of iron,
12 silica,
1 alumina.

100¶

In another specimen, which gelatinized with acids like zeolite, Klaproth found 66 oxide of zinc,
33 silica,

99

In another specimen, analyzed by Pelletier, the contents were

52 silica,
36 oxide of zinc,
12 water.

100*

Mr Kirwan has divided this species into three varieties.

Variety 1. Friable calamine.

In masses which easily crumble between the fingers. Lustre 0. Opaque. Texture earthy. When its colour is white, it is pure oxide of zinc; when yellow, it is mixed with oxide of iron. The white often becomes yellow when placed in a red heat, but resumes its colour on cooling. Common in China, where it is called *wohan* or *ore of Tutenago*.

† *Hauy, Jour. de Min.* N° xxxii. 669.
‡ Fig. 40.
§ Fig. 41.
‖ See *Hauy, ibid.* and *Romé de Lisle*, iii. 65.
* *Gillert.*
† *Brisson.*
‡ *Hauy, Jour. de Min. ibid.*
§ *Bergman*, ii. 345.
‖ *Ibid.* 347.
¶ *Ibid.* 333.
* *Bergman*, ii. 335.
† *Kirw.* ii. 233.—*Berg.* ii. 321.
‡ *Jour. de Min.*. No xxxii. 596.
§ *Kirwan.*
‖ *Hauy, Jour. de Min. ibid.*
¶ *Bergman*, ii. 323.
* *Jour. de Phys.* xx. 428.

Ores of Antimony.

Variety 2. Compact calamine.

Colour different shades of grey; sometimes yellow or brownish red. Lustre 0. Opaque. Texture compact.

Variety 3. Striated calamine.

This variety alone is found crystallized; but, like the others, it is also often amorphous. Colour white, and also various shades of grey, yellow, and red. Somewhat transparent. Texture striated. Lustre 2 to 1.

247 G. III. Salts. Sulphat of zinc.

GENUS III. SALTS OF ZINC.

SPECIES 1. Sulphat of zinc.

For a description of this salt, we refer to CHEMISTRY, n° 643. *Suppl.*

ORDER X. ORES OF ANTIMONY.

Antimony is much used to give hardness to those metals which otherwise would be too soft for certain purposes: printers types, for instance, are composed of lead and antimony. It is used also in medicine.

Ores of antimony are found abundantly in Germany, Hungary, France, Spain, Britain, Sweden, Norway, &c. They often accompany galena and hæmatites. They are found both in the secondary and primitive stratified mountains. Their gangue (o) is often quartz and sulphat of barytes.

248 G. I. Alloys. Native antimony. * *Kirw.* ii. 245.

GENUS I. ALLOYS OF ANTIMONY.

SPECIES 1. Native antimony *.

This mineral, which was first discovered by Dr Swab, has been found in Sweden and in France, both in masses and kidney shaped lumps. Colour white, between that of tin and silver. Lustre metallic. Texture foliated. Hardness 6. Sp. gr. above 6. Deflagrates with nitre. Before the blow-pipe melts and evaporates, depositing a white oxide of antimony.

It consists of antimony, alloyed with 3 or 4 *per cent.* of arsenic.

249 G. II. Sulphurets. Grey ore of antimony. * *Kirw.* ii. 247. † *Romé de Lisle*, iii. 49. ‡ *Ibid.*—See also *Hauy, Jour. de Min.* N° xxxii. 606. § *Brisson.*

GENUS II. SULPHURETS OF ANTIMONY.

SPECIES 1. Grey ore of antimony *.

This ore, which is the most common, and indeed almost the only ore of antimony, occurs both massive, disseminated, and crystallized. Its crystals are four-sided prisms, somewhat flattened, whose sides are nearly rectangles, terminated by short four-sided pyramids, whose sides are trapeziums †. Sometimes two of the edges are wanting, which renders the prism six-sided ‡.

Colour grey. Lustre metallic. Streak grey, metallic, and brighter. Powder black or greyish black. Hardness 6 to 7. Sp. gr. from 4.1327 to 4.516 §. Often stains the fingers. Before the blow-pipe melts easily, burns with a blue flame, and deposits a white oxide on the charcoal. When placed in an open vessel, over a slow fire, the sulphur evaporates, and leaves a grey oxide of antimony. This oxide, if fused with tartar, is reduced.

This ore, when taken out of the mine, almost always contains a large proportion of quartz or other stony matter. When pure, it is composed of about

74 antimony,
26 sulphur.

100

Metallic Ores.

Werner has divided this species into three varieties.

Variety 1. Compact sulphuret.

Colour bluish grey, surface often tarnished, and then it is blue or purplish. Lustre 1 to 2. Texture compact. Fracture fine grained, uneven. Powder black, dull, and earthy. Slightly stains the fingers.

Variety 2. Foliated sulphuret.

Colour light steel grey. Lustre 3 to 4. Texture foliated. Powder as that of the last variety.

Variety 3. Striated sulphuret.

Colour dark steel grey, and light bluish grey, surface often tarnished, and then it is dark blue or purplish. Lustre 3 to 2. Texture striated. Powder greyish black. This variety alone has been hitherto found crystallized.

250 Plumose antimonial ore. † *Kirw.* ii. 250.

SPECIES 2. Plumose antimonial ore †.

Sulphurets of antimony and arsenic.

This species, which is sometimes found mixed with the crystals of sulphurated antimony, is in the form of brittle, capillary, or lanuginous crystals, often so small that they cannot be distinctly seen without a microscope.

Colour steel or bluish grey, often tarnished, and then brown or greyish black. Lustre 1, semimetallic. Before the blow-pipe emits a smoke, which deposits a whitish and yellowish powder on the charcoal: it then melts into a black flag.

It is supposed to consist of sulphur, antimony, arsenic, and some silver.

251 Red antimonial ore. † *Kirw.* ii. 250.

SPECIES 3. Red antimonial ore †.

Hydrosulphuret of antimony.

This species is generally found in cavities of sulphurated antimonial ore. It is crystallized in delicate needles, often diverging from a common centre.

Colour red. Lustre 2, silky. Sp. gr. 4.7. Before the blow-pipe melts easily, and evaporates with a sulphureous smell.

This ore has not been analysed. Mineralogists have supposed it to be a natural kermes. If so, we may conclude, from the experiments of Berthollet *, that it is a hydrosulphuret of antimony, and consequently composed of oxide of antimony, sulphur, and sulphurated hydrogen gas.

* *Ann. de Chim.* xxv. 259.

252 G. III. Oxides of antimony.

GENUS III. OXIDES OF ANTIMONY.

There is a substance found incumbent on sulphuret of antimony, of a yellow colour, and an earthy appearance, which has been supposed an oxide of antimony, and denominated antimonial ochre. But hitherto it has not been analysed.

GENUS

(o) The word *gang* is used by German mineralogists to denote a metallic vein. Now, it is not often that these veins consist entirely of *ore*; in general, they contain stony matter besides. For instance, in the copper mine at Airthry, near Stirling, the copper ore is merely a narrow stripe in the middle of the vein, and the rest of it is filled up with sulphat of barytes. We use the word *gangue* (as the French do), to denote, not the *metallic* vein, but the *stony* matter which accompanies the ore in the vein. The gangue of the copper ore at Airthry is sulphat of barytes.

Ores of Bifmuth.

Genus IV. Salts of antimony.

Species 1. Muriat of antimony *.

253 G. IV. Salts. Muriat of antimony. * *Kirw.* ii. 251.

This ore, which has been found in Bohemia, is ſometimes in quadrangular tables; ſometimes in acicular cryſtals grouped like zeolites; and ſometimes in priſms.

Colour pale yellowiſh or greyiſh white. Luſtre 3 to 1, nearly metallic. Tranſparency 2. Texture foliated. Melts eaſily by the flame of a candle, and emits a white vapour †. Before the blow-pipe decrepitates; when powdered, and juſt ready to melt, it evaporates, and leaves a white powder around. Between two pieces of coal it is reducible to a metallic ſtate.

† *Hauy, Jour. de Min.* N° xxxii. 609.

Order XI. Ores of Bismuth *.

* *Pott, Obſerv. Chym.* 134—*Geoffroy, Mem. Par.* 1753, p. 296.

Bismuth is employed in the manufacture of pewter, of printers types, in ſoldering; and perhaps alſo its property of rendering other metals more fuſible, might make it uſeful in anatomical injections. The quantity conſumed in commerce is not great.

It has been found only in the primitive mountains, and is by no means common. When unaccompanied by any other metal, it does not form veins, but kidney-form maſſes. It often accompanies cobalt. Its gangue is commonly quartz. Its ores are not very abundant. They have been found chiefly in Sweden, Norway, Tranſylvania, Germany, France, and England.

Genus I. Alloys of bismuth.

Species 1. Native biſmuth *.

254 G. I. Alloys. Native biſmuth. * *Kirw.* ii. 264.

This mineral, which is found at Schneeberg, Johangeorgenſtadt, &c. in Germany, has commonly the form of ſmall plates lying above one another. Sometimes it is cryſtallized in four-ſided tables, or indiſtinct cubes.

Colour white with a ſhade of red; ſurface often tarniſhed red, yellow, or purple. Luſtre metallic, 3 to 2. Opaque. Texture foliated or ſtriated. Hardneſs 6. Sp. gr. 9.022 † to 9.57 ‡. Exceedingly fuſible. Before the blow-pipe gives a ſilvery white bead, and at laſt evaporates in a yellowiſh white ſmoke, which is depoſited on the charcoal.

† *Briſſon.* ‡ *Kirwan.*

It is generally accompanied by cobalt, and ſometimes contains arſenic.

Genus II. Sulphurets of bismuth.

Species 1. Common ſulphuret of biſmuth *.

255 G. II. Sulphurets. Common ſulphuret of biſmuth. * *Kirw.* ii. 266.—*Sage, Mem. Par.* 1782, 307.

This ore, which is found in Sweden, Saxony, and Bohemia, occurs ſometimes in amorphous maſſes, and ſometimes in needleform cryſtals.

Colour commonly bluiſh grey, ſometimes white; ſurface often tarniſhed yellow, red, and purple. Powder black and ſhining. Luſtre metallic, 2 to 3. Streak obſcurely metallic. Texture foliated. Hardneſs 5. Brittle. Sp. gr. 6.131 † to 6.4672 ‡. When held to the flame of a candle, it melts with a blue flame and ſulphureous ſmell. Before the blow-pipe emits a reddiſh yellow ſmoke, which adheres to the charcoal. This powder becomes white when it cools, and reſumes its former colour when the flame is directed upon it *.

† *Kirwan.* ‡ *Briſſon.*

* *Gillot, Jour. de Min.* N° xxxii. 585.

This ore, according to Sage, contains 60 biſmuth. And, according to La Perouſe, it holds 36 ſulphur.

99

A ſpecimen, analyſed by Klaproth, contained
95 biſmuth,
5 ſulphur.

100 †

Metallic Ores.

† *Beiträge*, i. 256.

It is commonly accompanied by quartz, aſbeſtos, or ſparry iron ore.

256 G. III. Oxides. Yellow oxide of biſmuth.

Genus III. Oxides of bismuth.

Species 1. Yellow oxide of biſmuth ‡.

Biſmuth ochre.

This ore generally accompanies the two ſpecies already deſcribed. It is found in two ſtates; either of an earthy conſiſtence, or cryſtallized in cubes or quadrangular plates.

‡ *Kirw.* ii. 263.

Colour uſually greeniſh yellow, ſometimes grey. Soluble in nitrous acid without effervеſcence, and may in a great meaſure be precipitated by the effuſion of water.

Order XII. Ores of Arsenic.

Arsenic is uſed as an alloy for ſeveral other metals, eſpecially copper. It is ſometimes employed to facilitate the fuſion of glaſs, or to render it opaque, in order to form an enamel. Preparations of arſenic are employed as paints; and, like moſt other violent poiſons, it has been introduced into medicine.

This metal is ſcattered in great abundance over the mineral kingdom, accompanying almoſt every other metal, and forming alſo ſometimes peculiar veins of its own. Of courſe it occurs in almoſt every ſpecies of mountain, and is accompanied by a variety of gangues.

257 G. I. Alloys. Native arſenic. † *Kirw.* ii. 255.

Genus I. Alloys of arsenic.

Species 1. Native arſenic †.

This mineral is found in different parts of Germany. It occurs generally in maſſes of various ſhapes, kidney-form, botryoidal, &c.

Colour that of ſteel. Its ſurface quickly becomes tarniſhed by expoſure to the air. Luſtre metallic (when freſh), 2 to 3. Streak bluiſh grey, metallic, and bright. Powder dull and black. Texture compact. Hardneſs 7 to 8. Brittle. Sp. gr. 5.67 † to 5.7249 ‡. Gives an arſenical ſmell when ſtruck. Before the blow-pipe emits a white ſmoke, diffuſes a garlic ſmell, burns with a blue flame, gradually evaporates, depoſiting a white powder.

† *Kirwan.* ‡ *Briſſon.*

It is always alloyed with ſome iron §, and often contains ſilver, and ſometimes gold.

§ *De Born. Catal of M. Raab.* ii. 194.

258 G. II. Sulphurets. Orpiment.

Genus II. Sulphurets of arsenic.

Species 1. Orpiment (p).

Auripigmentum.

This ore, which is found in Hungary, Wallachia, Georgia, and Turkey in Aſia, is either maſſive or cryſtallized. The cryſtals are confuſed, and their figure cannot be eaſily determined; ſome of them appear octohedrons, and others minute four-ſided priſms.

Its colour is yellow. Streak orange yellow. Luſtre waxy, 2 to 3. Tranſparency from 0 to 2. Texture foliated. Hardneſs 4 to 8. Sp. gr. from 3.048 * to 3.521 †. Effervеſces with hot nitric acid. Burns with

* *Kirwan.* † *Gillet.*

a

(p) *Kirw.* II. 260.—*Alberti de Auripigmento.*—*Scopoli in Anno 5to Hiſt. Naturali*, p. 59.—*Berg.* II. 297.

Ores of Arſeniat. a bluiſh white flame. Before the blow-pipe melts, ſmokes, and evaporates, leaving only a little earth and ſome traces of iron.

Compoſed of 80 ſulphur,
20 arſenic.

100

259 Realgar. SPECIES 2. Realgar *.

* *Kirw.* ii. 261.—*Berg.* ii. 297. This mineral is found in Sicily, about Mount Veſuvius, in Hungary, Tranſylvania, and various parts of Germany. It is either maſſive or cryſtallized. The primitive form of the cryſtals is, according to Romé de Liſle, a four-ſided rhomboidal priſm, terminated by four-ſided pyramids, the ſides of which are rhombs †. It commonly appears in 4, 6, 8, 10, or 12 ſided priſms, terminated by four-ſided ſummits ‡.

† *Cryſtal.* iii. 34.

‡ *Ibid.*

Colour red. Streak yellowiſh red. Powder ſcarlet. Luſtre 3 to 2. Tranſparency from 2 to 3; ſometimes 0. Hardneſs 5 to 6. Sp. gr. 3.3384 §. It is an electric *per ſe*, and becomes negatively electric by friction ||. Nitric acid deprives it of its colour. Before the blow-pipe it melts eaſily, burns with a blue flame and garlic ſmell, and ſoon evaporates.

§ *Briſſon.*

|| *Hauy, Jour. de Min.* N° xxxii. 612.

Compoſed of 20 ſulphur,
80 arſenic.

100

260 G. III. Oxides. White oxide of arſenic. GENUS III. OXIDES OF ARSENIC.

SPECIES 1. White oxide of arſenic *.

Native calx of arſenic.

* *Kirw.* ii. 258—*Berg.* ii. 285. This ore is found in various parts of Germany, Hungary, &c. either in powder, or maſſive, or cryſtallized in priſmatic needles.

Colour white or grey, often with a tint of red, yellow, green, or black. Luſtre common, 1 to 2. Tranſparency 1 to 0; when cryſtallized, 2. Texture earthy. Hardneſs 6. Brittle. Sp. gr. 3.7 †. Soluble in hot diluted nitric acid without effervеſcence. Soluble at 60° Fahrenheit in 80 times its weight of water. Before the blow-pipe ſublimes, but does not inflame. Tinges borax yellow.

† *Kirwan.*

ORDER XIII. COBALT ORES.

COBALT is employed to tinge glaſs of a blue colour, and is uſeful in painting upon porcelain.

Cobalt ores are found almoſt excluſively in the ſtratified mountains, except one ſpecies, ſulphuret of cobalt, which affects the primitive mountains. They are not very abundant; and for that reaſon cobalt is more valuable than many of the other metals which have been already treated of. They are commonly accompanied by nickel, biſmuth, or iron. They are moſt abundant in Germany, Sweden, Norway, and Hungary; they have been found alſo in Britain and France, but not in any great quantity.

261 G. I. Alloys. Cobalt alloyed with arſenic. GENUS I. ALLOYS OF COBALT.

SPECIES 1. Cobalt alloyed with arſenic †.

Dull grey cobalt ore.

† *Kirw.* ii. 270. This ore, which occurs in different parts of Germany, is either amorphous or cryſtallized. The forms of its cryſtals are the cube; ſometimes the cube with its angles, or edges, or both wanting; and the octahedron ‡.

‡ *Romé de Liſle*, iii. 123.

Its colour, when freſh broken, is whitiſh or bluiſh grey, ſometimes with a ſhade of red; when expoſed to the air it ſoon becomes tarniſhed. Streak bluiſh grey and metallic. Luſtre ſcarcely metallic, 0 to 1. Texture compact. Hardneſs 10. Difficultly frangible. Sp. gr. when amorphous, 5.309 to 5.571 §; when cryſtallized 7.7207 †. When ſtruck it gives out an arſenical ſmell. Before the blow-pipe it gives out an arſenical vapour, becomes magnetic, and melts eaſily, unleſs it contains a great quantity of iron. Tinges borax dark blue, and a ſmall metallic bead is obtained.

Metallic Ores.

§ *Kirw.* ii. 270.

† *Hauy, Jour. de Min.* N° xxxii. 588.

A ſpecimen of this ore from Cornwall, examined by Mr Klaproth, contained 20 cobalt,
24 iron,
33 arſenic.

77

with ſome biſmuth and ſtony matter *.

* *Klaproth's Cornwall*, p. 61.

Another ſpecimen from Tunaberg, according to the analyſis of the ſame chemiſt, contained

55.5 arſenic,
44.0 cobalt,
.5 ſulphur.

100 †

† *Beiträge*, ii. 307.

262 G II. Sulphurets. White cobalt ore. GENUS II. SULPHURETS OF COBALT.

SPECIES 1. White cobalt ore ‡.

Sulphuret of cobalt, arſenic, and iron.

† *Kirw.* ii. 273.—*Sage, Jour. de Phy.* xxxix. 53. The deſcriptions which different mineralogiſts have given of this ore are ſo various, that it is impoſſible not to ſuppoſe that diſtinct ſubſtances have been confounded together.

It occurs either in maſſes, or cryſtallized in cubes, dodecahedrons, octohedrons, and icoſahedrons.

Colour tin white, ſometimes tarniſhed reddiſh or yellowiſh. Powder ſteel grey. Luſtre partly metallic, and from 2 to 4; partly 0 or 1. Texture foliated. Hardneſs 8 to 9. Sp. gr. from 6 284 † to 6,4509 ‡. Before the blow-pipe generally gives out an arſenical vapour, and does not melt.

† *Kirwan.*
‡ *Hauy.*

The analyſes that have been given of this ore are very various. Sometimes it has been found to contain no arſenic nor iron, and ſometimes to contain both. A ſpecimen from Tunaberg in Sweden, which ought to belong to this ſpecies, was analyſed by Taſſaert, and found to conſiſt of 49 arſenic,
36.6 cobalt,
5.6 iron,
6.5 ſulphur.

97.7 †

† *Ann. de Chim.* xxviii 100.

Klaproth found a ſpecimen of the ſame ore to contain 55.5 arſenic,
44.0 cobalt,
0.5 ſulphur.

100.0 ‡

‡ *Beiträge*, ii. 307.

263 G. III. Oxides. Black cobalt ore or ochre. GENUS III. OXIDES OF COBALT.

SPECIES 1. Black cobalt ore or ochre §.

This ore, which occurs in different parts of Germany, is either in the form of powder, or indurated.

Colour black, often with a ſhade of blue, grey, brown, or green. Luſtre 0 to 1. Streak brighter. Hardneſs (of the indurated) from 4 to 8. Sp. gr. 3 to 4. Soluble in muriatic acid. Tinges borax blue.

§ *Kirw.* ii. 275.

SPECIES

Ores of Nickel.

294 Brown cobalt ore. * *Kirwan*, ii. 276.

SPECIES 2. Brown cobalt ore *.

Colour greyish or dark leather brown. Streak brighter, unctuous. Communicates a pale blue tinge in fusion.

265 Yellow cobalt ore. † *Ibid.*

SPECIES 3. Yellow cobalt ore †.

Colour yellow. Dull and earthy. Hardness 4 to 5. Texture earthy. Streak brighter, unctuous. Gives a weak blue tinge.

GENUS IV. SALTS OF COBALT.

266 G. IV. Salts. Arseniat of cobalt. ‡ *Id.* 278.

SPECIES 1. Arseniat of cobalt ‡.

Red cobalt ore.

This species, like most other ores of cobalt, has neither been accurately described nor analysed.

It is found in masses of various shapes, and crystallized in quadrangular tables or acicular prisms.

Colour red. Lustre from 2 to 3, sometimes 0. Transparency 0 to 2. Hardness 5 to 7. Brittle. Before the blow-pipe becomes blackish grey. Diffuses a weak arsenical smell. Tinges borax blue.

ORDER XIV. ORES OF NICKEL.

HITHERTO nickel has been found in too small quantities to be applied to any use; of course there are, properly speaking, no mines of nickel. It occurs only (as far as is yet known) in the secondary mountains, and it commonly accompanies cobalt. It has been found in different parts of Germany, in Sweden, Siberia, Spain, France, and Britain.

GENUS I. SULPHURETS OF NICKEL.

267 G. I. Sulphurets. Sulphuret of nickel with arsenic and iron. * *Ibid.* 286.

SPECIES 1. Sulphuret of nickel with arsenic and iron.

Kupfer nickel *.

This, which is the most common ore of nickel, occurs either massive or disseminated, but never crystallized.

Colour often that of copper, sometimes yellowish white or grey. Recent fracture often silver white. Lustre metallic, 2 to 3. Texture compact. Hardness 8. Sp. gr. 6.6086 to 6.6481 ‡. Soluble in nitric and nitro-muriatic acids. Solution green. Before the blow-pipe exhales an arsenical smoke, and melts into a bead which darkens by exposure to the air.

‡ *Brisson.*

It is composed of various proportions of nickel, arsenic, iron, cobalt, sulphur; often contains bismuth, and sometimes silver and copper.

268 G. II. Oxides. Nickel ochre. * *Kirwan*, ii. 284.

GENUS II. OXIDES OF NICKEL.

SPECIES 1. Nickel ochre *.

This mineral occurs either in the form of a powder, or indurated, and then is either amorphous, or crystallized in acicular form crystals. The powder is generally found on the surface of other nickel ores.

Colour different shades of green. Lustre 1 to 0. Texture earthy. Sp. gr. considerable. Slowly dissolves in acids: solution green. Before the blow-pipe does not melt; but gives a yellowish or reddish brown tinge to borax.

This ore often contains sulphat of nickel, which is soluble in water. The solution, when evaporated, gives oblong rhomboidal crystals, from which alkalies precipitate a greyish green oxide. This oxide is soluble by acids and by ammonia. The acid solution is green; the alkaline blue.

Metallic Ores

269 G. III. Salts. Arseniat of nickel. † *Kirwan*, ii. 285.

GENUS III. SALTS OF NICKEL.

SPECIES 1. Arseniat of nickel †.

This ore, which was lately discovered at Regendorff by Mr Gmelin, is found in shapeless masses, and is often mixed with plates of sulphat of barytes.

Colour pale grey, here and there mixed with pale green. Streak white. Lustre 0. Texture compact. Hardness 7. Difficultly frangible. Sp. gr. considerable. Adheres slightly to the tongue, and gives an earthy smell when breathed on. Soluble in hot nitric and muriatic acids: solution green.

Contains some cobalt and alumina.

ORDER XV. ORES OF MANGANESE (q).

HITHERTO manganese, in its metallic state, has scarcely been put to any use; but under the form of an oxide it has become of great importance. The oxide of manganese has the property of rendering colourless a variety of bodies which injure the transparency of glass; and it has been long used in glass manufactories for this purpose under the name of *glass soap*. By means of the same oxide, oxy-muriatic acid is prepared, which has rendered manganese of great importance in bleaching. Not to mention the utility of manganese to the chemist, the property which it has of facilitating the oxidation of other metals, and of rendering iron more fusible—will probably make it, in no very remote period, of very considerable importance in numerous manufactories.

Ores of manganese occur often in strata, both in the primitive and secondary mountains; scarcely ever, however, we believe, in those mountains which are considered as the most ancient of all. They are very common, having been found abundantly in Germany, France, Spain, Britain, Sweden, Norway, Siberia, and other countries.

270 G. I. Oxides.

GENUS I. OXIDES OF MANGANESE.

Hitherto manganese has only been found in the state of oxide. La Perouse, indeed, suspected that he had found it in a metallic state: but probably there was some mistake or other in his observations.

271 Oxide of manganese combined with barytes.

SPECIES 1. Oxide of manganese combined with barytes.

This species, which exists in great abundance in Romaneche near the river Soane in France, is found massive, forming a stratum in some places more than 12 feet thick.

Colour greyish black or brownish black, of great intensity. Lustre, external, 0; internal, metallic, 1. Soon tarnishes by exposure to the air, and then becomes intensely black. Texture granular. Fracture uneven; sometimes conchoidal. Often porous. Hardness 11. Difficultly frangible. Sp. gr. from 3.950 to 4.10. Absorbs water. When taken out of water after a minute's immersion it has a strong argillaceous smell. Conducts electricity nearly as well as if it were in a metallic state. Infusible by the blow-pipe. Tinges soda red; the colour disappears before the blue cone of flame, and is reproduced by the action of the yellow flame.

From

(q) *Pott. Miscelan. Berolens*, VI. 40.—*Margraff, Mem. Berlin*, 1773, p. 3.—*La Perouse, Jour. de Phys.* XVI. 156. and XV. 67. and XXVIII. 68.—*Sage, Mem. Par.* 1785, 235.

Ores of Manganese.

From the analysis of Vauquelin, it appears that it is composed of
50.0 white oxide of manganese,
33.7 oxygen,
14.7 barytes,
1.2 silica,
.4 charcoal.

100.0 ¶

¶ *Dolomieu, Jour. de Min.* N° xix 42.

SPECIES 2. Grey ore of manganese *.

272 Grey ore of manganese.

This ore occurs both massive and disseminated: it is also sometimes crystallized in slender four-sided prisms or needles.

* *Kirwan*, ii. 291.

Colour usually dusky steel grey; sometimes whitish grey, or reddish grey. Streak and powder black. External lustre 3 to 2; internal metallic, 2 to 1. Texture striated or foliated. Hardness 4 to 5. Brittle. Sp. gr. from 4.073 † to 4.8165 ‡. Before the blow-pipe darkens. Tinges borax reddish brown.

† *Vauquelin.* ‡ *Brisson.*

A specimen of oxide of manganese from the mountains of Vosges, which probably belonged to this species, and which was analysed by Vauquelin, was composed of
82 oxide of manganese,
7 carbonat of lime,
6 silica,
5 water.

100 §

§ *Jour. de Min.* N° xvii. 13.

Sometimes it contains a little barytes and iron.

273 Black or brown ore of manganese.

SPECIES 3. Black or brown ore of manganese *.

* *Kirwan*, ii. 292.—*Wedgewood, Phil. Trans.* lxxiii. 284.

This ore is found sometimes in the state of powder, and sometimes indurated in amorphous masses of various figures. Colour either black, sometimes with a shade of blue or brown; or reddish brown. Streak of the harder sorts metallic; of the others, black. Lustre 0 to 1; internal (when it is indurated), metallic. Texture compact. Hardness 5 to 7. Sp. gr. 3.7076 to 3.9039; that of the powdery sometimes only 2. Before the blow-pipe it exhibits the same phenomena as the last species.

A specimen of this ore, analysed by Westrum, contained
45.00 manganese,
14.00 oxide of iron,
11.00 silica,
7.25 alumina,
2.00 lime,
1.50 oxide of copper,
18.00 air and water.

98.75

274 G. II. Salts. Carbonat of manganese.

GENUS II. SALTS OF MANGANESE.

SPECIES 1. Carbonat of manganese †.

White ore of manganese.

† *Kirwan*, ii. 297.

This species occurs in Sweden, Norway, and Transylvania. It is either in the form of loose scales, or massive, or crystallized in needles.

Colour white, or reddish white. Texture either radiated or scaly. Lustre of the scaly 2. Transparency 1 to 2. Hardness of the massive 6 to 9. Sp. gr. 2.794. Effervesces with mineral acids. Heated to redness, blackens. Tinges borax violet.

SPECIES 2. Red ore of manganese †.

Carbonat of manganese and iron.

Metallic Ores.

275 Red ore of manganese.

† *Kirwan*, ii. 297.—*Napion, Mem. Turin*, iv. 303.

This species has been found in Piedmont and in the Pyrenees: It is sometimes in powder, sometimes massive, sometimes crystallized in rhomboidal prisms or needles.

Colour pale rosy red, mixed with white. Powder nearly white. Lustre 0. Transparency 1. Hardness 8. Sp. gr. 3.233. Effervesces with nitric and muriatic acids. When heated to redness becomes reddish brown. Tinges borax red.

A specimen, analysed by Ruprecht, contained
55.0 silica,
25.0 oxide of manganese,
7.0 oxide of iron,
1.5 alumina.

98.5 §

§ *Jour de Phys.* xxxi. 22.

ORDER XVI. ORES OF TUNGSTEN.

As no easy method has hitherto been discovered of reducing tungsten to a metallic state, we need not be surprised that it has been applied to no use. Ores of tungsten are by no means common. They have hitherto been found only in the primitive mountains. Their gangue is commonly quartz. They very often accompany tin ores.

276 G. I. Oxides. Wolfram.

GENUS I. OXIDES OF TUNGSTEN.

SPECIES 1. Wolfram (R).

Oxides of tungsten, iron, and *manganese*—*Tungstat of iron* and *manganese.*

This species is found in different parts of Germany, in Sweden, Britain, France and Spain; and is almost constantly accompanied by ores of tin. It occurs both massive and crystallized. The primitive form of its crystals, according to the observations of Mr Hauy, is a rectangular parallelopiped ‡, whose length is 8.66, whose breadth is 5, and thickness 4.33 *. It is not common, however, to find crystals of this perfect form; in many cases, the angles, and sometimes the edges, of the crystal are wanting †; owing, as Mr Hauy has shewn, to the superposition of plates, whose edges or angles decrease according to a certain law ‡.

‡ Fig. 42. * *Jour. de Min.* N° xix. 8. † Fig. 43. ‡ *Jour. de Min.* N° xix. 8.

Colour brown or browniſh black. Streak reddish brown. Powder stains paper with the same colour. Lustre external, 2; internal, 2 to 3; nearly metallic. Texture foliated. Easily separated into plates by percussion. Hardness 6 to 8. Sp. gr. from 7.006 * to 7.333 †. Moderately electric by communication. Not magnetic. Infusible by the blow-pipe. Forms with borax a greenish globule, and with microcosmic salt a transparent globule of a deep red ¶.

* *Kirwan.* † *Hauy.*

The specimen of this ore, examined by Messrs d'Elhuyart's, was composed of 65 oxide of tungsten,
22 oxide of manganese,
13 oxide of iron.

100

¶ *Vauquelin, Jour. de Min.* N° xix. 11.

Another

(R) *Kirw.* II. 316.—*De Luyart, Mem. Thoulouse*, II. 141.—*Gmelin, Crell's Jour.* English Trans. III. 127, 205, and 293.—*La Perouse, Jour. de Min.* N° IV. p. 23.

Ores of Molybdenum.

Another specimen from Pays le Mines in France, analysed by Vauquelin and Hecht, contained
67.00 oxide of tungsten,
18.00 black oxide of iron,
6.25 black oxide of manganese,
1.50 silica,
7.25 oxide of the iron and manganese.

100.00 §

§ *Vauquelin, Jour. de Min.* N° xix. 11.

GENUS II. SALTS OF TUNGSTEN.

SPECIES 1. Tungstat of lime (s). *Tungsten.*

277 G. II. Salts. Tungstat of lime.

This ore, which is now exceedingly scarce, has hitherto been found only in Sweden and Germany. It is either massive or crystallized; and, according to Hauy, the primitive form of its crystals is the octahedron †.

† *Jour. de Min.* N° xxxiii. 657.

Colour yellowish white or grey. Lustre 3 to 2. Transparency 2 to 3. Texture foliated. Hardness 6 to 9. Sp. gr. 5.8 to 6.0665. Becomes yellow when digested with nitric or muriatic acids. Infusible by the blow-pipe. With borax forms a colourless glass, unless the borax exceed, and then it is brown. With microcosmic salt it forms a blue glass, which loses its colour by the yellow flame, but recovers it in the blue flame ‡. It is composed of about 70 oxide of tungsten,
30 lime.
100

‡ *Scheele* and *Bergman.*

§ *Scheele.*

with a little silica and iron §.

278 Brown tungstat.

SPECIES 2. Brown Tungstat.

This ore is found in Cornwall, and is either massive or composed of small crystalline grains.

Colour grey, variegated with yellow and brown. Lustre 2, waxy. Hardness 6 to 7. Sp. gr. 5.57. Its powder becomes yellow when digested in aqua regia.

According to Klaproth, it is composed of
88.0 oxide of tungsten,
11.5 lime.
99.5

ORDER XVII. ORES OF MOLYBDENUM.

IF ever molybdenum be found in abundance, it will probably be useful in dyeing and painting. At present it is very scarce, having only been found in Sweden, Germany, Carniola, and among the Alpes. Like tin and tungsten, it affects the primitive mountains.

279 G. I. Sulphuret. Common sulphuret.

GENUS I. SULPHURET OF MOLYBDENUM.

SPECIES 1. Common sulphuret (T). *Molybdena.*

This ore, which is the only species of molybdenum ore at present known, is found commonly massive; sometimes, however, it is crystallized in hexahedral tables.

Colour light lead grey; sometimes with a shade of red. Streak bluish grey, metallic. Powder bluish. Lustre metallic, 3 to 2. Texture foliated. Lamellæ slightly flexible. Hardness 4. Sp. gr. 4.569 * to 4.7385 †. Feels greasy; stains the fingers. Marks bluish black. A piece of resin rubbed with this mineral becomes positively electric ‡. Insoluble in sulphuric and muriatic acids; but in a boiling heat colours them green. Effervesces with warm nitric acid, leaving a grey oxide undissolved. Before the blow-pipe, on a silver spoon, emits a white smoke, which condenses into a white powder, which becomes blue in the internal, and loses its colour in the external, flame. Scarcely affected by borax or microcosmic salt. Effervesces with soda, and gives it a reddish pearl colour.

Composed of about 60 molybdenum,
40 sulphur.

100 *

* *Karsten.* † *Brisson.*

Metallic Ores.

‡ *Hauy, Jour. de Min.* N° xix. 70.

* *Klaproth.*

ORDER XVIII. ORES OF URANIUM.

URANIUM has hitherto been found only in Germany, and has not been applied to any use. The only two mines where it has occurred are in the primitive mountains.

280 G. I. Oxides. Sulphuret of uranium.

GENUS I. OXIDES OF URANIUM.

SPECIES 1. Sulphuret of uranium †. *Pechblende.*

† *Kirwan,* ii. 305.

This ore, which has been found at Johanngeorgenstadt in Saxony, and Joachimsthal in Bohemia, is either massive or stratified with other minerals.

Colour black or browniſh black; sometimes with a shade of grey or blue. Streak darker. Powder opaque and black. Lustre semimetallic, from 3 to 1. Fracture conchoidal. Hardness 7 to 8. Very brittle. Sp. gr. from 6.3785 ‡ to 7.5, and even higher §. Imperfectly soluble in sulphuric and muriatic acids; perfectly in nitric acid and aqua regia. Solution wine yellow. Infusible with alkalies in a crucible: infusible by the blow-pipe *per se.* With borax and soda forms a grey opaque flag; with microcosmic salt, a green glass.

‡ *Morveau, Jour. de Min.* N° xxxii. 610.

§ *Klaproth, Beiträge,* ii. 197.

Composed of oxide of uranium and sulphur, and mixed with iron and silica, and sometimes lead.

A specimen of this ore from Joachimsthal, analysed lately by Klaproth, contained
86.5 uranium,
6.0 sulphuret of lead,
5.0 silica,
2.5 oxide of iron.

100.0 *

* *Beiträge,* ii. 221.

SPECIES 2. Yellow oxide of uranium ‡. *Uranitic ochre.*

281 Yellow oxide of uranium.

This ore is generally found on the surface of the last species at Johanngeorgenstadt, and is either massive or in powder.

‡ *Kirwan,* ii. 303.

Colour yellow, red, or brown. Streak of the yellow sorts yellow; of the red, orange yellow. Lustre 0. Slightly stains the fingers. Feels meagre. Texture earthy. Hardness 3 to 4. Sp. gr. 3.2438 ||. Infusible by the blow-pipe; but in a strong heat becomes browniſh grey.

|| *Hauy, Jour. de Min. ibid.*

Composed of oxide of uranium and oxide of iron.

(s) *Kirw.* II. 314.—*Scheele's Works* (French translation), II. 81.—*Bergman, ibid.* p. 94.—*Crell, Chem. Annalen.* 1784, 2 *Bard* 195.

(T) *Kirw.* II. 322.—*Scheele's Works* (French translation), I. 236.—*Pelletier, Jour. de Phyſ.* XXVII. 434.—*Ilſemann, ibid.* XXXIII. 292.—*Sage, ibid.* 389.—*Klaproth* and *Modeer, Ann. de Chim.* III. 120.

Ores of Titanium.

Genus II. Salts of uranium.

Species 1. Carbonat of uranium ¶.

282 G. II. Salts Carbonat of uranium

This ſubſtance is alſo found at Johanngeorgenſtadt, and near Eibenſtock and Rheinbreidenbach §. It is ſometimes amorphous, but more commonly cryſtallized. Its cryſtals are ſquare plates, octahedrons, and ſix ſided priſms.

¶ *Kirwan*, ii. 304.
§ *Gmelin.*

Colour green; ſometimes nearly white; ſometimes, though rarely, yellow. Streak greeniſh white. Luſtre 3 to 2; internal, 2; ſometimes pearly; ſometimes nearly metallic. Tranſparency 2 to 3. Texture foliated. Hardneſs 5 to 6. Brittle. Soluble in nitric acid without effervescence. Infuſible by alkalies.

Compoſed of carbonat of uranium, with ſome oxide of copper. When its colour is yellow it contains no copper.

Order XIX. Ores of Titanium.

Titanium has been known for ſo ſhort a time, and its properties are yet ſo imperfectly aſcertained, that many of its uſes muſt remain to be diſcovered. Its oxide, as we learn from Mr Darcet, has been employed in painting on porcelain *. Hitherto it has been found only in the primitive mountains, the Crapacks †, the Alpes (u), and the Pyrenees ‡. It has been found alſo in Brittany ‖ and in Cornwal.

* *Jour. de Min.* N° xv. 27.
† *Ibid.* N° xii. 51.
‡ *Jour. de Min.* N° xxxii. 614.
‖ *Ibid.*

Genus I. Oxides of titanium.

Species 1. Red oxide of Titanium.

Red ſhorl—Sagenite.

283 G. I. Oxides. Red oxide of titanium.

This ore has been found in Hungary, the Pyrenees, the Alpes, and in Brittany in France. It is generally cryſtallized. The primitive form of its cryſtals, according to the obſervations of Mr Hauy, is a rectangular priſm, whoſe baſe is a ſquare; and the form of its molecules is a triangular priſm, whoſe baſe is a right angled iſoſceles triangle, and the height is to any of the ſides of the baſe about the right angle as $\sqrt{12}$ to $\sqrt{5}$, or nearly as 3 : 2 ¶. Sometimes the cryſtals of titanium are ſix-ſided, and ſometimes four-ſided, priſms, and often they are implicated together ‡.

¶ *Jour. de Min.* N° xv. 28. and xxxii. 615.
‡ Fig. 44.

Colour red or browniſh red. Powder brick or orange red. Luſtre 3. Tranſparency commonly 0; ſometimes 1. Texture foliated. Hardneſs 9. Brittle. Sp. gr. from 4.18 * to 4.2469 †. Not affected by the mineral acids. When fuſed with carbonat of potaſs, and diluted with water, a white powder precipitates, heavier than the titanium employed. Before the blow-pipe it does not melt, but becomes opaque and brown. With microcoſmic ſalt it forms a globule of glaſs, which appears black; but its fragments are violet. With borax it forms a deep yellow glaſs, with a tint of brown. With ſoda it divides and mixes, but does not form a tranſparent glaſs.

* *Klaproth*
† *Vauquelin* and *Hecht.*

When pure, it is compoſed entirely of oxide of titanium.

Species 2. Menachanite (x).

Oxide of titanium combined with iron.

284 Menachanite.

This ſubſtance has been found abundantly in the valley of Menachan in Cornwal; and hence was called menachanite by Mr Gregor, the diſcoverer of it. It is in ſmall grains, like gunpowder, of no determinate ſhape, and mixed with a fine grey ſand. Colour black. Eaſily pulverized. Powder attracted by the magnet. Sp. gr. 4.427. Does not detonate with nitre. With two parts of fixed alkali it melts into an olive coloured maſs, from which nitric acid precipitates a white powder. The mineral acids only extract from it a little iron. Diluted ſulphuric acid, mixed with the powder, in ſuch a proportion that the maſs is not too liquid, and then evaporated to dryneſs, produces a blue coloured maſs. Before the blow-pipe does not decrepitate nor melt. It tinges microcoſmic ſalt green; but the colour becomes brown on cooling: yet microcoſmic ſalt does not diſſolve it. Soluble in borax, and alters its colour in the ſame manner.

Metallic ores.

According to the analyſis of Mr Gregor, it is compoſed of

46 oxide of iron,
45 oxide of titanium.

91 with ſome ſilica and manganeſe †.

† *M. Gregor. Jour. de Phyſ.* xxxix. 72. 152.

According to Mr Klaproth's analyſis, it is compoſed of

51.00 oxide of iron,
45.25 oxide of titanium,
3.50 ſilica,
.25 oxide of manganeſe.

100.00 ‡

‡ *Beiträge*, ii. 231.

A mineral, nearly of the ſame nature with the one juſt deſcribed, has been found in Bavaria. Its ſpecific gravity, however, is only 3.7. According to the analyſis of Vauquelin and Hecht, it is compoſed of

49 oxide of titanium,
35 iron,
2 manganeſe,
14 oxygen combined with the iron and manganeſe.

100 §

§ *Jour. de Min.* N° xix. 57.

Species 3. Calcareo-ſiliceous ore of titanium.

Oxide of titanium combined with lime and ſilica—Titanite †.

285 Calcareo-ſiliceous ore of titanium.

† *Kirwan*, ii. 331.

This ore has hitherto been found only near Paſſau. It was diſcovered by Profeſſor Hunger. It is ſometimes maſſive, but more commonly cryſtallized in four-ſided priſms, not longer than one fourth of an inch.

Colour reddiſh, yellowiſh, or blackiſh brown; ſometimes whitiſh grey. Powder whitiſh grey. Luſtre waxy or nearly metallic, 2 to 3. Tranſparency from 0 to 2. Texture foliated. Hardneſs 9 or more. Brittle. Sp. gr. 3.510. Muriatic acid, by repeated digeſtion, diſſolves one-third of it. Ammonia precipitates from this ſolution a clammy yellowiſh ſubſtance. Infuſible by the blow pipe, and alſo in a clay crucible; but in charcoal is converted into a black opaque porous ſlag.

According to the analyſis of Klaproth, it is compoſed of

33 oxide of titanium,
35 ſilica,
33 lime.

101

Order

(u) *Dolomieu, Jour. de Min.* N° XLII. 431. and *Sauſſure, Voyages*, N° 1894.
(x) *Kirw.* II. 326.—*Gregor, Jour. de Phyſ.* XXXIX. 72. and 152.—*Schmeiſſer, Crell's Annals* (Engliſh tranſlation), III. 252.

Ores of Tellurium.

Order XX. ORES OF TELLURIUM.

Hitherto tellurium has only been found in Tranſylvania. It occurs in three different mines; that of Fatzbay, Offenbanya, and Nagyag, which are conſidered as gold mines, becauſe they contain leſs or more of that metal. Its gangue is commonly quartz.

286 G. I. Alloys. White gold ore of Fatzbay.

Genus I. alloys of tellurium.

species 1. White gold ore of Fatzbay.

Alloy of tellurium and iron, with ſome gold.

This ſpecies is generally maſſive. Its colour is between tin white and lead grey. Luſtre conſiderable, metallic. Texture granular *.

* *Ann. de Chim.* xxv. 327.

According to Klaproth's analyſis, it is compoſed of

72.0 iron,
25.5 tellurium,
2.5 gold.

100.0 †

† *Ibid.* 280.

287 Graphic gloden ore of Offenbanya.

species 2. Graphic golden ore of Offenbanya.

Tellurium alloyed with gold and ſilver.

This ore is compoſed of flat priſmatic cryſtals; the arrangement of which has ſome reſemblance to Turkiſh letters. Hence the name of the ore.

‡ *Ann. de Chim.* xxv. 328.

Colour tin white, with a tinge of braſs yellow ‡. Luſtre metallic, 3, Hardneſs 4 to 5. Brittle. Sp. gr. 5.723. Before the blow-pipe decrepitates, and melts like lead. Burns with a lively brown flame and diſagreeable ſmell, and at laſt vaniſhes in a white ſmoke, leaving only a whitiſh earth ||.

|| *De Born, Kirwan's Min.* ii. 110.

According to Klaproth's analyſis it is compoſed of

60 tellurium,
30 gold,
10 ſilver.

100 §

§ *Ann. de Chim.* xxv. 280.

The yellow gold ore of Nagyag would belong to this ſpecies were it not that it contains lead. Its compoſition, according to Klaproth's anaylſis, is as follows:

45.0 tellurium,
27.0 gold,
19.5 lead,
8.5 ſilver,

100.0 and an atom of ſulphur *.

* *Ibid.*

288 Grey foliated gold ore of Nagyag.

species 3. Grey foliated gold ore of Nagyag.

This ore is found in plates, of different degrees of thickneſs, adhering to one another, but eaſily ſeparable: theſe are ſometimes hexahedral, and often accumulated ſo as to leave cells between them.

Colour deep lead grey, paſſing to iron black, ſpotted. Luſtre metallic, moderate. Texture foliated; leaves ſlightly flexible †. Hardneſs 6. Sp. gr. 8.919. Stains the fingers. Soluble in acids with effervescence ‡.

† *Klaproth, Ann. de Chim.* xxv. 329.

‡ *De Born, Kirwan's Min.* ii. 99.

According to Klaproth, it is compoſed of

50.0 lead,
33.0 tellurium,
8.5 gold,
7.5 ſulphur,
1.0 ſilver and copper.

100.0 §

§ *Ann. de Chim. ibid.* 280.

Metallic Ores.

Order XXI. ORES OF CHROMUM.

Chromum has hitherto been found in too ſmall quantities for its extenſive application to the arts. Whenever it becomes plentiful, its properties will render it of great importance both to the dyer and painter. Nature has uſed it to colour ſome of her moſt beautiful mineral productions: And can art copy after a better model? Hitherto it has been found only in two places, near Ekaterinbourg in Siberia, and in the department of the Var in France. In the firſt of theſe places, and probably alſo in the ſecond, its gangue is quartz.

289 G. I. Salts. Chromat of lead.

Genus I. salts of chromum.

species 1. Chromat of lead.

Red lead ore of Siberia.

This ſingular mineral, which has now become ſcarce, is found in the gold mines of Bereſof near Ekaterimbourg in Siberia, cryſtallized in four-ſided priſms, ſometimes terminated by four-ſided pyramids, ſometimes not.

Colour red, with a ſhade of yellow. Streak and powder a beautiful orange yellow. Luſtre from 2 to 3. Tranſparency 2 to 3. Structure ſo liated. Texture compact. Fracture uneven. Hardneſs 5 to 4. Sp. gr. 6.0269 † to 5.75 ‡. Does not effervesce with acids. Before the blow-pipe decrepitates; ſome lead is reduced, and the mineral is converted to a black ſlag, which tinges borax green.

† *Briſſon.* ‡ *Bindheim.*

According to the analyſis of Vauquelin, it is compoſed of

65.12 oxide of lead,
34.88 chromic acid.

100.00 ||.

|| *Jour. de Min.* N° xxxiv. 760.

species 2. Chromat of iron.

290 Chromat of iron.

This mineral, which has been found only near Gaſſin in the department of Var in France, is in irregular meſſas.

Colour brown, not unlike that of brown blende. Luſtre metallic. Hardneſs moderate. Sp. gr. 4.0326. Melts with difficulty before the blow-pipe; to borax it communicates a dirty green. Inſoluble in nitric acid. Melted with potaſs, and diſſolved in water, the ſolution aſſumes a beautiful orange yellow colour.

It is compoſed of 63.6 chromic acid,
36.0 oxide of iron.

99.6 †

† *Taſſaert, Ann. de Chim.* xxxi. 220.

Chap. V. Of the Chemical Analysis of Minerals.

291 Analyſis of minerals.

The progreſs which the art of analyſing minerals has made within theſe laſt twenty years is truly aſtoniſhing. To ſeparate five or ſix ſubſtances intimately combined together, to exhibit each of them ſeparately, to aſcertain the preciſe quantity of each, and even to detect the preſence and the weight of ſubſtances which do not approach $\frac{1}{100}$th part of the compound, would, at no very remote period, have been conſidered as a hopeleſs, if not an impoſſible, taſk; yet this can now be done with the moſt rigid accuracy.

292 Begun by Margraff.

The firſt perſon who undertook the analyſis of minerals was Margraff of Berlin. His attempts were indeed rude; but their importance was ſoon perceived by other chemiſts, particularly by Bergman and Scheele,

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whoſe induſtry and addreſs brought the art of analyſing minerals to a conſiderable degree of perfection.

But their methods, though they had very conſiderable merit, and, conſidering the ſtate of the ſcience, are wonderful proofs of the genius of the inventors, were often tedious and uncertain, and could not in all caſes be applied with confidence. Theſe defects were perceived by Mr Klaproth of Berlin, who applied himſelf to the analyſis of minerals with a perſevering induſtry which nothing could fatigue, and an ingenuity and accuracy which nothing could perplex. He corrected what was wrong, and ſupplied what was wanting, in the analytical method; invented new proceſſes, diſcovered new inſtruments; and it is to his labours, more than to thoſe of any other chemiſt, that the degree of perfection, to which the analyſis of minerals has attained, is to be aſcribed. Many improvements, however, were introduced by other chemiſts, eſpecially by Mr Vauquelin, whoſe analyſes in point of accuracy and ingenuity rival thoſe of Klaproth himſelf.

293 Improved by Klaproth

294 And other chemiſts.

We ſhall, in this chapter, give a ſhort deſcription of the moſt perfect method of analyſing minerals, as far as we are acquainted with it. We ſhall divide the chapter into four ſections. In the firſt, we ſhall give an account of the inſtruments uſed in analyſes; in the ſecond, we ſhall treat of the method of analyſing ſtones; in the third, of analyſing combuſtibles; and in the fourth, of the analyſes of ores.

Sect. I. *Of the Inſtruments of Analyſes.*

295 Method of obtaining chemical agents pure.

I. The chymical agents, by means of which the analyſis of minerals is accompliſhed, ought to be prepared with the greateſt care, becauſe upon their purity the exactneſs of the operation entirely depends. Theſe agents are the three alkalies, both pure and combined with carbonic acid; the ſulphuric, nitric, and muriatic acids; hydroſulphuret of potaſs and ſulphurated hydrogen gas diſſolved in water; pruſſic alkali, and a few neutral ſalts.

1. Potaſs and ſoda may be obtained pure, either by means of alcohol, or by the method deſcribed in the article Chemistry, n° 372. *Suppl.* Theſe alkalies are known to be pure when their ſolution in pure water occaſions no precipitate in lime and barytic water; when the precipitate which it produces in a ſolution of ſilver is completely diſſolved by nitric acid; and, laſtly, when ſaturated with carbonic acid it depoſits no ſilica.

2. Ammonia is procured by diſtilling one part of muriat of ammonia with two parts of quicklime, and receiving the gas in a diſh containing a quantity of pure water, equal in weight to the muriat employed. Its purity is known by the ſame teſts which aſcertain the purity of fixed alkalies.

3. The carbonats of potaſs and ſoda may be formed by diſſolving the potaſs and ſoda of commerce in pure water, ſaturating the ſolution with carbonic acid, and cryſtallizing them repeatedly. When pure, theſe cryſtals effloreſce in the air; and the precipitate which they occaſion in ſolutions of barytes and of ſilver is completely ſoluble in nitric acid. Carbonat of ammonia is obtained by diſtilling together one part of muriat of ammonia and two parts of carbonat of lime.

4. The ſulphuric acid of commerce often contains nitric acid, potaſs, lead &c. It may be purified by diſtillation in a low cucurbite. The firſt portion, when it comes over, muſt be ſet aſide; it contains the nitric acid. The other impurities remain behind in the cucurbite. Sulphuric acid, when pure, diſſolves indigo without altering its colour, does not attack mercury while cold, and cauſes no precipitate in pure alkaline ſolutions.

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5. Nitric acid often contains both ſulphuric and muriatic acids. It is eaſily purified by throwing into it about three parts of litharge in fine powder for every 100 parts of the acid, allowing the mixture to remain for 24 hours, ſhaking it occaſionally, and then diſtilling it. The ſulphuric and muriatic acids combine with the lead, and remain behind in the retort. Pure nitric acid occaſions no precipitate in the ſolutions of barytes and ſilver.

6. The muriatic acid of commerce uſually contains ſulphuric acid, oxymuriatic acid, and oxide of iron. It may be purified by diſtillation with a little muriat of ſoda; taking care to ſet aſide the firſt portion which comes over. When pure it cauſes no precipitate in the ſolution of barytes, nor of pure alkalies, and does not attack mercury while cold.

7. Hydroſulphuret of potaſs is made by ſaturating a ſolution of pure potaſs with ſulphurated hydrogen gas; and water may be ſaturated with ſulphurated hydrogen gas in the ſame manner. See Chemistry, n° 857. *Suppl.*

8. The method of preparing pruſſic alkali, oxalic acid, and the other ſubſtances uſed in analyſes, has been already deſcribed in the article Chemistry, *Suppl.* it is unneceſſary therefore to repeat it here.

296 How to reduce the mineral to powder.

II. Before a mineral is ſubmitted to analyſis, it ought to be reduced to an impalpable powder. This is by no means an eaſy taſk when the ſtone is extremely hard. It ought to be raiſed to a bright red or white heat in a crucible, and then inſtantly thrown into cold water. This ſudden tranſition makes it crack and break into pieces. If theſe pieces are not ſmall enough, the operation may be repeated on each till they are reduced to the proper ſize. Theſe fragments are then to be beaten to ſmall pieces in a poliſhed ſteel mortar; the cavity of which ſhould be cylindrical, and the ſteel peſtle ſhould fit it exactly, in order to prevent any of the ſtone from eſcaping during the act of pounding. As ſoon as the ſtone is reduced to pretty ſmall pieces, it ought to be put into a mortar of rock cryſtal or flint, and reduced to a coarſe powder. This mortar ſhould be about four inches in diameter, and rather more than an inch in depth. The peſtle ſhould be formed of the ſame ſtone with the mortar, and care ſhould be taken to know exactly the ingredients of which this mortar is compoſed. Klaproth's mortar is of flint. We have given its analyſis in n° 32. of this article.

When the ſtone has been reduced to a coarſe powder, a certain quantity, whoſe weight is known exactly, 100 grains for inſtance, ought to be taken and reduced to as fine a powder as poſſible. This is beſt done by pounding ſmall quantities of it at once, not exceeding 10 grains. The powder is as fine as poſſible when it feels ſoft, adheres together, and as it were forms a cake under the peſtle. It ought then to be weighed exactly. It will almoſt always be found heavier after being pounded than it was before; owing to a certain quantity of the ſubſtance of the mortar which has been rubbed off during the grinding and mixed with the powder.

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der. This additional weight muſt be carefully noted; and after the analyſis, a portion of the ingredients of the mortar, correſponding to it, muſt be ſubtracted.

297 Chemical diſhes.

III. It is neceſſary to have a crucible of pure ſilver, or, what is far preferable, of platinum, capable of holding rather more than ſeven cubic inches of water, and provided with a cover of the ſame metal. There ſhould alſo be ready a ſpatula of the ſame metal about four inches long.

The diſhes in which the ſolutions, evaporations, &c. are performed, ought to be of glaſs or porcelain. Thoſe of porcelain are cheaper, becauſe they are not ſo apt to break. Thoſe which Mr Vauquelin uſes are of porcelain; they are ſections of ſpheres, and are glazed both within and without, except that part of the bottom which is immediately expoſed to the fire.

SECT. II. *Analyſis of Stones* (y).

298 Ingredients of ſtones.

The only ſubſtances which enter into the compoſition of the ſimple ſtones, as far at leaſt as analyſis has diſcovered, are the ſix earths, ſilica, alumina, zirconia, glucina, lime, and magneſia; and the oxides of iron, manganeſe, nickel, chromum, and copper (z). Seldom more than four or five of theſe ſubſtances are found combined together in the ſame ſtone: we ſhall ſuppoſe, however, in order to prevent unneceſſary repetitions, that they are all contained in the mineral which we are going to analyſe.

259 Method of decompoſing ſtones.

Let 100 or 200 grains of the ſtone to be analyſed, previouſly reduced to a fine powder, be mixed with three times its weight of pure potaſs and a little water, and expoſed in the ſilver or platinum crucible to a ſtrong heat. The heat ſhould at firſt be applied ſlowly, and the matter ſhould be conſtantly ſtirred, to prevent the potaſs from ſwelling and throwing any part out of the crucible. When the whole water is evaporated, the mixture ſhould be kept for half an hour or three quarters in a ſtrong red heat.

If the matter in the crucible melts completely, and appears as liquid as water, we may be certain that the ſtone which we are analyſing conſiſts chiefly of ſilica; if it remains opaque, and of the conſiſtence of paſte, the other earths are moſt abundant; if it remains in the form of a powder, alumina is the prevalent earth. If the matter in the crucible be of a dark or browniſh red colour, it contains oxide of iron; if it is graſs green, manganeſe is preſent; if it is yellowiſh green, it contains chromum.

When the crucible has been taken from the fire and wiped on the outſide, it is to be placed in a capſule of porcelain, and filled with water. This water is to be renewed from time to time till all the matter is detached from the crucible. The water diſſolves a part of the combination of the alkali with the ſilica and alumina of the ſtone; and if a ſufficient quantity were uſed, it would diſſolve the whole of that combination.

Muriatic acid is now to be poured in till the whole of the matter is diſſolved. At firſt a flaky precipitate appears, becauſe the acid combines with the alkali which kept it in ſolution. Then an effervescence takes place, owing to the decompoſition of ſome carbonat of potaſs formed during the fuſion. At the ſame time the flaky precipitate is rediſſolved; as is alſo that part of the matter which, not having been diſſolved in the water, had remained at the bottom of the diſh in the form of a powder. This powder, if it conſiſts only of ſilica and alumina, diſſolves without effervescence; but if it contains lime, an effervescence takes place. Analyſis of Minerals.

If this ſolution in muriatic acid be colourleſs, we may conclude that it contains no metallic oxide, or only a very ſmall portion; if its colour be purpliſh red, it contains manganeſe; orange red indicates the preſence of iron; and golden yellow the preſence of chromum.

This ſolution is to be poured into a capſule of porcelain, covered with paper, and evaporated to dryneſs in a ſand bath. When the evaporation is drawing towards its completion, the liquor aſſumes the form of jelly. It muſt then be ſtirred conſtantly with a glaſs or porcelain rod, in order to facilitate the diſengagement of the acid and water, and to prevent one part of the matter from being too much, and another not ſufficiently dried. Without this precaution, the ſilica and alumina would not be completely ſeperated from each other.

300 How the ſilica is ſeparated.

When the matter is reduced almoſt to a dry powder, a large quantity of pure water is to be poured on it; and, after expoſure to a ſlight heat, the whole is to be poured on a filter. The powder which remains upon the filter is to be waſhed repeatedly, till the water with which it has been waſhed ceaſes to precipitate ſilver from its ſolutions. This powder is the whole of the *ſilica* which the ſtone that we are analyſing contained. It muſt firſt be dried between folds of blotting paper, then heated red hot in a platinum or ſilver crucible, and weighed while it is yet warm. It ought to be a fine powder, of a white colour, not adhering to the fingers, and entirely ſoluble in acids. If it be coloured, it is contaminated with ſome metallic oxide; and ſhews, that the evaporation to dryneſs has been performed at too high a temperature. To ſeparate this oxide, the ſilica muſt be boiled with an acid, and then waſhed and dried as before. The acid ſolution muſt be added to the water which paſſed through the filter, and which we ſhall denominate A.

The watery ſolution A is to be evaporated till its quantity does not exceed 30 cubic inches, or nearly an Engliſh pint. A ſolution of carbonat of potaſs is then to be poured into it till no more matter precipitates. It ought to be boiled a few moments to enable all the precipitate to fall to the bottom. When the whole of the precipitate has collected at the bottom, the ſupernatant liquid is to be decanted off; and water being ſubſtituted in its place, the precipitate and water are to be thrown upon a filter. When the water has run off, the filter with the precipitate upon it is to be placed between folds of blotting paper. When the precipitate has acquired ſome conſiſtence, it is to be carefully collected by an ivory knife, mixed with a ſolution of pure potaſs, and boiled in a porcelain capſule. If any alumina

(y) Part of this ſection is to be conſidered as an abſtract of a treatiſe of Vauquelin on the analyſis of ſtones, publiſhed in the *Annales de Chimie*, Vol. XXX. p. 66.

(z) Barytes has alſo been diſcovered in one ſingle ſtone, the *ſtaurolite*; but its preſence in ſtones is ſo uncommon, that it can ſcarcely be looked for. The method of detecting it ſhall be noticed afterwards.

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alumina or glucina be preſent, they will be diſſolved in the potaſs; while the other ſubſtances remain untouched in the form of a powder, which we ſhall call B.

301 And the alumina,

Into the ſolution of potaſs as much acid muſt be poured as will not only ſaturate the potaſs, but alſo completely rediſſolve any precipitate which may have at firſt appeared. Carbonat of ammonia is now to be added in ſuch quantity that the liquid ſhall taſte of it. By this addition the whole of the alumina will be precipitated in white fleaks, and the glucina will remain diſſolved, provided the quantity of carbonat of ammonia uſed be not too ſmall. The liquid is now to be filtered, and the alumina which will remain on the filter is to be waſhed, dried, heated red hot, and then weighed. To ſee if it be really alumina, diſſolve it in ſulphuric acid, and add a ſufficient quantity of ſulphat or acetite of potaſs; if it be alumina, the whole of it will be converted into cryſtals of alum.

302 Glucina,

Let the liquid which has paſſed through the filter be boiled for ſome time, and the glucina, if it contains any, will be precipitated in a light powder, which may be dried and weighed. When pure, it is a fine, ſoft, very light, taſteleſs powder, which does not concrete when heated, as alumina does.

303 Lime,

The reſiduum B may contain lime, magneſia, and one or more metallic oxides. Let it be diſſolved in weak ſulphuric acid, and the ſolution evaporated to dryneſs. Pour a ſmall quantity of water on it. The water will diſſolve the ſulphat of magneſia, and the metallic ſulphats; but the ſulphat of lime will remain undiſſolved. Let it be heated red hot in a crucible, and weighed. The lime amounts to 0.41 of the weight.

Let the ſolution containing the remaining ſulphats be diluted with a large quantity of water, let a ſmall exceſs of acid be added, and then let a ſaturated carbonat of potaſs be poured in. The oxides of chromum, iron, and nickel, will be precipitated, and the magneſia and oxide of manganeſe will remain diſſolved. The precipitate we ſhall call C.

304 Manganeſe,

Into the ſolution let a ſolution of hydroſulphuret of potaſs be poured, and the manganeſe will be precipitated in the ſtate of a hydroſulphuret. Let it be calcined in contact with air, and weighed. The magneſia may then be precipitated by pure potaſs, waſhed, expoſed to a red heat, and then weighed.

305 Magneſia,

Let the reſiduum C be boiled repeatedly with nitric acid, then mixed with pure potaſs; and after being heated, let the liquid be decanted off. Let the precipitate, which conſiſts of the oxides of iron and nickel, be waſhed with pure water; and let this water be added to the ſolution of the nitric acid and potaſs. That ſolution contains the chromum converted into an acid. Add to this ſolution an exceſs of muriatic acid, and evaporate till the liquid aſſumes a green colour; then add a pure alkali: The chromum precipitates in the ſtate of an oxide, and may be dried, and weighed.

306 Chromum,

307 Iron,

Let the precipitate, conſiſting of the oxides of iron and nickel, be diſſolved in muriatic acid; add an exceſs of ammonia: the oxide of iron precipitates. Let it be waſhed, dried, and weighed.

308 And nickel.

Evaporate the ſolution, and the oxide of nickel will alſo precipitate; and its weight may be aſcertained in the ſame manner with the other ingredients.

The weights of all the ingredients obtained are now to be added together, and their ſum-total compared with the weight of the matter ſubmitted to analyſis. If the two are equal, or if they differ only by .03 or .04 parts, we may conclude that the analyſis has been properly performed: but if the loſs of weight be conſiderable, ſomething or other has been loſt. The analyſis muſt therefore be repeated with all poſſible care. If there is ſtill the ſame loſs of weight, we may conclude that the ſtone contains ſome ſubſtance, which has either evaporated by the heat, or is ſoluble in water.

Analyſis of Minerals.

309 Method of detecting volatile bodies.

A freſh portion of the ſtone muſt therefore be broken into ſmall pieces, and expoſed in a porcelain crucible to a ſtrong heat. If it contains water, or any other volatile ſubſtance, they will come over into the receiver; and their nature and weight may be aſcertained.

If nothing comes over into the receiver, or if what comes over is not equal to the weight wanting, we may conclude that the ſtone contains ſome ingredient which is ſoluble in water.

310 Method of aſcertaining whether ſtones contain potaſs

To diſcover whether it contains *potaſs*, let the ſtone, reduced to an impalpable powder, be boiled five or ſix times in ſucceſſion, with very ſtrong ſulphuric acid, applying a pretty ſtrong heat towards the end of the operation, in order to expel the exceſs of acid; but taking care that it be not ſtrong enough to decompoſe the ſalts which have been formed.

Water is now to be poured on, and the reſiduum, which does not diſſolve, is to be waſhed with water till it becomes taſteleſs. The watery ſolution is to be filtered, and evaporated to dryneſs, in order to drive off any exceſs of acid which may be preſent. The ſalts are to be again diſſolved in water; and the ſolution, after being boiled for a few moments, is to be filtered and evaporated to a conſiſtence proper for cryſtallizing. If the ſtone contains a ſufficient quantity of alumina, and if potaſs be preſent, cryſtals of alum will be formed; and the quantity of potaſs may be diſcovered by weighing them, it being nearly $\frac{1}{10}$th of their weight. If the ſtone does not contain alumina, or not in ſufficient quantity, a ſolution of pure alumina in ſulphuric acid muſt be added. Sometimes the alum, even when potaſs is preſent, does not appear for ſeveral days, or even weeks; and ſometimes, when a great quantity of alumina is preſent, if the ſolution has been too much concentrated by evaporation, the ſulphat of alumina prevents the alum from cryſtallizing at all. Care, therefore, muſt be taken to prevent this laſt ſource of error. The alum obtained may be diſſolved in water, and barytic water poured into it as long as any precipitate forms. The liquor is to be filtered, and evaporated to dryneſs. The reſiduum will conſiſt of potaſs and a little carbonat of potaſs. The potaſs may be diſſolved in a little water. This ſolution, evaporated to dryneſs, gives us the potaſs pure; which may be examined and weighed.

311 Or ſoda.

If no cryſtals of alum can be obtained, we muſt look for ſome other ſubſtance than potaſs. The ſtone, for inſtance, may contain ſoda. The preſence of this alkali may be diſcovered by decompoſing the ſolution in ſulphuric acid, already deſcribed, by means of ammonia. The liquid which remains is to be evaporated to dryneſs, and the reſiduum is to be calcined in a crucible. By this method, the ſulphat of ammonia will be volatilized, and the ſoda will remain. It may be rediſſolved in water, cryſtallized, and examined.

If ſulphuric acid does not attack the ſtone, as is often the caſe, it muſt be decompoſed by fuſion with ſoda,

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da, in the ſame manner as formerly directed with potaſs. The matter, after fuſion, is to be diluted with water, and then ſaturated with ſulphuric acid. The ſolution is to be evaporated to dryneſs, the reſiduum again diſſolved in water, and evaporated. Sulphat of ſoda will cryſtallize firſt; and by a ſecond evaporation, if the ſtone contains potaſs and alumina, cryſtals of alum will be depoſited.

The preſence of potaſs may be diſcovered, by mixing with a ſomewhat concentrated ſolution of muriat of platinum, the ſalt obtained, either by decompoſing the ſtone immediately by an acid, or by ſaturating with an acid the matter obtained by fuſing the ſtone with ſoda. If any potaſs be preſent, a very red precipitate will be formed. This precipitate is a triple ſalt, compoſed of potaſs, muriatic acid, and oxide of platinum. Ammonia, indeed, produces the ſame precipitate; but ammonia has not hitherto been diſcovered in ſtones.

312 Analyſis of ſaline ſtones,

In this manner may ſimple ſtones and aggregates be analyſed. As to ſaline ſtones, their analyſis muſt vary according to the acid which they contain. But almoſt all of them may be decompoſed by one or other of two methods; of each of which we ſhall give an example.

I. Analyſis of Carbonat of Strontites.

313 Of Carbonats,

Klaproth analyſed this mineral by diſſolving 100 parts of it in diluted muriatic acid: during the ſolution, 30 parts of carbonic acid eſcaped. The ſolution cryſtallized in needles, and when diſſolved in alcohol, burnt with a purple flame. Therefore it contained ſtrontites. He diſſolved a grain of ſulphat of potaſs in ſix ounces of water, and let fall into it three drops of the muriatic ſolution. No precipitate appeared till next day. Therefore the ſolution contained no barytes; for if it had, a precipitate would have appeared immediately.

He then decompoſed the muriatic acid ſolution, by mixing it with carbonat of potaſs. Carbonat of ſtrontites precipitated. By the application of a ſtrong heat, the carbonic acid was driven off. The whole of the earth which remained was diſſolved in water. It cryſtallized; and when dried, weighed 69½*.

* *Klaproth's Beiträge*, i. 260.

II. Analyſis of Sulphat of Strontites.

Mr Vauquelin analyſed an impure ſpecimen of this mineral as follows:

314 Sulphats,

On 200 parts of the mineral, diluted nitric acid was poured. A violent effervescence took place, and part of the mineral was diſſolved. The undiſſolved portion, after being heated red hot, weighed 167. Therefore 33 parts were diſſolved.

The nitric ſolution was evaporated to dryneſs: A reddiſh ſubſtance remained, which indicated the preſence of oxide of iron. This ſubſtance was rediſſolved in water, and ſome ammonia mixed with it; a reddiſh precipitate appeared, which, when dried, weighed 1, and was oxide of iron. The remainder of the ſolution was precipitated by carbonat of potaſs. The precipitate weighed, when dried, 20, and poſſeſſed the properties of carbonat of lime. Therefore 200 parts of this mineral contain 20 of carbonat of lime, 1 of oxide of iron, and the remainder of the 33 parts he concluded to be water.

The 167 parts, which were inſoluble in nitric acid, were mixed with 500 parts of carbonat of potaſs, and 7000 parts of water, and boiled for a conſiderable time. The ſolution was then filtered, and the reſiduum waſhed and dried. The liquid ſcarcely effervesced with acids; but with barytes it produced a copious precipitate, totally indiſſoluble in muriatic acid. Therefore it contained ſulphuric acid. Analyſis of Minerals.

The undiſſolved reſiduum, when dried, weighed 129 parts. It diſſolved completely in muriatic acid. The ſolution cryſtallized in needles; when diſſolved in alcohol, it burnt with a purple flame; and, in ſhort, had all the properties of muriat of ſtrontites. Therefore theſe 129 parts were carbonat of ſtrontites. Now, 100 parts of this carbonat contain 30 of carbonic acid; therefore 129 contain 38.7. Therefore the mineral muſt contain in 200 parts 90.3 of ſtrontites.

Now, the inſoluble reſiduum of 167 parts was pure ſulphat of ſtrontites; and we have ſeen that it contained 90.3 of ſtrontites. Therefore the ſulphuric acid muſt amount to 76.7 parts *.

* *Jour. de Min.* N° xxxvii. p. 1.

Nearly in the ſame manner as in the firſt of theſe examples, may the analyſis of carbonat of lime and barytes be performed; and nearly in the ſame manner with the ſecond, we may analyſe the ſulphats of lime and barytes.

315 Phoſphats,

Phoſphat of lime may be diſſolved in muriatic acid, and the lime precipitated by ſulphuric acid, and its quantity aſcertained by decompoſing the ſulphat of lime obtained. The liquid ſolution may be evaporated to the conſiſtence of honey, mixed with charcoal powder, and diſtilled in a ſtrong heat. By this means phoſphorus will be obtained. The impurities with which the phoſphat may be contaminated will partly remain undiſſolved, and be partly diſſolved, in muriatic acid. They may be detected and aſcertained by the rules laid down in the ſecond ſection of this chapter.

316 Fluats,

The fluat of lime may be mixed with ſulphuric acid and diſtilled. The fluoric acid will come over in the form of gas, and its weight may be aſcertained. What remains in the retort, which will conſiſt chiefly of ſulphat of lime, may be analyſed by the rules already laid down.

317 And borats.

The borat of lime may be diſſolved in nitric or ſulphuric acid. The ſolution may be evaporated to dryneſs, and the boracic acid ſeparated from the reſiduum by means of alcohol, which will diſſolve it without acting on any of the other ingredients. The remainder of the dry maſs may be analyſed by the rules laid down in Sect. II. of this Chapter.

SECT. III. *Of the Analyſis of Combuſtibles.*

THE only combuſtibles of whoſe analyſis it will be neceſſary to ſpeak are coals and ſulphur; for the method of analyſing the diamond and oil has already been given in the article CHEMISTRY, *Suppl.*

318 Earths of coal how examined.

Coal is compoſed of carbon, bitumen, and ſome portion of earth. The earths may be detected by burning completely a portion of the coal to be analyſed. The aſhes which remain after incineration conſiſt of the earthy part. Their nature may be aſcertained by the rules laid down in Sect. II. of this Chapter.

For the method of aſcertaining the proportion of carbon and bitumen in coal, we are indebted to Mr Kirwan.

319 Method of detecting the relative proportions of charcoal and bitumen.

When nitre is heated red hot, and charcoal is thrown on it, a violent detonation takes place; and if the quantity of charcoal be ſufficient, the nitre is completely decompoſed. Now, it requires a certain quantity of pure carbon

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carbon to decompoſe a given weight of nitre. From the experiments of Lavoiſier, it follows that, when the detonation is performed in cloſe veſſels under water, 13.21 parts of charcoal are capable of decompoſing 100 parts of nitre *. But when the detonation is performed in an open crucible, a ſmaller proportion of charcoal is neceſſary, becauſe part of the nitre is decompoſed by the action of the ſurrounding air. Scheele found that under theſe circumſtances 10 parts of plumbago were ſufficient to decompoſe 96 parts of nitre, and Mr Kirwan found that nearly the ſame quantity of charcoal was ſufficient for producing the ſame effect.

* *Mem. Sçav. Etrang.* xi. 626.

Macquer long ago obſerved, that no volatile oily matter will detonate with nitre, unleſs it be previouſly reduced to a charcoal; and that then its effect upon nitre is preciſely proportional to the charcoal which it contains †. Mr Kirwan, upon trying the experiment with *vegetable pitch* and *maltha*, found that theſe ſubſtances did not detonate with nitre, but merely burn upon its ſurface with a white or yellow flame; and that after they were conſumed, nearly the ſame quantity of charcoal was neceſſary to decompoſe the nitre which would have been required if no bitumen had been uſed at all ‡. Now coals are chiefly compoſed of charcoal and bitumen. It occurred therefore to Mr Kirwan, that the quantity of charcoal which any coal contains may be aſcertained by detonating it with nitre: For ſince the bitumen of the coal has no effect in decompoſing nitre, it is evident that the detonation and decompoſition muſt be owing to the charcoal of the coal; and that therefore the quantity of coal neceſſary to decompoſe a given portion of nitre will indicate the quantity of carbon which it contains: and the proportion of charcoal and earth which any coal contains being aſcertained, its bituminous part may be eaſily had from calculation.

† *Macquer's Dictionary*, 2d edit. p. 481.

‡ *Mineralogy*, ii. 522.

The crucible which he uſed in his experiments was large: it was placed in a wind furnace at a diſtance from the flue, and the heat in every experiment was as equal as poſſible. The moment the nitre was red hot, the coal, previouſly reduced to ſmall pieces of the ſize of a pea head, was projected in portions of one or two grains at a time, till the nitre would no longer detonate; and every experiment was repeated ſeveral times to enſure accuracy.

He found that 480 grains of nitre required 50 grains of Kilkenny coal to decompoſe it by this method. Therefore 10 grains would have decompoſed 96 of nitre; preciſely the quantity of charcoal which would have produced the ſame effect. Therefore Kilkenny coal is compoſed almoſt entirely of charcoal.

Cannel coal, when incinerated, left a reſiduum of 3.12 in the 100 parts of earthy aſhes. 66.5 grains of it were required to decompoſe 480 grains of nitre; but 50 parts of charcoal would have been ſufficient: therefore 66.5 grains of cannel coal contain 50 grains of charcoal, and 2.08 of earth; the remaining 14.42 grains muſt be bitumen. In this manner may the compoſition of any other coal be aſcertained.

320 Method of analyſing ſulphur.

As for ſulphur, in order to aſcertain any accidental impurities with which it may be contaminated, it ought to be boiled in thirty times its weight of water, afterwards in diluted muriatic acid, and laſtly in diluted nitro-muriatic acid. Theſe ſubſtances will deprive it of all its impurities without acting on the ſulphur itſelf, at leaſt if the proper cautions be attended to. The ſulphur may then be dried and weighed. The deficiency in weight will mark the quantity of the ſubſtances which contaminate the ſulphur. The ſolutions may be evaporated and examined, according to the rules laid down in the ſecond and fourth ſections of this chapter.

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Sect. IV. *Of the Analyſis of Ores.*

321 No general method of analyſing ores.

The method of analyſing ores muſt vary conſiderably, according to the metals which they are ſuſpected to contain. A general method, therefore, of analyſing would be of no uſe, even if it could be given, becauſe it would be too complicated ever to be practiſed. We ſhall content ourſelves with exhibiting a ſufficient number of the analyſis of ores, to take in moſt of the caſes which can occur. He who wiſhes for more information on the ſubject, may conſult the treatiſe of Bergman on the *Analyſes of Ores*; Mr Kirwan's treatiſe on the ſame ſubject; and, above all, he ought to ſtudy the numerous analyſes of ores which have been publiſhed by Mr Klaproth.

I. Analyſis of Red Silver Ore.

326 Method of analyſing red ſilver ore.

Mr Vauquelin analyſed this ore as follows: He reduced 100 parts of it to fine powder, poured over it 500 parts of nitric acid previouſly diluted with water, and applied a gentle heat to the mixture. The colour of the powder, which before the mixture with nitric acid was a deep purple, became gradually lighter, till at laſt it was pure white. During this change no nitrous gas was extricated; hence he concluded, that the metals in the ore were in the ſtate of oxides.

When the nitric acid, even though boiled gently, did not appear to be capable of diſſolving any more of the powder, it was decanted off, and the reſiduum, after being carefully waſhed, weighed 42.06.

Upon theſe 42.06 parts concentrated muriatic acid was poured; and by the application of heat, a conſiderable portion was diſſolved. The reſiduum was repeatedly waſhed with muriatic acid, and then dried. Its weight was 14.6666. One portion of theſe 14.6666 parts, when thrown upon burning coals, burnt with a blue flame and ſulphureous ſmell. Another portion ſublimed in a cloſe veſſel without leaving any reſiduum. In ſhort, they had all the properties of ſulphur. Therefore 100 parts of red ſilver ore contain 14.6666 of ſulphur.

The muriatic acid ſolution was now diluted with a great quantity of water; it became milky, and depoſited a white flaky powder, which when waſhed and dried weighed 21.25. This powder, when heated with tartar in a crucible, was converted into a bluiſh white brittle metal, of a foliated texture, and poſſeſſing all the other properties of antimony. Red ſilver ore, therefore contains 21.25 of oxide of antimony.

The ſolution in nitric acid remained now to be examined. When muriatic acid was poured into it, a copious white precipitate appeared, which, when waſhed and dried, weighed 72.66. It had all the properties of muriat of ſilver. According to Mr Kirwan's tables, 72.66 of muriat of ſilver contain 60.57 of oxide of ſilver. Therefore red ſilver ore, according to this analyſis, is compoſed of

60.57	oxide of ſilver,
21.25	oxide of antimony,
14.66	ſulphur.
96.48	

The

The loſs, which amounts to 3.52 parts, is to be aſcribed to unavoidable errors which attend ſuch experiments.

II. Antimoniated Silver Ore.

323 Analyſis of antimoniated ſilver ore.

Klaproth analyſed this ore as follows:

On 100 parts of the ore, reduced to a fine powder, he poured diluted nitric acid, raiſed the mixture to a boiling heat, and after pouring off the acid, added new quantities repeatedly, till it would diſſolve nothing more. The reſiduum was of a greyiſh yellow colour, and weighed, when dry, 26.

Theſe 26 parts he digeſted in a mixture of nitric and muriatic acid; part was diſſolved, and part ſtill remained in the form of a powder. This reſiduum, when waſhed and dried, weighed 13 parts. It had the properties of ſulphur; and when burnt, left a reſiduum of one part, which had the properties of ſilica. Antimoniated ſilver ore, therefore, contains, in the 100 parts, 12 parts of ſulphur and 1 of ſilica.

When the nitro-muriatic ſolution was diluted with about 20 times its weight of water, a white precipitate appeared; which, when heated to redneſs, became yellow. Its weight was 13. No part evaporated at a red heat: therefore it contained no arſenic. On burning coals, eſpecially when ſoda was added, part was reduced to a metal, having the properties of antimony; and in a pretty high heat, the whole evaporated in a grey ſmoke. Theſe 13 parts were therefore oxide of antimony: They contain about 10 parts of metallic antimony; and as the ſtate of oxide was produced by the action of the nitric acid, we may conclude that antimoniated ſilver ore contains 10 parts of antimony.

The nitric acid ſolution remained ſtill to be examined. It was of a green colour. When a ſolution of common ſalt was poured in, a white precipitate was obtained, which poſſeſſed the properties of muriat of ſilver. When dried, it weighed 87.75 parts; and when reduced, 65.81 parts of pure ſilver were obtained from it. Antimoniated ſilver ore, therefore, contains 65.81 of ſilver.

Into the nitric acid ſolution, thus deprived of the ſilver, he dropped a little of the ſolution of ſulphat of ſoda; but no precipitate appeared. Therefore it contained no lead.

He ſuperſaturated it with pure ammonia, on which a grey precipitate appeared. When dried, it weighed 5 parts. This, on burning coals, gave out an arſenical ſmell. It was rediſſolved in nitric acid; ſulphurated alkali occaſioned a ſmutty brown precipitate; and pruſſic alkali a pruſſian blue, which, after torrefaction, was magnetic. Hence he concluded, that theſe five parts were a combination of iron and arſenic acid.

The nitric ſolution, which had been ſuperſaturated with ammonia, was blue; he therefore ſuſpected that it contained copper. To diſcover this, he ſaturated it with ſulphuric acid, and put into it a poliſhed plate of iron. The quantity of copper was ſo ſmall, that none could be collected on the iron.

III. Grey Copper Ore.

324 Analyſis of grey copper ore.

Klaproth analyſed this ore as follows:

Three hundred grains of it, not completely freed from its matrix, were reduced to a fine powder; four times their weight of nitric acid was poured on them, and the whole was digeſted. The acid was then poured off, and an equal quantity again digeſted on the reſiduum. The two acid ſolutions were mixed together. The reſiduum was of a yellowiſh grey colour, and weighed 188 grains.

On this reſiduum ſix times its weight of muriatic acid was boiled. The reſiduum was waſhed, firſt with muriatic acid, and afterwards with alcohol, and the waſhings added to the muriatic acid ſolution. The reſiduum, when dried, weighed 105.5 grains. Part of it burned with a blue flame; and was therefore ſulphur. The reſiduum amounted to 80.25 grains, and had the properties of ſilica. When melted with black flux, about $\frac{3}{4}$ths of a grain of ſilver were obtained from it. Thus 300 parts of grey copper ore contain 25.25 gr. of ſulphur, and 79.5 of ſilica.

The muriatic acid ſolution, which was of a light yellow colour, was concentrated by diſtillation, a few cryſtalls of muriat of ſilver appeared in it, which contained about $\frac{1}{4}$th grain of ſilver. The ſolution, thus concentrated, was diluted with a great quantity of water; a white precipitate was depoſited, which, when dried, weighed 97.25 grains. It poſſeſſed the properties of oxide of antimony, and contained 75 grains of antimony. Therefore 300 grains of grey copper ore contain 70 of antimony.

The nitric acid ſolution was of a clear green colour. A ſolution of common ſalt occaſioned a white precipitate, which was muriat of ſilver, and from which 31.5 grains of ſilver were obtained.

A little ſulphat of potaſs, and afterwards ſulphuric acid, were added, to ſee whether the ſolution contained lead; but no precipitate appeared.

The ſolution was then ſuperſaturated with ammonia; a looſe fleaky browniſh red precipitate appeared, which, when heated to redneſs, became browniſh black, and weighed 9$\frac{1}{2}$th grains. This precipitate was diſſolved in muriatic acid; half a grain of matter remained undiſſolved, which was ſilica. The muriatic acid ſolution, when pruſſic alkali was added, afforded a blue precipitate; and ſoda afterwards precipitated 1.5 grains of alumina. Therefore 300 grains of grey copper ore contain 7.25 grains of iron, and 1.5 of alumina.

Into the nitric ſolution ſuperſaturated with ammonia, and which was of an azure blue colour, a poliſhed plate of iron was put: By this method 69 grains of copper were obtained.

IV. Sulphuret of Tin.

Klaproth analyſed this ore as follows *:

On 120 grains of the ore reduced to powder, ſix times their weight of nitro-muriatic acid, compoſed of 2 parts of muriatic, and 1 of nitric acid, were poured. There remained undiſſolved 43 grains, which had the appearance of ſulphur; but containing green ſpots, was ſuſpected not to be pure. After a gentle combuſtion, 13 grains remained; 8 of which were diſſolved in nitro-muriatic acid, and added to the firſt ſolution. The remaining 5 were ſeparated by the filtre, and heated along with wax. By this method about a grain of matter was obtained, which was attracted by the magnet; and which therefore was iron. The reſiduum weighed 3 grains, and was a mixture of alumina and ſilica. Thus 120 grains of ſulphuret of tin contain 30 grains of ſulphur, 1 of iron, and 3 of alumina and ſilica.

325 Analyſis of ſulphuret of tin.

* *Obſervations on the Foſſils of Cornwall*, p. 48.

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The nitro-muriatic ſolution was completely precipitated by potaſs. The precipitate was of a greyiſh green colour. It was waſhed and dried, and again diſſolved in diluted muriatic acid. Into the ſolution a cylinder of pure tin was put, which weighed exactly 217 grains. The ſolution became gradually colourleſs, and a quantity of copper precipitated on the cylinder of tin, which weighed 44 grains. To ſee whether it was pure, a quantity of nitric acid was digeſted on it; the whole was diſſolved, except one grain of tin. Therefore 120 grains of ſulphuret of tin contains 43 grains of copper.

The cylinder of tin now weighed only 128 grains; ſo that 89 grains had been diſſolved. Into the ſolution a cylinder of zinc was put; upon which a quantity of tin precipitated. When waſhed and dried, it weighed 130 grains. The tin he melted with tallow and powdered charcoal; and when cold, he waſhed off the charcoal. Among the tin globules were found ſome black flocculi of iron, which weighed one grain. Deducting this grain, and the 89 grains of the tin cylinder which had been diſſolved, we ſee that the 120 grains of ſulphuret of tin contained 40 grains of tin beſides the grain which had been detected in the copper.

V. Plumbiferous Antimoniated Silver Ore.

326 Analyſis of plumbiferous antimoniated ſilver ore.

Klaproth analyſed this ore as follows:

He digeſted 400 grains of it, reduced to a fine powder, firſt in five times its weight of nitric acid, and then in twice its weight of the ſame acid. He then diluted this laſt portion of acid with eight times its weight of water, and continued the digeſtion. The undiſſolved reſiduum, when waſhed and dried, weighed 326 grains.

On this reſiduum he boiled muriatic acid repeatedly. The ſolution, on cooling, depoſited acicular cryſtals. Theſe he carefully ſeparated, and put by. The undiſſolved reſiduum weighed 51 grains. It had the properties of ſulphur. When burned, it left one grain of ſilica.

The muriatic acid ſolution was concentrated to half its former bulk by diſtillation: this made it depoſite more acicular cryſtals. He continued the diſtillation as long as any cryſtals continued to appear. He then collected the whole of theſe cryſtals together. They had the properties of muriat of lead. When mixed with twice their weight of black flux, and heated in a crucible lined with charcoal, they yielded 160⅛ grains of lead.

Sulphuret of ammonia was now added to the muriatic acid ſolution; an orange-coloured precipitate appeared, which ſhewed that the ſolution contained antimony. It was precipitated by a copious effuſion of water, and by ſoda. The oxide of antimony being reduced to a maſs with Spaniſh ſoap, mixed with black flux, and heated in a lined crucible, yielded 28.5 grains of antimony.

Into the nitric acid ſolution, obtained by the firſt part of the proceſs, a ſolution of muriat of ſoda was dropped; a white precipitate was depoſited, and over it acicular cryſtals. Theſe cryſtals he diſſolved, by pouring boiling water on the precipitate. The water was added to the nitric acid ſolution. The white precipitate was muriat of ſilver: when heated with twice its weight of ſoda, it yielded 81.5 grains of ſilver.

He now concentrated the nitric acid ſolution by evaporation; and then adding a ſolution of ſulphat of ſoda, a white precipitate was obtained, which had the properties of ſulphat of lead, and weighed 43 grains. It contained 32 grains of pure lead. Analyſis of Minerals.

He now poured ammonia into the ſolution; a pale brown precipitate was obtained, which weighed 40 grains, and which appeared to conſiſt of oxide of iron and alumina. He rediſſolved it in nitric acid, precipitated the iron by pruſſic alkali, and the alumina by ſoda. The alumina, after being heated to redneſs, weighed 28 grains; conſequently the oxide of iron was 12 grains, which is equivalent to 9 grains of iron.

VI. Molybdat of Lead.

Mr Hatchett analyſed this ore as follows*:

On 250 grains of the ore, reduced to a fine powder, he poured an ounce of ſtrong ſulphuric acid, and digeſted the mixture in a ſtrong heat for an hour. When the ſolution was cool, and had ſettled, he decanted it off, and waſhed the undiſſolved powder with pure water, till it came away taſteleſs. This operation was repeated twice more; ſo that three ounces of ſulphuric acid were uſed. All theſe ſolutions were mixed together, and filtered. 327 Analyſis of molybdat of lead.

* *Phil. Tranſ.* lxxxvi. 320.

Four ounces of a ſolution of carbonat of ſoda were poured upon the powder which remained undiſſolved, and which conſiſted of ſulphat of lead. The mixture was boiled for an hour, and then poured off. The powder was then waſhed, and diluted nitric acid poured on it: The whole was diſſolved, except a little white powder, which, when waſhed, and dried on a filter by the heat of boiling water, weighed ſeven-tenths of a grain. It poſſeſſed the properties of ſilica.

The nitric acid ſolution was ſaturated with pure ſoda; a white precipitate was obtained, which, when waſhed, and dried for an hour in a heat rather below redneſs, weighed 146 grains. It poſſeſſed the properties of oxide of lead.

To ſee whether this oxide of lead contained any iron, it was diſſolved in diluted nitric acid, and the lead precipitated by ſulphuric acid. The ſolution was then ſaturated with ammonia; a brown powder precipitated, which, when dried, weighed one grain, and had the properties of oxide of iron.

The ſulphuric acid ſolution was of a pale blue colour: It was diluted with 16 times its weight of pure water, and then ſaturated with ammonia. It became of a deep blue colour, and appeared turbid. In 24 hours a pale yellow precipitate ſubſided, which, when collected on a filter, and dried by a boiling water heat, weighed 4.2 grains. Its colour was yelloviſh brown. Muriatic acid diſſolved it, and pruſſiat of potaſs precipitated it from its ſolution in the ſtate of pruſſian blue. It was therefore oxide of iron.

The ſulphuric acid ſolution, ſaturated with ammonia, was gradually evaporated to a dry ſalt. This ſalt was a mixture of molybdat of ammonia and ſulphat of ammonia. A ſtrong heat was applied, and the diſtillation continued till the whole of the ſulphat of ammonia was driven off; and to be certain that this was the caſe, the fire was raiſed till the retort became red hot. The reſiduum in the retort was a black bliſtered maſs; three ounces of nitric acid, diluted with water, were poured upon it, and diſtilled off. The operation was again repeated.

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peated. By this method the oxide of molybdenum was converted into a yellow powder, which was yellow acid of molybdenum. It weighed 95 grains.

VII. Grey Ore of Manganeſe.

* *Jour. de Min.* N° xvii. p. 12.

Mr Vauquelin analyſed this ore as follows *.

318 Analyſis of grey ore of manganeſe.

When 200 grains of it were expoſed to a ſtrong heat in a retort, there came over 10 grains of water, and 18 cubic inches of oxygen gas, mixed with a little carbonic acid gas. The mineral now weighed only 176 grains. Therefore the weight of the gas was 14 grains.

On 200 grains of the ſame mineral muriatic acid was poured, and heat applied. 75 cubic inches of oxy-muriatic acid gas came over, which, though mixed with ſome carbonic acid gas, enflamed metals when reduced to powder. When no more gas came over, the reſiduum was boiled. The whole was diſſolved except a white powder, which weighed 12 grains, and which poſſeſſed the properties of ſilica.

Carbonat of potaſs was poured into the ſolution; a white precipitate was obtained, which became black by expoſure to the air, and weighed 288 grains. Strong nitric acid was boiled on it repeatedly to dryneſs. It became of a deep black colour, and, when well waſhed with water and dried, weighed 164 grains. This powder was black oxide of manganeſe.

To ſee whether it contained iron, nitric acid, with a little ſugar, was poured upon it, and digeſted on it. The acid diſſolved it completely. Therefore no oxide of iron was preſent.

Into the water with which the black oxide of manganeſe had been waſhed, carbonat of potaſs was poured; a white powder precipitated, which, when dried, weighed 149 grains, and which poſſeſſed the properties of carbonat of lime.

VIII. Wolfram.

329 Analyſis of wolfram.

Meſſrs Vauquelin and Hecht analyſed this mineral as follows:

On 200 parts of Wolfram in powder, three times its weight of muriatic acid were poured, and the mixture boiled for a quarter of an hour: a yellow powder appeared, and the ſolution was of a brown colour. The acid was allowed to cool, and then carefully decanted off, and the reſiduum waſhed. The reſiduum was then digeſted for ſome hours with ammonia, which diſſolved a part of it. The reſiduum was waſhed, and new muriatic acid again poured over it; then the reſiduum was digeſted with ammonia, as before: and the operation was continued till the whole wolfram was diſſolved.

All the ammoniacal ſolutions being joined together, were evaporated to dryneſs, and the ſalt which remained was calcined: a yellow powder was obtained; it weighed 134 grains, and was yellow acid of tungſten.

Into the muriatic acid ſolutions, which were all mixed together, a ſufficient quantity of ſulphuric acid was poured to decompoſe all the ſalts. The ſolution was then evaporated to dryneſs; and the ſalts which were obtained by this evaporation were rediſſolved in water. A white powder remained, which weighed three grains, and which poſſeſſed the properties of ſilica.

Analyſis of Minerals.

The exceſs of acid of the ſolution was ſaturated with carbonat of potaſs; the liquor became brown, but nothing precipitated. When boiled, a red powder precipitated, and the brown colour diſappeared. The addition of more carbonat of potaſs cauſed a farther precipitation of a yellowiſh powder. This precipitate conſiſted of the oxides of iron and manganeſe combined. Nitric acid was diſtilled off it repeatedly; it was then boiled in acetous acid. The acetous ſolution was precipitated by potaſs. Nitric acid was again diſtilled off it, and it was again boiled in acetous acid. This proceſs was repeated till nitric acid produced no further change. The different powders which could not be diſſolved in the acetous acid were collected, mixed with a little oil, and heated red hot. The powder became black, and was attracted by the magnet. It was therefore oxide of iron. It weighed 36 grains.

The acetous ſolution contained the oxide of manganeſe: It was precipitated by an alkali, and, when dried, weighed 12.5 grains.

IX. Oxide of Titanium and Iron.

Vauquelin analyſed this ore as follows:

330 Analyſis of oxide of titanium and iron.

A hundred parts of the ore, reduced to a fine powder, and mixed with 400 parts of potaſs, were melted in a ſilver crucible for an hour and a half. When cool, the mixture was diluted with water; a powder remained of a brick red colour, which when waſhed and dried weighed 124 parts.

The watery ſolution had a fine green colour; when an exceſs of muriatic acid was added, it became red. By evaporation the liquor loſt its colour. When evaporated to dryneſs, a ſalt remained, which was totally diſſolved by water. From this ſolution carbonat of potaſs precipitated two parts, which had the properties of oxide of manganeſe.

The 124 parts of reſiduum were boiled in a ſolution of pure potaſs for an hour. The ſolution was ſaturated with an acid, filtered, and carbonat of potaſs added, which precipitated three parts. Theſe had the properties of oxide of titanium.

The remainder of the 124 parts of reſiduum, which ſtill was undiſſolved, was boiled with diluted muriatic acid. The liquor became yellow, and depoſited 46 parts of a white powder, with a tint of red. This powder was ſoluble in ſulphuric and muriatic acids: from theſe ſolutions, it was precipitated of a brick red colour by the infuſion of nut-galls; of a green colour by ſulphuret of ammonia and pruſſiat of potaſs; and of a white colour by carbonat of potaſs and pure ammonia. A rod of tin made theſe ſolutions red; a rod of zinc made them violet. Theſe 46 parts therefore are oxide of titanium.

The muriatic ſolution, from which theſe 46 parts were depoſited, formed, with pruſſiat of potaſs, a pruſſian blue; and ammonia precipitated from it 50 parts, which had the properties of yellow oxide of iron.

INDEX.

Petrilite,

Mirabeau. MIRABEAU (Honnoré Gabriel, Compte de), well known both by his writings and the active part which he took in bringing about the French revolution, was born in 1749 of a noble family. Throughout life he diſplayed a ſpirit averſe from every reſtraint, and was one of thoſe unhappy geniuſes in whom the moſt brilliant talents ſerve only as a ſcourge to themſelves and all around them. It is told by his democratical panegyriſts, as a wonderful proof of family tyranny under the old government, that not leſs than 67 *lettres de cachet* had been obtained by Mirabeau the father againſt this ſon and others of his relatives. This ſtory, if true, proves, with at leaſt equal force, what many anecdotes confirm, that, for his ſhare of them, the ſon was not leſs indebted to his own ungovernable diſpoſition than to the ſeverity of his parent. He was indeed a monſter of wickedneſs. Debauchery, gaming, impiety, and every kind of ſenſuality, were not enough for him. He was deſtitute of decency in his vices; and to ſupply his expences, ſcrupled not to perform tricks which would diſgrace a thief-catcher. His father and mother diſagreeing, commenced a proceſs of ſeparation; when Mirabeau, juſt liberated from priſon for a groſs miſdemeanor, was in want of money. He went to his father, ſided with him againſt his mother, on whom he poured a torrent of invectives; and, for 100 guineas, wrote his father's memorial for the court. He then went to his mother; and by a ſimilar conduct got the ſame ſum from her; and both memorials were preſented. That the father of ſuch a man ſhould frequently get him ſhut up in priſon, can excite no ſurpriſe; for confinement only could withhold him from the perpetration of crimes. Mirabeau.

The talents of Mirabeau led him frequently to employ his pen; and his publications form the chief epochas of his life. His firſt publication was, 1. *Eſſai ſur le Deſpotiſme*, "An Eſſay on Deſpotiſm," in 8vo. Next, in one of his confinements, he wrote, 2. a work in two vols 8vo, *On Lettres de Cachet*. 3. *Conſiderations ſur l'Ordre de Cincinnatus*, 8vo. A remonſtrance againſt the order of Cincinnatus, propoſed at one time to be eſtabliſhed in America. The public opinion in America favoured this remonſtrance, and it proved effectual. 4. His next work was in favour of the Dutch, when Joſeph II. demanded the opening of the Sheldt, in behalf of the Brabançons. It is entitled, *Doutes ſur la Liberté de l'Eſcant*, 8vo. 5. *Lettre à l'Empereur Joſeph II. ſur ſon Réglement concernant l'Emigration*; a pamphlet of forty pages, in 8vo. 6. *De la Caiſſe d'Eſcompte*; a volume in 8vo, written againſt that eſtabliſhment. 7. *De la Banque d'Eſpagne*, 8vo; a remonſtrance againſt eſtabliſhing a French bank in Spain. A controverſy

Mirabeau. controverſy ariſing upon this ſubject, he wrote again upon it. 8. Two pamphlets on the monopoly of the water company in Paris.

Soon after the publication of theſe works, he was ſent in a public character to the court of Berlin; where he conducted the king's affairs juſt as he had formerly done thoſe of his father and mother, fully ready to ſacrifice all parties, and to ſell himſelf to the higheſt bidder. With ſuch a diſpoſition, he could not long avoid the notice of the Pruſſian illuminees; and Nicolai Bieſter, Gedicke, and Leuchſenring, ſoon became his conſtant companions. At Brunſwick he met with Mauvillon, the worthy diſciple of Philo Knigg, and at that time a profeſſor in the Caroline college. This was the man who initiated the profligate Marquis in the laſt myſteries of illuminiſm.

Mirabeau was ſtill at Berlin when Frederick II. died. That monarch, as is well known, was a naturaliſt, who, holding this life for his all, encouraged the propagation of infidelity in his dominions, from which reſulted the very worſt conſequences to the peace of ſociety. Of this truth his ſucceſſor Frederick William was duly ſenſible; and determined to ſupport the church eſtabliſhment in the moſt peremptory manner, conſiſtent with the principles of religious toleration. He publiſhed, therefore, ſoon after his acceſſion, an edict on religion, which is a model worthy of imitation in every country; but it was attacked with the greateſt virulence in numberleſs publications. It was called an unjuſtifiable tyranny over the conſciences of men; the dogmas ſupported by it were termed abſurd ſuperſtitions; the king's private character and his religious opinions were ridiculed and ſcandalouſly abuſed. The moſt daring of theſe attacks was a collection of anonymous letters on the conſtitution of the Pruſſian ſtates, univerſally believed to be the compoſition of Mirabeau, who certainly wrote a French tranſlation, with a preface and notes more impudent than the work itſelf. The monarch is declared to be a tyrant; the people of the Pruſſian dominions are addreſſed as a parcel of tame wretches, crouching under oppreſſion; and the inhabitants of Sileſia, repreſented as ſtill in a worſe condition, are repeatedly called upon to rouſe themſelves, and aſſert their rights.

About this time he publiſhed, 9. An *Eſſai ſur le Secte des Illuminés*; one of the ſtrangeſt and moſt impudent books that ever appeared. In it he deſcribes a ſect exiſting in Germany, called the *Illuminated*; and ſays, that they are the moſt abſurd and groſs fanatics imaginable, waging war with every appearance of reaſon, and maintaining the moſt *ridiculous ſuperſtitions*. He gives ſome account of theſe, and of their rituals and ceremonies, as if he had ſeen them all; yet no ſuch ſociety as he deſcribes ever exiſted: and Mirabeau employed his powers of deception, merely to ſcreen from obſervation the real *illuminati*, by holding out to the rulers of ſtates this *ignis fatuus* of his own brain. For a while the eſſay certainly contributed to blind the eyes of the German princes; and Nicolai, with others of the junto, adopting the whim, called Mirabeau's fanatics *Obſcuranten*, and joined with him in placing on the liſt of *Obſcuranten* ſeveral perſons whom they wiſhed to make ridiculous.

Long before his initiation in the myſteries of illuminiſm, Mirabeau had been acquainted with all the revolutionary powers of the maſonic lodges; nor did he, when initiated, undervalue thoſe which ſlowed, or might flow, from Weiſhaupt's inventive genius. On his return to France, he began to introduce the new myſteries among ſome of his maſonic brethren. His firſt aſſociate was the Abbe Talleyrand de Perigord, who had already begun to act the part of Judas in the firſt order of the church. But to have only introduced the myſteries was not ſufficient for the Marquis; he would have teachers come from Germany, who were better verſed than he was in the illuminizing arts. Well acquainted with the reaſons that had induced the chiefs of the order to defer the converſion of France, he found means to convince them, that the time was now come for the accompliſhment of their views; and at his requeſt a deputation was ſent by Spartacus to illuminize that great kingdom. See ILLUMINATI, n° 40, 41, *Suppl.* Mirabeau.

When the aſſembly of Notables was convened at Paris, Mirabeau foretold that it would ſoon be followed by a meeting of the States; and at that period he publiſhed a volume againſt the ſtockjobbing, then carried to a great height, intitled, 10. *Denonciation de l'agiotage au Roi, et a l'Aſſemblée de Notables*, 8vo. A *lettre de cachet* was iſſued againſt him in conſequence of this publication; but he eluded purſuit, and publiſhed a pamphlet as a ſequel to the book. His next work was againſt M. Necker, 11. *Lettre á M. de Cretelle, ſur l'Adminiſtration de M. Necker*, a pamphlet in 8vo. 12. A volume in 8vo, againſt the Stadtholderſhip: *Aux Bataves, ſur le Stadthouderat.* 13. *Obſervations ſur la maiſon de force appellé Bicetre*, an 8vo pamphlet. 14. Another tract, intitled, *Conſeils à un jeune Prince qui ſent la néceſſité de refaire ſon education.* 15. He now proceeded to a larger and more arduous work than any he had yet publiſhed, on the Pruſſian monarchy under Frederick the Great: *De la Monarchie Pruſſienne ſous Frederic le Grand*, 4 vols, 4to, or eight in 8vo. In this work he undertakes to define preciſely how a monarchy ſhould be conſtituted. When the orders were iſſued for convening the States-general, Mirabeau returned into Provence; and at the ſame time publiſhed, 16. *Hiſtoire Secrette de la Cour de Berlin*, two volumes of letters on the Secret Hiſtory of the Court of Berlin. This work was condemned by the parliament of Paris, for the unreſerved manner in which it delivered the characters of many foreign princes. As the elections proceeded, he offered himſelf a candidate in his own order at Aix; but he was ſo abhorred by the nobleſſe, that they not only rejected him, but even drove him from their preſence. This affront ſettled his meaſures, and he determined on their ruin. He went to the commons, diſclaimed his being a gentleman, ſet up a little ſhop in the market-place of Aix, where he ſold triſles; and now fully reſolved what line he ſhould purſue, he courted the commons, by joining in all their exceſſes againſt the nobleſſe, and was at laſt returned a member of the aſſembly.

In conſequence of this, he went to Paris; where the part he took was active, and ſuch as tended, in general, to accelerate all the violences of the revolution. He now publiſhed, periodically, 17. his *Lettres à ſes Commettans*, Letters to his Conſtituents, which form, when collected, 5 vols 8vo. It is ſuppoſed, that the fatal meaſure of the junction of the three orders into one national

Mirabeau, Miſtral.

tional aſſembly, was greatly promoted by theſe letters. The public events of theſe times, and the part taken in them by Mirabeau, are the ſubject of general hiſtory. He lived to ſee the conſtitution of 1789 eſtabliſhed, but not to ſee its conſequences—the deſtruction of the monarchy, the death of the king, and the ruin of all property! He was accuſed, as well as the duke of Orleans, of hiring the mob which attacked Verſailles on the 5th and 6th of October 1789; but with him was alſo acquitted by the tribunal of the Châtelet. The dominion of his eloquence in the National Aſſembly had long been abſolute, and, on the 29th of January 1791, he was elected preſident. At the latter end of March, in the ſame year, he was ſeized by a fever, and died on the 2d of April.

The talents of Mirabeau will not be doubted, though they were certainly rather brilliant than profound. To be noticed, and to lead, were the ſole objects of his ambition; and for the attainment of them, he took the ſide of the diſcontented, as the beſt field for his matchleſs eloquence. Yet there was no man more devoted to the principles of a court than this Marquis, provided he could have a ſhare in the adminiſtration; and a ſhare he would have obtained, if any thing moderate would have ſatisfied him: But he thought nothing worthy of him but a place of active truſt, and a high department; ſtations which all knew him not qualified to fill. Wanting knowledge of great things, he was learned only in the buſtling detail of intrigue, and would, at any time, have ſacrificed his deareſt friend, and the intereſts of his country, for an opportunity of exerciſing his brilliant eloquence, and indulging his propenſity to ſatire and lampoon. But the greateſt obſtacle to his advancement under the old government was the abject worthleſſneſs of his character. Drinking was the only vice in which he did not indulge; and from this he was reſtrained by his exhauſted conſtitution. To his brother, the Viſcount, who was frequently intoxicated, the Marquis one day ſaid, "How can you, brother, ſo expoſe yourſelf? "What (replied the Viſcount)! how inſatiable are you? Nature has given you every vice; and having left me only this one, you grudge it me!

MISTRAL, the name of a wind, which is mentioned in almoſt every account that we have of Provence, and which is remarkable for blowing almoſt the whole year from north-weſt or weſt-north-weſt, in a climate where the wind ſhould be variable. It is ſaid to contribute to the ſalubrity of the air, by diſperſing the exhalations of the marſhes and ſtagnant waters, ſo common in the ſouth of Languedoc and Provence; but at times it is alſo very injurious, or at leaſt very troubleſome. It is not, however, on either of theſe accounts that it is introduced into this Work, but for the ſake of the cauſes aſſigned by Sauſſure for its conſtancy, which may be applied to other winds that nearly reſemble it; and which he found might be reduced to three.

"The firſt and moſt effectual cauſe (he ſays) is the ſituation of the Gulf of Lyons, the banks of which are the principal theatre of its ravages. This Gulf, in fact, is ſituated at the bottom of a funnel, formed by the Alps and Pyrenees. All the winds blowing from any point between weſt and north, are forced by theſe mountains to unite in the Gulf. Thus, winds which would not have prevailed but at one extremity of the Gulf, or even much beyond it, are obliged to take this route, after having undergone the repercuſſion of theſe mountains; and the middle of the Gulf, inſtead of the calm which it might have enjoyed, is expoſed to the united efforts of two ſtreams of wind, deſcending in different directions. Hence ariſe thoſe whirlwinds which ſeem to characteriſe the miſtral, and appear to have induced the ancients to call it *Circius, à turbine ejus ac vertigine.* See *Aul. Gellius*, l. ii. cap. 22.

Miſtral || Mœris.

"The ſecond cauſe is, the general ſlope of the grounds, deſcending from all ſides towards the Gulf; which becoming all at once lower and more ſoutherly than the lands extending behind it, is, from theſe joint circumſtances, rendered the hotteſt point of all the adjacent country: and, as the air on the ſurface of the earth always tends from the colder to the warmer regions, the Gulf of Lyons is actually the centre towards which the air from all colder points between eaſt and weſt muſt preſs. This cauſe, then, alone would be productive of winds directed to the Gulf, even if the repercuſſion of the mountains did not exert its influence.

"Finally, it is well known, that in all gulfs the land-winds blow more forcibly than oppoſite to plains and promontories, whatever be the ſituation of thoſe gulfs. I apprehend, indeed, on ſtrict examination (ſays our author), that this cauſe is blended with the preceding; but as the fact is generally admitted, and in ſome caſes can be explained only by reaſons drawn from the effects of heat, it may not improperly, perhaps, be diſtinctly mentioned. It is, at leaſt, neceſſary to ſuppoſe, that ſeveral cauſes produce the miſtral, in order to underſtand why, notwithſtanding the variableneſs of the ſeaſons and temperatures, that wind is ſo ſingularly conſtant in Lower Languedoc and Lower Provence. A very remarkable inſtance of this conſtancy is recorded by the Abbé Papon, in his *Voyage de Provence*, tom. ii. p. 81. He aſſerts, that during the years 1769 and 1770, the miſtral continued for fourteen months ſucceſſively. But the three cauſes which I have ſtated, taken ſeparately, will explain its frequency, and, united, will account for its force."

MIXT ANGLE, or *Figure*, is one contained by both right and curved lines.

MIXT Number, is one that is partly an integer and partly a fraction; as $3\frac{1}{2}$.

MIXT Ratio, or *Proportion*, is when the ſum of the antecedent and conſequent is compared with the difference of the antecedent and conſequent;

$$\text{as if } \begin{cases} 4 : 3 :: 12 : 9 \\ a : b :: c : d \end{cases}$$

$$\text{then } \begin{cases} 7 : 1 :: 21 : 3 \\ a+b : a-b :: c+d : c-d. \end{cases}$$

MOCASSIMAH, in Bengal, revenue ſettled by a diviſion of the produce.

MOCHULKAH, bond or obligation.

MŒRIS, a lake in EGYPT, occaſionally mentioned in that article (*Encycl.*), and generally ſuppoſed the production of human art. Of this, however, Mr Brown ſays it bears no mark. "The ſhape, as far as was diſtinguiſhable, ſeems not inaccurately laid down in D'Anville's map, unleſs it be, that the end neareſt the Nile ſhould run more in a north-weſt and ſouth-eaſt direction. The length may probably be between 30 and 40 miles; the breadth, at the wideſt part he could gain, was 5000 toiſes, as taken with a ſextant; that is, nearly

Mofuſſel
||
Mola.

ly ſix miles. The utmoſt poſſible extent of circuit muſt of courſe be 30 leagues. On the north-eaſt and ſouth is a rocky ridge, in every appearance primeval. In ſhort, nothing can preſent an appearance more unlike the works of men. Several fiſhermen, in miſerable boats, are conſtantly employed on the lake. The water is brackiſh, like moſt bodies of water under the ſame circumſtances. It is, in the language of the country, *Birket-el-kerun*, probably from its extremities bearing ſome reſemblance to horns.

MOFUSSEL, a relative term, ſignifying the ſubordinate lands or diſtricts, oppoſed to SUDDER, which is the head.

MOHACZ, MOHATZ, or *Mohoz*, a town in the Lower Hungary, upon the Danube, between the river Sarwizu to the north, and the Drave to the ſouth; four German miles from either, ſix from Eſſeck to the north, and nine from Colocoa to the ſouth. This otherwiſe ſmall place is memorable for two great battles here fought; the firſt between Lewis king of Hungary and Solyman the Magnificent, in 1526: in which that unfortunate Prince Lewis (being about 20 years old), with 25,000 men, fought 300,000 Turks; when, being overpowered by numbers, 22,000 of the Chriſtian army were ſlain upon the place; 5000 waggons, eighty great cannon, 600 ſmall ones, with all their tents and baggage, were taken by the victors; and the King, in his flight over the brook Curaſs, fell into a quagmire, and was ſwallowed up. After which, Solyman took and ſlew 200,000 Hungarians, and got ſuch a footing in that kingdom, that he could never be expelled. This fatal battle was fought October 29. The ſecond, in ſome part, retrieves the loſs and infamy of the former. The Duke of Loraine being ſent by the Emperor, with expreſs orders to paſs the Drave and take Eſſeck, his highneſs, July 10, 1687, with great difficulty paſſed that river, then extremely ſwelled with rains; but finding the Prime Viſier encamped at Eſſeck, with an army of 100,000 men, ſo ſtrongly, that it was not poſſible to attack him in that poſt without the ruin of the Chriſtian army, he retreated, and repaſſed it the 23d of the ſame month; where, upon the 29th, the Prime Viſier paſſed that river at Eſſeck; and upon Auguſt 12th, there followed a bloody fight, in which the Turks loſt 100 pieces of cannon, 12 mortars, all their ammunition, proviſion, tents, baggage, and treaſure, and about 8000 men upon the place of battle, beſides what were drowned in paſſing the river, which could never be known. After which victory, General Dunewalt, September 30th, found Eſſeck totally deſerted by the Turks, and took poſſeſſion of it.

MOHER, in Bengal, a gold coin, worth about 33 ſhillings.

MOHERIR, a writer of accounts.

MOINEAU, a flat baſtion raiſed before a curtin when it is too long, and the baſtions of the angles too remote to be able to defend one another. Sometimes the moineau is joined to the curtin, and ſometimes it is divided from it by a moat. Here muſquetry are placed to fire each way.

MOLE (See TALPA, *Encycl.*), is an animal exceedingly troubleſome, both to gardeners and farmers; and there are perſons who contrive to make a livelihood by the trade of *mole-catching*. Theſe men, it is well known, are generally quacks and cheats; and the ſecrets which they ſell for extirpating thoſe deſtructive animals are of very little avail. Even poiſon ſeldom produces any conſiderable effect; becauſe the mole, while it does not drink, lives only on roots and worms. Under the word MOLE (*Encycl*), ſome directions will be found for clearing fields of this deſtructive animal; but the following are perhaps preferable, as they ſeem to have been the reſult of much experience: Mole.

Immediately at day-break, it will be neceſſary to make a tour round the garden or meadow, from which it is wiſhed to extirpate the moles; for at that time they will be all found at work, as may be ſeen by the hills newly thrown up. If the perſon is then cloſe to the hill, he muſt proceed as the gardeners do, and turn up with a ſtroke of the ſpade the hill together with the digger. The paſſage is then cut through before the animal is aware of the attack; and therefore it has not power to eſcape. If the mole-hill be freſh, even though the animal may not be throwing up earth, the perſon ought not to loſe his time in waiting, but ſhould immediately proceed to the operation above-mentioned.

If you find a freſh hill ſtanding by itſelf, which ſeems to ſhew by its ſituation that it has no communication with any other, which is always the caſe when the mole has worked from the ſurface downwards in endeavouring to procure a more convenient habitation, after the hill has been turned up with the ſpade, a bucket of water ſhould be poured over the mouth of the paſſage. By theſe means the animal, which is at no great diſtanc, will be obliged to come forth, and may be eaſily caught with the hand.

You may diſcover alſo whether a hill has any communication with another, if you apply your ear to it, and then cough or make a loud noiſe. If it has no communication with the neighbouring hills, you will hear the terrified animal make a noiſe by its motion. It will then be impoſſible for it to eſcape; and you may either pour water into the hole, or turn up the hill with a ſpade, until the mole is found; for, in general, it never goes deeper into the earth than from fifteen to eighteen inches.

When any of the beds in a garden have been newly watered, the mole, attracted by the coolneſs and moiſture, readily repairs thither, and takes up its reſidence in them, making a paſſage at the depth of ſcarcely an inch below the ſurface. In that caſe it may eaſily be caught. When you ſee it at work, you need only tread behind the animal with your feet on the paſſage to prevent its retreat, and then turn up the hill with a ſpade; by which means you will be ſure to catch it.

When you dig after it with a ſpade, the animal forces its way downwards into the earth in a perpendicular direction, in order that it may the better eſcape the threatened danger. In that caſe it will not be neceſſary to dig long, but to pour water over the place, which will ſoon make the animal return upwards.

People, in general, are not aware of the great miſchief occaſioned in fields and gardens by theſe animals. We are, however, informed by Buffon, that in the year 1740 he planted fifteen or ſixteen acres of land with acorns, and that the greater part of them were in a little time carried away by the moles to their ſubterranean retreats. In many of theſe there were found half a buſhel, and in others a buſhel. Buffon, after this circumſtance, cauſed a great number of iron traps to be conſtructed;