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CHECKED



A  
SYSTEM  
OF  
MINERALOGY,  
FORMED CHIEFLY  
ON THE  
Plan of Cronstedt.

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VOL. II.

---

By J. G. SCHMEISSER,  
F. R. S. &c.

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LONDON:

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P R E F A C E.

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I HEREWITH deliver the second Volume of the System of Mineralogy.

I have endeavoured throughout the Work, to merit the candour and liberality of a discerning Public, by executing as much as my knowledge enabled me to do, and as the subject seemed to demand.

I have furnished the Reader with the

principal parts of the Science of Mineralogy, with the discoveries and improvements which have been made, of late years, on the Continent, and with such as I could add from my own industry and knowledge; and I hope, I have fully illustrated the importance and utility, which this Science so justly claims.

To improve this Work in proportion as my knowledge may increase, will be my future endeavour. In this, I intend to follow the plan, of which, I have given a sketch in the Appendix to this Volume, and of which, the Continuation shall follow in the form of a Supplement. This Continuation I shall publish from time to time, in Numbers, according to the advancements and discoveries which may be made in the  
Science;

Science ; by this means, the Reader will come to possess all the new and progressive observations, discoveries, and improvements, almost as soon as they are published abroad ; particularly those contained in the Journal called *Bergmanischer Journal*, and the Chemical Journal of Crell—Works, which convey very useful information on subjects relating to Chemistry and Mineralogy, and hence, I hope, not unacceptable to those who pursue these studies. I intend that the first Number shall contain an account of such mineral substances, and such improvements, as have been lately published abroad, and were not in my possession when I finished this Work ; several of which, I have found in some excellent books of Gmelin and Suckow, and other eminent authors in Germany.

Various new observations, and an account of some newly discovered mineral products of these Islands, and particularly of Ireland, I expect we shall be informed of, by the ingenious and excellent chemist, Mr. KIRWAN, in his new edition of Mineralogy. To him, to the late Cronstedt—Klaproth—Suckow—Monge—De la Metherie—Born—Gmelin—Werner—Blumenbach—Westrumb—Heyer—Chaptal—Furcroi—and several other eminent Authors, I acknowledge my sincerest thanks, for the instruction I have derived from their Publications.

It will be obvious from the nature of my new Plan, that I shall have occasion to transpose some species in the system; as the tremolit—mica—and several others.

I shall

I shall also make some alteration, and give a more full account of the substances which come under the head of rocks, or mineral substances, whose component parts are variously mixed, or blended together; as I have had lately some, and shall soon have greater opportunities, of exploring that subject myself, with greater attention; for which opportunities, I acknowledge with pleasure, that I am greatly indebted to a valuable Friend and a countryman of mine, whose noble character and benevolent deeds towards the relief of misfortune and indigence, are greatly felt and acknowledged in his own country; while his laudable intentions, and indefatigable ardour to collect, cultivate, and promote the useful sciences, will hardly escape the attention of the great body of philosophical men in this country, whose

whose zeal for science, and for charity, is so congenial with his.

I also beg leave to mention, that since this Publication, I have paid much attention to the subject which relates to chemical attraction (generally called affinities) of bodies, and that I have finished a new Table, exhibiting such; this I shall insert in the Work I have now finished, and shall call it EXPERIMENTAL CHEMISTRY. It is finished chiefly after the doctrines of the new Theory. In this, I have procured myself the advantage of having repeated most of the interesting experiments, and have improved and added several new ascertained facts, and some observations of my own, which I have drawn from well established facts, as far as I could do it from the present knowledge we possess of bodies  
examined

examined by chemical experiments. This Work, I wish to be understood, is not meant to give an account of all the different Theories, and their history, as these may be better taught occasionally in Lectures, or may be read in several books published on that subject, to which I refer. It is merely to be considered as a Collection of the best established Facts in Chemistry, arranged in an order, which from experience, I thought the most proper for beginners in Chemistry, and easiest to be understood. It will be very useful for students who attend Lectures, and even for such who wish to make application of their obtained knowledge, in performing experiments themselves. The method which I have adopted, will not interfere with the utility of attending Lectures on Chemistry, though these  
may

may be, perhaps, arranged in a different manner, as the facts will always keep their value. It will contain likewise, an explanation of the best established methods of making chemico-pharmaceutical preparations, with an advantage both for the operators, and for physicians, who are to make use of them. Many medicines, or preparations, have lost their reputation, owing to the improper manner of preparing them. I have also noticed the methods of discovering the adulterations of the different articles. The whole will be comprised in one Volume.

Before I conclude, I beg leave to mention a fact which I lately ascertained, and which relates to the experimental part of this Work, in making the chemical analysis of minerals. It is the  
method



method of separating argillaceous earth from magnesia, when both are contained in one mineral, which hitherto could not be done without great difficulty, I mean, to any nicety.

When both are in a solution of muriatic acid in a saturated state, the argillaceous earth may be perfectly separated by ammonia saturated with fixed air, as this will only separate that earth, and the magnesia will be retained in solution; the magnesia may then be separated, by decomposing the solution after being boiled, with a solution of pure potash or soda.



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————— <i>ores</i>	—————	—————	190 to 200

S E C O N D P A R T  
OF THE  
SYSTEM OF MINERALOGY.

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C L A S S I V.

OF

METALS OR METALLIC SUBSTANCES.

**T**HESSE substances are, according to the old theory, considered as compound bodies composed of the metallic earth and phlogiston, or the matter which gives metals their lustre, and renders them more or less inflammable; and, according to the new theory, the metals are understood to be simple bodies, or bodies which cannot be decomposed, but which are liable to be changed by other bodies. When united to

other bodies, they can always be recovered from any state. The new theory seems to turn out more favourable respecting certain facts; yet neither of them is sufficiently investigated and proved, as to explain all the means and operations, which nature may have employed to exhibit the metals in the various states, in which they are found in different parts and situations of the Earth.

Metals, in general, are distinguished from all other known mineral products, by certain peculiar properties: They have a peculiar lustre; they exceed all other bodies by their specific gravity, density, ductility, and malleability. They are not soluble in pure water, but all of them are soluble in nitric and muriatic acid, either in the one or in the other separately, or in both mixed together.

Metals all melt in the fire, but each of them seems to require a different degree of heat for fusion; some of the semi-metals, as the wolfram, uranium, and molybdena, require a very intense heat, or some additional substances to render them more fusible. No metals are so hard as to scratch glass; most of them are inflammable, or burn in pure air or oxygen-gas, by the assistance of heat, but they certainly differ from the real inflammable and combustible

combustible substances; since none of the metals can be converted into the state of air or gas, when burnt in pure air or oxygen-gas, like charcoal, &c. which are consumed, and enter during the combustion, into the composition of permanent gas, viz. fixed air, or carbonic acid gas; nor do the metals form perfect acids when exposed to heat and pure air like sulphur; they only absorb the basis of the pure air, or the oxygen, and a certain portion of moisture, from the surrounding atmosphere, in which they are heated or burnt, and which alters their state and appearances, and occasions an increase in their weight.

Metallic substances are generally divided into two general classes; namely, into *real metals*, and *semi-metals*.

The first kind are distinguished by their malleability, the cohesion of their particles not being destroyed by hammering. Some are found unalterable in the atmosphere, and undestructible in common fire, such as *platina*, *gold*, and also *silver*, and these are called *perfect* or *noble metals*. Whilst others, which undergo a greater or less alteration when exposed to heat, or even only to the atmosphere, as *copper*, *tin*, *iron*, *lead*, *mercury*—are called *imperfect metals*.

The second kind, or the *semi-metals*, viz: *antimony, cobalt, bismuth, manganese, wolfram, molybdena, uranium arsenic*, are more or less brittle, and not malleable; they also undergo different changes when exposed to heat and air; and some of them may even be volatilised by heat, such as *arsenic* and *antimony*.—*Zink* has also been ranked with the semi-metals; but it belongs on account of its great degree of ductility, more properly to the imperfect metals, as it may be extended or brought into the state of thin plates by pressure.

The metallic substances in general possess certain qualities, in which they exceed one another; thus, respecting their different degrees of density or specific gravity, they may be placed in the following order: First, platina, gold, wolfram, mercury, lead, silver, bismuth, copper, arsenic, iron, cobalt, uranium, tin, manganese, zink, and antimony.

Secondly, with regard to tenacity—gold, iron, silver, copper, tin, lead, &c.

Thirdly, with respect to hardness—iron, platina, copper, silver, gold, tin, lead.

Fourthly, as to malleability—gold, silver, platina, copper, iron, tin, lead.

Fifthly, with respect to fusibility—mercury, tin, bismuth, lead, zink, antimony, silver, gold, arsenic, cobalt, copper, iron, and platina.

Metals,

Metals, when melted or fused, and exposed to cool gradually, always exhibit a convex surface, and occasionally cubical or octoedrical crystals, which figure is peculiar to all metals.

Most metals have an affinity to each other, and unite in a greater or less proportion when in a fluid state; but they have no affinity, or cannot combine with earths, except they are previously brought into the state of calx or oxyd.

All metals, except platina, gold, and silver, are liable to undergo an alteration, when exposed to heat, and air, that is, to such air as is necessary for the support of life and flame, by which the metals lose their lustre, coherency; malleability, and the quality of uniting to each other by fusion; they become more or less friable, exhibit different colours, and their weight is increased, which, according to the new theory, has been accounted for by the absorption of oxygen.

The increase of weight has been found different in different metals; hence the following table has been formed, exhibiting the different increase of weight: Mercury increases 0,6.—Bismuth 0,8.—Silver 12.—Lead 15.—Copper 19.—Cobalt 20.—Antimony 21.—Zink 25.—

Manganese 30.—Iron and tin 40. The metals are then called calxes, or oxyds of metals.

Some metals undergo that alteration, when exposed to the temperature of the atmosphere; others require more or less heat; and a few of them, such as the perfect or noble metals, are not acted upon by the atmosphere, nor by water nor heat, which explains the reason why those metals are almost always found in their perfect metallic state, and when they are brought into that state by other operations, they can be recovered by the mere application of heat, which is, according to the new theory, explained, from the weak affinity of these metals to oxygen.

When metals are brought into the state of calxes or oxyds, they are rendered fit for entering into the mixture of different earths, and composition of different stones, in which they occasion an alteration, both with respect to coherency and colour.

Most of the metals have an affinity to sulphur, except gold and platina, and therefore enter into combination; by means of which, the metallic substances are also altered, and exhibit an appearance different from their original one, and also different from their afore-mentioned state. They become more or less brittle, according to  
to



to the quantity of sulphur with which they unite, and also according to the different degrees of intimate combination.

Certain metals, when in the state of calx or oxyd, and united with sulphur, occasion, when exposed to moisture and the atmosphere, an alteration in the nature of the sulphur which approaches gradually to the state of acid, and which, according to the new theory, is accounted for by the absorption of oxygen, which is considered as the acidifying principle, and which forms acids when combined with acidifiable substances, such as the sulphur; in which case, that acid, namely, the sulphuric acid, acts again upon the metal, with which it was united and forms a new body, which, when united with a proper proportion of water, exhibits the metal in the state of salt; hence the origin of the vitriols of iron and copper, which are found in the earths, may be explained.

Metals in general are found in the state of nests, and veins also intermixed in different stones, which form gangues in certain mountains or rocks. The veins are more or less inclined to the horizon; and the degrees of inclination have caused them to be distinguished by the names direct, oblique, inclined, or level veins, according to the angle they make with

the horizon. The part of rock which rests upon the veins, is called the roof; and that part upon which the vein rests itself, is called the bed of the veins. They possess a greater or less degree of continuity, according to which they are distinguished by the names of continued or broken veins; and when the ore is found in spherical parts or masses, from space to space, these masses are called stock-work, or bellies.

The nature of the stones which compose mountains, is the best indicator of ores; and all the other marks are very imperfect, and most of them ridiculous.

We know that granit, and other rocks of a primitive origin, seldom contain metals, or the mountains of modern formation; but it is found, that mountains of a secondary formation, are the chief matrixes in which metals exist. The mountains of gneiss, or shistous rocks, contain the richest veins of metallic substances; quartz, calcareous stones, and heavy spars, are also good indicators of ores.

On account of the afore-mentioned different states in which metals are found, in or on the surface of the earth, they may be brought under the following divisions.

DIVISION.

## DIVISION I.

## NATIVE METALS AND SEMI-METALS.

This denomination signifies, when metallic substances are found in the earth in the metallic state, possessing and exhibiting all their peculiar properties and appearances. They are in that state not united to, nor altered by any other substance. So we find platina, gold, silver, mercury, copper, antimony, arsenic, cobalt; iron, tin, and lead, are also supposed to have been found in that state, but very rarely.

Platina is always found in the metallic state; gold also most generally. The other metals, as silver and copper, &c. are frequently found in the state united with sulphur, or in the state of calx or oxyd.

When metals are found in their metallic state, they are easily discovered by their properties. They are extracted or separated from their matrixes, first, by reducing them, together with the matrixes, to small particles by pounding; after which they are washed by streams, in order to separate such heterogeneous particles, from the metallic, as from their  
inferior

inferior gravity, can be washed away: The thus separated, or remaining metallic particles, are then dried, and further extracted; either by the process of amalgamation, as gold and silver, which easily unite with mercury, and from which the mercury can be separated again by distillation, in earthen retorts, or distilling vessels, on account of its volatile nature.

The gold or silver which remains in the distilling vessel, is further freed from other imperfect metallic substances by the process of cupellation, which is done by uniting the gold or silver with a certain proportion of lead, and exposing it in small quantities upon small cupels, or tests chiefly made of bone ashes, to such a degree of heat in an assaying furnace, (in which the heat is applied from the upper part) so as to occasion the lead to unite with the heterogeneous imperfect metal, with which it vitrifies, soaking into the pores of the test, and leaving the nobler metal, as the gold or silver in its pure state behind. Sometimes this process is repeated, if the gold is found not quite pure.

The other metals, when in the metallic state, (and sometimes also silver) are separated from their matrixes, by the process of fusion or smelting; in which, is first to be observed, the different degree of heat which  
certain

certain metals require for fusion, without destroying them; secondly, the nature of the matrixes, according to which, certain materials must be added to render the matrix more fusible, so that the metallic particles may unite, and be easily separated by virtue of their superior gravity. Or, in other cases, substances are added to scorify the heterogeneous substances, and to separate thus the metallic particles. Or such substances are added, as prevent the effect of pure air upon those metals, which easily calcine or absorb oxygen, when exposed to heat, such as charcoal.

Lime-stone and quartz are frequently employed in smelting different ores.

## DIVISION II.

### METALS AND SEMI-METALS UNITED OR MINERALISED BY SULPHUR OR ARSENIC.

In this state the metals have lost their coherency, malleability, and peculiar lustre. They are more or less brittle, and exhibit a lustre different from their original one; when they exhibit a metallic lustre, they are generally called pyrites, such as the iron, copper, and  
arsenic;

arsenic, when united to sulphur; the metals and the sulphur are in different proportion, and different metals and other substances are frequently intermixed.

Metals in this state are easily distinguished by the sulphuric or arsenical vapour or smell, which they emit when exposed to heat. By a strong heat, they are converted into slags.

The metals are separated in this state from the sulphur or arsenic, by torrefaction, which is done by exposing the previously pounded ores upon flat earthen vessels, to such a degree of heat, as is only required to volatilise the sulphur or arsenic; whereas a greater degree of heat, would alter and destroy part of the metal. After which, the remaining metallic parts are further freed from the rest of the sulphur, either by iron, or by other substances, according to the nature of the metals. So must afterwards other substances be added, accordingly in order, to separate the metallic parts, and to recover them, when in the state of calx, by charcoal, which I have mentioned in the different species of ores.

Silver, copper, iron, tin, lead, antimony, and mercury, are frequently found united to sulphur, but platina never, and gold very seldom; and then it appears to be owing to  
the

the admixture of iron, in a similar manner, as zink seems to be united to sulphur, in blende.

## DIVISION III.

## METALS AND SEMI-METALS

IN THE STATE OF CALX OR COMBINED WITH OXYGEN, CALLED CALCES OR OXYDS OF METALS,

How metals have obtained that state, is still variously explained.

According to the old theory, when metals were brought into this state, it was said, they parted with their phlogiston, or that matter which recovers them again, when afterwards employed, through the means of such substances as contain it; according to the new theory, it is said, the metals have combined with oxygen, from the surrounding atmosphere, or from other substances as contain the oxygen, such as water and acids, and have thus obtained their additional weight.

The metals in this state, are more or less friable, have an earthy appearance, and exhibit different colours, but no lustre. They are easily acted upon by acids, and enter into the  
mixture

mixture of other substances, in which they produce different colours.

The metals are recovered from this state, either by mere heat or by charcoal, when they regain their lustre, coherency, and their other properties.

Certain metals when in the state of calx, are found united to fixed air, or carbonic acid; and in that case, they exhibit often a regular shape.

In the state of calx, or oxydated, we find iron, cobalt, copper, arsenic, bismuth, antimony, zink, manganese, tin, lead, and mercury.

#### DIVISION IV.

##### METALS AND SEMI-METALS

##### COMBINED WITH ACIDS, OR METALLIC SALTS.

When metallic substances are in this state, they bear again a different appearance from all the aforementioned states; when united with a sufficient quantity of water, they are exhibited in regular crystals. They have a different colour, according to the different metals and acids of which they are composed.

In



In the saline state, metals are more seldom found than in any other, and only a few of them, such as the vitriol of iron, copper, and zink, are employed for useful purposes, and these are found in greater quantities than the other metallic salts; but they are not used for the purpose of extracting or separating the metals from them.

Of metals in the state united to acids, we find

1. The *sulphuric* or *vitriolic acid* united to copper, iron, zink, silver, and mercury.

2. The *muratic* or *marine acid* united to silver, antimony, mercury and copper.

3. To *phosphoric acid*, iron, lead.

4. To *arsenical acid*, cobalt, lead, copper, and silver.

5. To *carbonic acid* or *fixed air*, iron, lead, cobalt, copper, manganese.

## DIVISION I.

*Perfect or Noble Metals.*

### GENUS I.

#### PLATINA.

This metal was first notified in the year 1748, by *Don Antonio Ulloa*, and *Charles Wood*, who brought

brought it from Jamaica, and made experiments upon it, which were published in the *Philosoph. Transact.* for the year 1749 and 1750.

Messrs. *Scheffer*, in Sweden; *Lewis*, in England; *Margraaf*, in Prussia; *Macquer*, *Baumé*, *De Buffon*, *De Milly*, *De Lisle*, *De Morveau*, and *Baron de Sickingen*, have successively made researches on this metal, in order to discover its nature still more, and to ascertain its superior qualities.

Platina has hitherto been found in America, near the village Choco. In the environs of the river *Pinto*, in *Peru*; in the sand of several rivers in America, viz. the river *Bogoda*, at Santa Fé, near Carthagen; near the mountains of the district of *Novita* and *Cytara*, in South America, it has been found mixed with auriferous sand.

In all those different places, the Platina is found always in its metallic state, and there are no different species and varieties known yet. It is found in the form of small grains, or flat pieces, very seldom exceeding the size of a pea. The grains appear generally silver-white, or have rather the colour intermediate between that of silver and iron. It is from the resemblance which it bears to silver, with respect to colour

colour or lustre, that it has been called Platina in the Spanish language.

It is never found pure; but always more or less mixed with iron, and frequently also with gold; sometimes it contains so much iron, as to be attracted and taken up by the magnet.

In the state in which Platina is brought to us, we often discover a little mercury adhering to it, arising from the process of amalgamation, which the platina-grains have been exposed to, in extracting the gold from it; but from which it is easily freed by exposure to heat:

From iron it may be freed either by boiling it; when previously reduced to fine particles, or with muriatic acid, which takes up the iron, and leaves the Platina behind; or the Platina may be mixed with sal ammoniac; or *muriate of ammonia*, and exposed in a glass vessel to sublimation, by which means the sal ammoniac, being volatile by heat, leaves the Platina, and carries the iron parts, which it has also rendered volatile, along with it into the upper and cooler part of the subliming vessel, which is seen by the yellow or orange colour of the sublimed salt; this process must be repeated, until the sal ammoniac sublimes colourless.

Platina, when pure, is the heaviest and most refractory of all metals; it undergoes no alteration by exposure to the atmosphere; it is unalterable in fire or in any heat, which can be produced in common furnaces, and requires a very vehement heat to render it even liquid; but it may be easier fused upon charcoal, by the assistance of oxygen-gaz, or pure air; or by means of a large burning glass.

It resists the action of all acids, except the nitro-muriatic and fur-oxygenated muriatic acid, in which it is perfectly soluble, by the assistance of heat; and when in the state of solution, it may be easily discovered by the precipitate which it occasions, when muriate of ammonia or sal ammoniac be added, in which it differs from gold. The solution of Platina exhibits also a deeper yellowish brown colour than the solution of gold, and gives a brown colour to the skin.

On account of its being very difficult to melt, it is necessary to mix it with other substances which renders it more fusible; and by which means it becomes also malleable. Mr. Achard has recommended us to take equal parts of platina, white arsenic, and cream of tartar, and to put the mixture into a crucible well luted, which is then to be exposed for  
one

one hour to a very strong heat, that will fuse the Platina; but in this state it is brittle, and must be exposed under a muffle in a furnace, in order to separate the arsenic.

Vessels of Platina may be made by fusing the Platina with arsenic, and casting the melted mass; after which, the arsenic is separated again in the afore-mentioned way by heat.

Mr. Morveau substitutes the arseniate of potash, with advantage, instead of simple arsenic; he also melts Platina by a flux of powdered glass, borax, and charcoal.

Mr. Beaumé advises to fuse Platina with a slight addition of lead, bismuth, or antimony.

When Platina has been dissolved in aqua regia, and is precipitated again by sal ammoniac, it becomes easily fusible; if the precipitated Platina be mixed with phosphoric glass, and melted, it may be perfectly freed from iron, and thus rendered superior in quality to that which is melted with arsenic.

## GENUS II.

## GOLD.

*Aurum.* Ital. Oro. Fr. Or.

Germ. Gold. Hung. Arany.

This metal, which, from its superior qualities, is considered as the most precious of all, is found in most parts of the earth; it is (iron excepted) more frequently found than any of the other metals, but in less proportion, and scarcely in any other state than in the metallic; never in the state of calx or oxyd, nor in the saline state, very seldom mixed with sulphur, but always alloyed with some other metal, as platina, silver, copper, or mixed with iron, lead, or antimony; whereby the gold, according to the proportion of the alloy, obtains a different colour, and becomes either heavier or lighter. Gold is found partly in rivers mixed with sand, generally in the greatest proportion nearer their origin or sources.

It is sometimes found in the vallies of metaliferous mountains, often mixed with various kinds of stones or ores. Peru, Spain, Transylvania, Hungary, and Siberia, are particularly remarkable for gold mines.

The stones, or matrix in which gold is generally found, are quartz, gneiss rock, petrofilex, and ferruginous stones, seldomer calcareous spar, green-clay, heavy spar, grey, grit, &c.

As to the nature and quality of gold, when freed from all heterogeneous substances, it exhibits always a yellow colour, which is more or less intense, according to the manner in which it is wrought.

It is next to platina, the heaviest of the metals, and exceeds them all with respect to malleability.

Its specific gravity is generally  $\approx 19,25$ .

The atmosphere and water have no effect upon it; nor is it alterable in the heat or fire which is produced in common furnaces. When exposed to heat, called red-heat, it emits a sea-green light, but does not melt before the heat is increased to  $5237^{\circ}$  Fahr. which is commonly called a white-heat. When perfectly fused, and suffered to cool very gradu-

ally, it exhibits four sided pyramidal figures on its surface.

When melted with borax, it produces a glass of a ruby colour.

Gold has, of all metals, the least affinity to oxygen, or to the basis of pure air, which changes metals into the state of calx or oxyd; this accounts for the fact why gold is never found in the earth in the state of calx or oxyd.

It is not acted upon by any other acid, but by the nitro muriatic acid, commonly called *aqua regia*, or the sur-oxygenated muriatic acid, in both of which it is readily soluble; the solution being of a yellow colour, and lighter than that of platina or iron, in the same acid.

If we add a drop of the solution of gold to a solution of tin, dissolved in the same acid, a purple precipitate takes place.

The solution of gold also occasions a purple stain upon the skin, and is not decomposed by sal-ammoniac, or *muriate of ammonia*, like the solution of platina; from which it also differs by its being precipitable from its solvent menstruum by *sulphate of iron*, or martial vi-triol, which occasions no precipitate in the solution of platina.



Gold, when separated, or precipitated from the acid by alkaline salt, in the state of calx or oxyd, recovers itself again by mere exposure to heat, without any additional substance, owing to its weak affinity to oxygen.

It easily unites with mercury, which latter has, on that account, become a good menstruum for separating gold from its stony matrix, upon which the mercury has no effect.

Gold does not intimately combine with sulphur, or it has no affinity to it, which explains why it is hardly ever found in the earth united with sulphur, and when found so, the mixture or affinity has been occasioned by some other substance as iron, similar to what we find in zink, when mixed with sulphur.

#### DIVISION I.

NATIVE GOLD, or gold in its perfect metallic state; also called virgin gold.

Lat. *Aurum nativum.*

Germ. *Gediegen, or natürlich gold.*

Fr. *Or natif.*

Ital. *Oro-nativo.*

Hung. *Termes-arany.*

In this state gold is almost always found; however, as it is never found quite pure, but

always mixed with more or less of another metal, or other substances which alter its appearance and quality, I thought it more proper to divide and describe the different states in which gold has thus been found, as varieties respecting its alloy or admixture,

*Gold with simple alloy of metals.*

SPEC. I.

PURE GOLD, *aurum nudum.*

*Gold gelb, gediegen gold of Werner.*

This kind is understood to be the purest state in which nature exhibits gold.

It has all the appearance and qualities of refined gold, and is therefore easily distinguished. It is, in this state, found in solid masses of different magnitudes, and generally without any particular shape, embodied in stones, commonly of a siliceous nature; we find it thus in Transylvania—in India, &c. More frequently it is found in the state of small particles, having no determined shape, and dispersed through different stones, as ferruginous quartz, and metalliferous

talliferous rock, &c. It is found thus at Cremnitz—in Transylvania—Peru—*Schemnitz*—and Siberia. On *Schlangenberge*, in Germany, it has been found in heavy spar; in Silesia, interspersed through coals; again in the state of detached grains, as in the valleys of certain metalliferous rocks, and in certain rivers in Transylvania—Spain—Cremnitz, &c.

Gold is also found in the state of dust, or in such minute particles as are hardly discoverable by the naked eye, mixed with various kinds of stones and ores; in this state it has been called *aurum larvatum*; it is thus found in brown hornstone, ferruginous red jasper, red quartz, grey clay, black slate, scaly calcareous spar, in galena and pyrites. The mines of Transylvania and lower Hungary present us with this sort of gold.

*Native gold is often found in different shapes, viz.*

(a.) In FILAMENTS OF FILAMENTOUS, in sulphurated cobalt ore, on red blende, and in lamellated selenite with quartz; in Transylvania, in the Bannat of Hungary, &c.

(b.) DENTRITICAL, on green ferruginous clay, copper pyrites and quartz; in calcareous spar, with manganese and green fibrous shörl, as in  
certain

certain mines in the territories of Salzburg; in Transylvania and Bohemia, upon white quartz.

(c.) LAMELLATED, or in thin laminæ, in different stones, viz. in white quartz, in Upper Hungary and Salzburg; frequently in ferruginous quartz, grey grit mixed with mica, and in calcareous spar, in Transylvania.

(d.) WIRE-SHAPED and net-like in and on different stones.

(e.) Of regular figure or crystallised, viz. cubical, in three or four sided pyramids, in four or six sided columns, and in six sided plates, mostly found in Transylvania.

## SPEC. II.

### GOLD ALLOYED WITH PLATINA.

#### PLANTINIFEROUS GOLD.

*Aurum platiniferum.*

*Graugelb gediegen gold* of WERNER.

This kind has a yellowish grey colour, is harder and heavier than pure gold.

It is only found in the state of small grains, involved in the platina. The admixture of platina may be discovered by dissolving a little in nitro-muriatic acid, or aqua regia, and on adding muriate of ammonia, or sal ammoniac to it, which precipitates the platina, and leaves the gold in solution.

SPEC.

## SPEC. III.

## GOLD DISTINCTLY ALLOYED WITH SILVER.

## ARGENTIFEROUS GOLD.

*Aurum argentiferum.**Aurum nativum electrum.**Messing-gelbes gold* of WERNER.

It has a pale yellow colour or lustre, similar to that of martial pyrites.

It is also lighter than pure gold.

This kind is not, or very seldom found in masses, generally dispersed through certain stones, either in the state of small particles, or in lamellæ, filaments, and in six sided plates. It may be easily discovered by digesting it with nitric acid, which takes up the silver, and leaves the gold behind.

## DIVISION II.

*Gold alloyed with other metals, and mixed with sulphur or arsenic.*

*The admixture of arsenic or sulphur may be easily discovered by exposing a little of the ore to the blowpipe, when the vapours which are disengaged, indicate the sulphur or arsenic.*

SPEC.

## SPEC. IV.

GOLD ALLOYED WITH SILVER AND  
MIXED WITH SULPHUR.

## BISMUTHIC GOLD.

*Aurum bismuthicum.*Germ. *Weiß gold-erz.*

It may be assayed by extracting the bismuth and the silver with nitric acid; separating the bismuth by diluting the solution with a sufficient quantity of water, and afterwards extracting the ore, by aqua regia, or nitro-muriatic acid, which takes up the gold, and leaves the sulphur behind.

It is found solid, and in needle shaped crystals, scattered through certain stones; as to its external appearance, it is whitish, a little inclining to brass yellow; it has a strong lustre, a lamellated texture, and is soft. It contains generally 18 parts of gold, 6 of silver, and the rest bismuth and sulphur.

It is found in Francistolle at Offenbanya, in Transylvania.

## SPEC. V.

GOLD MIXED WITH A METAL NOT YET  
ASCERTAINED, AND A SMALL POR-  
TION OF ARSENIC AND NICKEL.Born. *Cath. Raif.*

It has a brilliant white lustre, a lamellated texture, sometimes so compact as to resemble  
the

the texture of steel. It is found in lithomarge and quartz, sometimes mixed with sulphur, whereby it obtains a blackish or tarnished appearance, and a granular texture; it is brittle, so as to be easily reduced to powder; it crackles when first exposed to the flame of the blow-pipe, but melts soon after like lead, and dissipates gradually in the state of white fumes, leaving behind the small portion of gold.

Arsenic and sulphur are sufficiently discoverable by the strong smell which this ore emits when torrifed.

Its matrix is generally quartz and metalliferous rock.

Sometimes this ore exhibits dendritical figures composed of small, flat, shining prismatic crystals, which respecting the peculiar disposition of the crystals, has been called character-gold. *Aurum graphicum*. It is sometimes found in the state of filaments disposed in a parallel direction, upon white quartz. It is found at Offenbanya in Transylvania.

#### SPEC. VI.

### GOLD COMBINED WITH SULPHUR, BY MEANS OF IRON.

#### GOLD PYRITES.

Cronst. *Pyrites aureus*.

Ital. *Oro pirituoso*.

In this kind of gold ore, the sulphur is discovered and obtained by torrefaction; the iron by muriatic acid; and the gold by nitro-muriatic acid.

It differs from the ore in which native gold is found dispersed through pyrites, as before mentioned, and to which it bears some resemblance, as the gold in this ore has undergone a real combination with sulphur.

It resembles somewhat martial pyrites, but has a brighter lustre.

It is found in the gold mines of Mexico, Hungary, and Adelfors, in Transylvania, and in Dauphiny, mostly in quartz; sometimes in mercurial ore, as in Hungary; in blende, of a red colour, as found at *Schwartzenberg*, in Saxony.

It yields sometimes from 30 to 40 ounces of gold in a hundred pounds weight.

#### SPEC. VII.

#### GOLD MIXED WITH SULPHUR, ARSENIC, AND IRON.

##### ARSENICATED GOLD.

In this kind of ore, the arsenic and sulphur are discovered and separated by torrefaction; the iron by muriatic, and the gold by nitro-muriatic acid.

It



It has a yellow colour, and a fibrous texture. It is found in the gold mines of Transylvania.

## SPEC. VIII.

GOLD MIXED WITH SILVER, LEAD,  
IRON, ANTIMONY, ARSENIC.

## NAGYAG GOLD ORE.

*Aurum mineralisatum najyacense.*

Born. Cathal. Raif. *Or combiné avec le soufre, l'antimoine, l'arsenic, le plomb, le fer, & l'argent.*

The silver and lead may be separated by nitric, the iron by muriatic acid, the gold and antimony by nitro-muriatic acid, and the sulphur and arsenic by torrefaction.

It is only found at Nagyag in Transylvania. It contains sometimes 10 ounces gold in a hundred weight.

The gold in this ore, has entered into such combination with the sulphur, and other substances, that it cannot be separated from the ore, by amalgamation.

It consists generally of iron black—or lead grey—shining lamellæ, which are flexible and soft enough to be cut with a knife. Sometimes it is found in six sided plates. Its matrix is generally rose coloured fieldspar, white manganese,

nese, and quartz. Sometimes blende is mixed with it.

As to the process on a larger scale, of separating the gold from its different alloys, or admixtures, and matrix; this is to be done in different ways; according to the state of the gold, and according to the nature of the different substances which are found mixed with it.

When gold is in a state nearly pure; as it is found dispersed through stones, or mixed with sand, it may first be reduced to small granular pieces; together with the matrix; a table of several feet long, and one and a half broad, with ledges round three of its sides, and pieces of cloth with a long nap nailed on the board, is placed under a gentle stream of water, upon which the pounded ore or sand is thrown; by this contrivance, the lighter and heterogeneous substances are washed or carried off.

When the stuff or cloth is sufficiently charged with the particles of gold adhering to it, on account of its superior gravity, it is then collected from the board, and put into a vessel, where it is further agitated with water, and more freed from the lighter substances. It is then mixed with  $\frac{1}{5}$  of mercury, and triturated in an iron or copper vessel containing boiling water,

water, until the mercury has absorbed all the gold particles. The mercury thus containing the gold in solution, is then separated, first from the water, next from the earthy particles, and then from the sand, by throwing the whole upon a table placed in an inclined direction; when the mercury charged with gold, but still vivid, will, when assisted by a little stirring, or manipulation, run off the table, and leave the sand behind. The mercury is then separated from the gold, (and silver if any) by exposing the amalgam in earthen retorts to such an heat as will occasion the mercury distilling off, which is collected again in a receiver with water, and the gold not being volatile in fire, is thus left behind, and is afterwards further freed from the heterogeneous imperfect metallic substances, by the process of cupellation.

After these processes, the silver, if the gold contains any, is separated by reducing it first to very fine laminæ, and then extracting the silver by nitric acid, which leaves the gold behind; the silver may be separated from the nitric acid, by muriatic acid, with which it makes luna cornua. Luna cornua is to be decomposed again, by mixing it with soda and charcoal, and exposing it to a sufficient heat in a crucible, whereby the soda unites to the muriatic acid, and sets the silver free.

Gold may also be purified by antimony, which occasions the other metals to separate.

When gold is united to platina, it may be separated from it by mercury, through the process of amalgamation.

When gold is found mixed with sulphur or arsenic, and other metals, the ore must first be torrifed, to separate the volatile substances, after which, the remaining sulphureous particles will be entirely separated, by melting the whole with iron, and by scorifying lastly the heterogeneous metallic substances by fluxes, consisting of tartar and nitre, which have no effect upon gold when the sulphur is previously separated; without this previous separation, the sulphur would unite with part of the alkali of the nitre, and make a hepar of sulphur, which would take up a portion of the gold, and thus diminish the produce. The gold left by the melting with the flux, is afterwards further purified by cupellation.

When gold ore is free from sulphur, it may also at once, after being pounded and washed, be melted with one and a half part of litharge, and three parts of glass, in a crucible covered with common salt, or muriate of soda. By this operation, all the imperfect metals will scorify, and set the gold free.

GENUS

## GENUS III.

## SILVER.

## ARGENTUM.

Fr. *Argent.* Germ. *Silber.* Ital. *Argento.*  
 Swed. *Silwer.* Dan. *Solvet.* Hung. *Erzüst.*

This metal, which is the last in our order of the noble or perfect metals, is found in different parts of the earth, and in different states. The *Erzgebürge*, or metalliferous rocks of Mexico and Potosi, are the most productive; those of Saxony, Bohemia, Norway, the mines of Kapnik in Transylvania, in the Elfaz, and at Schemnitz in Hungary, are also rich.

Silver when free from heterogeneous substances, reflects a peculiar white, and when its surface is polished, a brilliant white lustre. It has a solid fine texture, and is very malleable and ductile; its specific gravity is = 10,000, sometimes a little more; it is harder than gold, but softer and less elastic than copper; it is not altered by pure water, nor by the atmosphere, and is almost unaltera-

ble in fire ; but it is easily affected and tarnished by hepatic air, more than any other metal. It requires near 1000 degrees of heat (Fahr. scale) for fusion.

It discovers almost no affinity to *oxygen*, or in other words, it is not altered by the basis of pure air, which explains why it is not found in nature, separately, in the state of *oxyd* or calx. And when it is brought by means of chemical operations into the state of *oxyd*, it even then shows a very weak affinity to the basis of pure air or *oxygen*, as it can be freed from it by the mere application of heat, which destroys its affinity.

But silver has an affinity to sulphur, and combines with it ; in this it differs from gold and platina. In the state united to sulphur, it is very easily fusible by a slight degree of heat.

Silver unites easily with mercury, and combines with all metals except cobalt and nickel.

It is readily soluble in pure nitric acid in a great proportion, but not in muriatic acid. The latter acid separates it from the nitric acid, when the silver appears in the state of needle-shaped shining crystals, which are distinguished by that peculiar property of turning purple or blackish, when exposed to the sun or to light.

Sulphuric

Sulphuric acid acts only upon the silver when in a concentrated state, and assisted by heat. Finally, it does not vitrify with lead, by the process of cupellation.

It is found in the earth in different states: in the metallic state, united to sulphur or to arsenic, commonly called mineralised—and united with acids. Besides the mentioned substances, it is found alloyed with other metals, as is mentioned in the following order or arrangement, comprising the different species of silver ores.

It is observed, that wherever metallic veins are found, charged with arsenic, and joining veins, which contain oxyd or calx of iron, there are generally rich ores of silver; and almost all ores which contain iron and arsenic, contain a more or less portion of silver.

Among the matrixes in which silver is generally found, we find the *carbonate of lime*, or calcareous stones, which contain fixed air—heavy spar—quartz—sometimes stones belonging to primitive rocks, and not unfrequently mixed with cobalt, arsenic, and nickel ores.

## DIVISION I.

*Silver in the metallic state : Malleable, soluble in nitric acid and mercury.*

## SPEC. I.

NATIVE SILVER, OR SILVER IN THE METALLIC STATE.

*ARGENTUM NATIVUM.*

Germ. *Gediegen-Silber.*

Swed. *Gedieget Silwer.*

Fr. *Argent natif.*

Dan. *Natürlig eller Klar Solv.*

Hung. *Termes Ezüst.*

In this state, silver is frequently found. It possesses thus all qualities of pure silver, and generally exhibits its natural lustre. It often appears tarnished, as brown, yellowish, or greyish black. It is in this state easily distinguished from any other.

It is perfectly malleable, and soft enough to be cut with a knife, when it exhibits its brilliant white lustre.

Its



Its specific gravity is  $\approx 10,000$

It does not emit any fumes of sulphur or of arsenic, when exposed to heat.

It is perfectly soluble in nitric acid; the solution is colourless, and the silver can entirely be separated from that acid, by muriatic acid in the state of fine crystals of muriate of silver.

It is perfectly soluble in, or can be taken up by mercury.

If it contains a small admixture of copper, the solution in nitric acid obtains a blueish appearance, which becomes more evident, on adding a little ammonia to the solution.

If it contains a little gold, the solution in nitric acid deposits it in the state of a black precipitate. When the gold is in greater proportion mixed with the silver, it may be distinguished or discovered by the yellow bright colour which it exhibits, and by its superior specific gravity, &c. In this state it is called by Werner *güldisch gediegen silber*, *argentum nativum electrum*, which kind is found in *Schlangenberge*, Siberia, and in Norway.

As to the matrix or stony masses which contain silver in the metallic state, we find it in heavy spar (*sulphate of baryt*), calcareous stones and spars (or *carbonate of lime*), petriflex, quartz, steatites, lithomarge, &c. From all

these substances it can be separated by the process of amalgamation, to which it is previously prepared by selecting or picking, pounding and washing, &c. similar to what is observed in the afore-mentioned process of extracting native gold by amalgamation.

Or the silver may be separated by the process of fusion or smelting, after which it is freed from the adhering heterogeneous imperfect metallic particles, by the process of cupellation with lead, similar to the manner in which gold is refined, or also by melting it repeatedly with nitre.

As to the different shapes under which nature exhibits occasionally native silver, the following varieties are known :

It is found in solid pieces, sometimes of considerable weight, as in *Königsberg*.

In small particles of an indeterminate shape, interspersed through different kinds of stones, or ores, as cobalt, pyrites, &c.

In grains—dendritical—in filaments, probably originating from decomposed vitreous or sulphurated silver ore.—In lamellæ—arborescent; and also sometimes exhibiting a regular figure, as cubical. In simple and double four sided pyramids, the latter kind is found in the *Elfaz*.

The

The other varieties are frequently found in either of the following places :

In the metalliferous rocks (or Erzgebürge) of Mexico; of Potosi, in Peru; near Johan-Georgenstadt; Schneeberg; -Freiberg; Joachimsthal, in Bohemia; Königsberg, in Norway; Transylvania; Hungary; Harz; and near Catharinenberg, in Siberia.

The following species include the different ores, in which silver is mixed or mineralised with arsenic or sulphur, or with both. In this state the silver is called mineralised *Argentum Mineralisatum*.

It has a different appearance from its metallic state. It has lost its malleability, and is become more or less brittle; it can no longer be distinguished by its specific gravity, as that must vary, according to the sulphur and other substances, with which it has united.

The sulphur, or mineraliser, may be discovered by the smell or fumes which the ores emit, when washed or torrifed, or when exposed to a gentle heat produced by the blow-pipe upon charcoal. The silver cannot be extracted from these ores by the simple mode of amalgamation, nor by simple fusion, on account of the sulphur; for which reason the sulphur or arsenic must first be separated by torrifaction,

torrification, the remaining ore is then fused with iron, which takes up all the remaining sulphur, on account of its having a greater affinity to the sulphur, than the sulphur has to the silver; after this the silver is washed, and either extracted by amalgamation with mercury, or by melting the silver in the same state with a sufficient quantity of lead, or any other substance that will occasion a scorification of the adhering imperfect metallic substances and stones, so as to obtain all the pure silver.

The following species, is the second in order of the silver ores in general.

SPEC. II.

ARSENICATED SILVER, OR SILVER  
UNITED TO ARSENIC.

*ARGENTUM ARSENICALE.*

Fr. *Argent Arsenical.*

Dan. *Arsenikalst Solvmalm.*

Hun. *Egèrköves Ezüst ásvány.*

Born. Catal. raison. *Argent allié avec l'arsenic & une petite ou plus grande portion du fer.*

The

The arsenic contained in this ore may be discovered by its peculiar smell or fumes, which it emits when exposed to a gentle heat; by which means the arsenic is also separated, and leaves the silver behind, which is easily discovered by dissolving it in nitric acid, and by the precipitate, which the muriatic acid, when added, occasions.

As to colour, it generally resembles that of tin; sometimes it is tarnished; it is soft and heavy; it is found in solid pieces, and also in the state of small particles dispersed in certain stones; sometimes in the state of scales or scaly, in reniform or kidney-shaped pieces, and also occasionally crystallised or exhibiting a regular figure, as long six-sided prismatic crystals, or simple six-sided pyramids.

The crystals are shining, and have a lamellated texture resembling somewhat bismuth. It yields often 20 per cent. silver.

It is often found accompanying native silver, in arsenical ores, in quartz, heavy spar, in red silver ore, and sometimes in calcareous spar. As to the places where it is found, we find, Andreasberg in the Harz, Spain, Fürstenberg in Germany, particularly productive of the arsenicated silver ores.

## DIVISION II.

*Silver mineralised by sulphur, more or less brittle, emitting sulphureous vapour when heated, not soluble in nitric acid nor in mercury.*

## SPEC. III.

SILVER UNITED TO SULPHUR.  
VITREOUS SILVER.

Fr. *Sulfure d'argent, ou mine d'argent vitreuse.*

Germ. *Glaserz or geschwefeltes Silber.*

Ital. *Argento sulfureo.*

Swed. *Silwer glaserz.*

Dan. *Blaaes vovlet. Solvalm.*

Hung. *Uveg ezüst ásvány.*

Cronst. and Waller. *Argentum sulphure mineralisatum.*

This species is one of the richest silver ores. The silver may be discovered and extracted by digesting the powdered ore with nitric acid, which

which takes up the silver, and leaves the sulphur behind, which last is easily ascertained by the smell, when thrown upon red hot charcoal. The silver is separated again from the nitric acid, by marine or muriatic acid.

When this ore is to be worked on a large scale, it may first be reduced to small particles, and then torrefied by a gentle heat, in order to separate the sulphur, after which it is melted with iron and charcoal, by which means the iron takes up the remaining particles of sulphur, and the silver is left pure. The ore is generally found to be composed of 70 parts of silver, and 25 of sulphur.

The colour or appearance of the ore is deep lead grey, greyish black, or the colour of steel; it exhibits but a slight mark of metallic lustre; sometimes it appears variegated on the surface.

It is found lamellar, granular, capillary, and also crystallised, exhibiting double four-sided pyramids, sometimes in cubes.

When broken it exhibits more of a metallic appearance. It is soft enough to suffer impressions like lead; it melts very easily even by the flame of a candle, into a vitreous mass.

It is a little flexible, and may be somewhat extended by the hammer. Its texture is lamellar.

Its

Its specific gravity is generally = 7,200.

Its matrix is either quartz, gypsum, gneiss, pyrites, red jasper, or metalliferous rock.

It is found in Hungary near Schemnitz, near Freiberg in Saxony, Joachimsthal in Bohemia, Kunsberg in Norway. When it is found in brown spar, it has been called *Tiegererz*.

#### SPEC. IV.

### SILVER UNITED WITH SULPHUR AND ARSENIC.

#### RUBY SILVER ORE.

*Argentum mineralisatum rubrum.*

Germ. *Roth gülden erz.*

Ital. *Argento rosso.*

Fr. *Mine d'argent rouge.*

Dan. *Rod solvmalm.*

Hung. *Veres ezüst ásvány.*

Cronstedt, and Wallerius. *Argentum sulphure, ferro, & arsenico mineralisatum.*

This ore may be ascertained by extracting the silver by means of nitric acid, &c. and the sulphur and arsenic are discovered by the smell



smell or fumes which the ore emits when thrown upon red hot charcoal, or when torrifed, the sulphur and arsenic thereby being separated.

The ore appears either steel grey or cochineal red, and is found of different degrees of transparency.

It is found in solid pieces, in grains, and crystallised, exhibiting six-sided prisms, sometimes, though rarely, of one inch in diameter. The crystals have a compact texture.

Romé de Lisle describes its regular figure as a rhomboidal dodecahedron, terminating in three-sided obtuse pyramids; but it is generally modified so as to exhibit long six-sided prisms with three or six-sided pyramids, with angles of  $70$  and  $110^{\circ}$ . More varieties of figure are exhibited in the different plates of Romé de Lisle's *CrySTALLIGRAPHIA*.

It is sometimes found in the state of radiated incrustation.

It may be cut with a knife; it is friable or brittle; when broken, it has a vitreous appearance, and is of a lighter colour than on the outside. When scraped with a knife, the particles appear scarlet.

The deeper the colour of the ore, the richer it is found in silver.

It crackles when exposed to heat, but melts very easily before the blowpipe; it detonates with nitre, when thrown into a red hot crucible, and becomes then capillary silver; it may be considered as a mixture of realgar, or red arsenic and silver. Its specific gravity is generally = 5,500.

It yields by analysis, 60 parts silver, 13 sulphur, and 27 arsenical acid.

Its matrix is quartz, calcareous spar, pyrites, chiefly in gangues.

It is found at Andreasberg in the Harz, at Joachimsthal in Bohemia, Schemnitz in Hungary, Himmelfürz, Markirch, Manenburg, Schneeberg, and Freiberg.

#### SPEC. V.

PYRITICAL SILVER ORE, OR SILVER UNITED TO IRON AND SULPHUR.

ARGENTIFEROUS MARTIAL PYRITES.

Ital. *Argento piritoso.*

Germ. *Silberhaltiger Kies.*

Cronstedt. *Argentum ferro (vel etiam arsenico.) Sulphurato mineralisatum.*

In this ore the sulphur is discoverable by the smell when torrified, the iron by digesting the pounded ore with muriatic acid, and the silver by nitric acid, as the muriatic acid takes up the iron, and the nitric acid the silver, which is afterwards separated again by the proper process of decomposition.

There are two kinds of the argentiferous pyrites; the one is generally yellowish or brownish, containing from 2 to 15 ounces silver in 100 pounds weight, and is found on Kungfberg in Norway, and near Schemnitz.

Another kind which contains a small portion of arsenic besides the other substances, is called in Germany, *Weisserz*. It is almost white and shining; it is found solid and crystallised, interspersed in gangues or veins; when struck with a steel, it emits the arsenical smell. It is found in Dauphiny, in Saxony, and on *Schlangenberge*. Both varieties may be worked by torrefaction, and by scorifying the remaining heterogeneous substances.

#### SPEC. VI.

SILVER MIXED WITH SULPHUR,  
ARSENIC, AND COPPER.

BRITTLE SILVER ORE, BLACK SILVER  
ORE.

*Argentum mineralisatum nigrum.*

Fr. *Mine d'argent noire.*

Germ. *Spröd, Glaserz, Röschgewächs, or  
Schwarzgülden.*

Wall. *Minera argenti nigra.*

This ore may be chemically ascertained by separating first the sulphur and arsenic by torrefaction, after which the remainder may be digested with nitric acid, which takes up the metals from the solution; the silver may be separated by marine acid, in the state of luna cornua, afterwards the iron by volatile alkali, which precipitates the iron and keeps the copper in solution, from this last it may be separated by a plate of polished iron in the metallic state.

Its colour is lead grey, more generally blackish, and leaves a black trace when rubbed upon paper. It contains often 60 and more per cent. silver. When to be wrought, it is freed from the mineralisers by torrefaction, and from the other admixed imperfect metals, by scorifying them with proper vitrifiable fluxes,

fluxes, or lead. It is found in the state of dust deposited upon various other silver and lead ores, in cellular pieces, or also of regular shape, exhibiting six-sided prisms, six-sided plates, and sometimes lenticular crystals. The crystals are shining when broken.

Different varieties of this species are found near Freiberg, at Johanngeorgenstadt, Schneeberg, and also near Schemnitz.

A certain kind of the black silver ore composed of silver, iron, sulphur, and arsenic, which is found in the state of dust or *mulm*, coating other silver ores, and effervescing with acids, is called in German *Silberschwärze*, *Argentum fuliginosum*. It is found in the silver mines of Saxony, Bohemia, and Hungary.

#### SPEC. VII.

#### MOLYBDENIC SILVER ORE.

Fr. *Argent allié avec le molybdéne sulfuré.*

This ore has but of late become known, and has only been found at *Deutsch-Pilsen*, in Hungary.

It is composed of broad shining lamellæ, placed one over the other, sometimes of one

E 2

inch

inch thick, in grey argill. It gives a grey stain to paper, and resembles somewhat common molybdena. It yields by assaying, 23 ounces of silver, in a hundred weight.

### SPEC. VIII.

#### SILVER MIXED WITH LEAD, ANTIMONY, IRON, AND SULPHUR.

##### GREY SILVER ORE.

Germ. *Weiss giltig erz.*

Fr. *Mine d'argent blanche.*

Swed. *Weiss gyldeu.*

Dan. *Graae agtig Solv malm.*

Hung. *Fejér ezüst ásvány, also Plackmal.*

This ore may be analysed by extracting the antimony and iron from it, by the nitromuriatic acid (or aqua regia) from which solution, the antimony can be separated by merely diluting the solution with a sufficient quantity of water. The silver and lead may then be separated by digesting the remainder of the extraction with aqua regia, in nitric acid, which takes up the silver and the lead,  
and

and leaves the sulphur behind. The silver is then to be separated from the lead by muriatic acid, added to the sufficiently diluted solution, which unites with the silver, and precipitates it in the state of luna cornua, and the lead is left in the nitric acid, from which it may be separated by an alkali.

The ore has a lead grey appearance. It is found in solid masses, dispersed in, and deposited upon different stones. It has a slight lustre, is soft enough to be cut with a knife. It has never been found crystallised. It is found near Freiberg.

By decomposition, it has yielded 20 parts silver, 48 lead, 7 iron, 7 antimony, and 12 sulphur and flux.

Its matrix is generally white and yellow quartz, granite and fluor.

## SPEC. IX.

## ZINCOUS SILVER ORE.

Germ. *Zinkisches Silber.*

Cronst. *Argentum Zinco Sulphurato mineralisatum.*

It is found in a black blende, having a pitch lustre, in mines of *Schneeberg*, in Saxony; of *Schemnitz*; of *Joachimsthal*, in Bohemia.

It has a scaly texture, generally a globular shape, hence it has been called *Kugelerz*.

Sometimes it is composed of polyangular shining black or yellowish crystals, in cliffs of quartz-rock.

The silver in this ore can be ascertained by digesting the ore with nitric acid, which takes up the silver; from which it can be separated again by muriatic acid; the sulphur is easily discovered by the smell which the ore emits on heating.

On analysis, it yields generally 24 parts of silver, 30 of zink and sulphur.

There are other ores which contain a small portion of silver, but not, or at least seldom, in a sufficient quantity to be wrought: as galena, cobalt, bismuth, &c. These are mentioned in their proper places.



## SPEC. X.

## SILVER COMBINED WITH ANTIMONY, SULPHUR, AND SULPHURIC ACID.

Germ. *Lichtes Rothguldenerz.*

Its colour is cochineal-red, lead grey or blood-red.

It is found exhibiting acute angular six-sided pyramids, with three or six faces. The crystals are shining, mostly semi-transparent and soft. It breaks in fragments with a conchoidal surface.

It yields by analysis, 60 parts silver, 20,3 antimony, 11,7 sulphur, and 8 sulphuric acid.

The sulphuric acid may be separated and ascertained by digesting the pounded ore with alkaline salt, the silver by nitric acid, the antimony by nitro-muriatic acid; after which the sulphur remains behind.

SPEC.

## SPEC. XI.

SILVER COMBINED WITH MURIATIC ACID, AND A LITTLE SULPHURIC ACID.

CORNEOUS SILVER. NATIVE LUNA CORNUA.

Germ. *Silber Horn erz*, or *Salzsaures Silber*.

Fr. *Muriate d'argent natif*, or *Argent Cornè*.

It appears under different colours: pearl grey, violet grey, and yellowish grey. It has a lamellar texture. It is found in solid masses, dispersed in certain stones—in the state of hollow globular pieces, containing black silver dust—in rhombic cubes—in needle shaped crystals. When in thin lamellæ, it is a little semi-transparent—it is soft and easily cut with a knife—melts very easily—becomes purple on exposure to the sun—it has a waxy lustre.

It is found in ferruginous and argillaceous shistus.

It is found in the Elfaz; at Johangeorgenstadt; at Schlangenberg, in Siberia; and in Mexico.

The

The best kind contains 72 per cent. of silver.

The silver may be separated after the sulphur is separated, by decomposing the remainder with mineral alkali or soda, which when mixed with it, and exposed in a crucible to heat, combines with the acid, and thus separates the silver in the pure state.

There is another silver ore almost of the same composition, but which has a different appearance, and is called *Buttermilcherz*. It appears in the state of thin white, bluish, and brownish skins; in calcareous spar, formerly found at Andreasberg on the Harz.

By analysis, it yields generally from 20 to 24 parts of silver, 8 parts muriatic acid, and 67 of clay, sometimes a small trace of copper.

GENUS

## GENUS IV.

## MERCURY.

*ARGENTUM VIVUM. MERCURIUS VIVUS.  
HYDRARGYRUS.*

Germ. *Quickfilber.*

Hung. *Kénye-Sö:*

Swed. *Quickfilfer.*

Dan. *Quegsolv.*

Fr. *Vif argent.*

Ital. *Argento vivo.*

This metal is found in different parts of the earth: in Europe, Asia, and America. The mines of Deux-Ponts, and the Palatinate, of Almaden, in Spain, of Sweden and Bohemia, of the Province Quito, in Peru, &c. have been remarkably productive; so have the mines near Idria, for in one year (1663) they produced 12,000 pounds of mercury in the state of cinnabar.

The mine Guanca-belica, in the Province of Quito, has produced one million pounds of mercury in one year. The mines of Saalberg, near Maschellandsberg, 30,000 pounds weight. The other places where mercury is also found, are mentioned under the different species of the ores in their order.

Mercury differs from all other metals, by exhibiting a fluid state at the common temperature of our atmosphere.

It can only be brought to a solid and malleable state, by an extreme cold, such as  $39^{\circ}$  below the freezing point of Fahrenh. Scale.

It exhibits a white brilliant lustre when pure.

Its specific gravity, compared to that of distilled water, is = 13,568.

It is volatile, or can be dispersed in the state of almost invisible particles or vapours, by means of a heat, in which other metals remain fixed; hence the bad effect which those persons experience, who are employed in operating on mercury by heat or fire.

It is more and much readier expanded by different degrees of heat, than any other metal, which, together with its fluid nature, &c. has occasioned it to be used for thermometers, and other purposes of that kind.

It is scarcely affected by the atmosphere, nor by pure water; but it is easily, and much affected by hepatic air; hence it is used for discovering such air in mineral waters.

It has an affinity to most of the metals, and dissolves or combines readily with gold, silver, lead, tin, bismuth, antimony, and zink, when in a metallic state; but in a less degree, or with more difficulty with the other metals; with platina, cobalt, and nickel, it seems not to unite by any means; nor does it unite with earths or stones, nor metallic oxyds. It is therefore found useful for extracting gold or silver, from their ores or matrix; for dividing gold into very minute particles, so as to be deposited upon the surface of certain other metals, as in gildings; in which the cleaned surface of such metals is first coated with the mixture of gold and mercury, or gold-amalgam, and then exposed to a heat, which volatilises the mercury, and leaves by that means the fine particles of gold close on the surface of the metal; for uniting with certain metals which render it fit for coating glass for looking glasses. It combines with sulphur, and forms, when assisted by heat, cinnabar. It has an affinity to oxygen, but when combined with it, it can be easily

easily deprived of it, by the mere application of heat when in a close vessel.

It is readily soluble in nitric acid, from which it can be separated again by copper in a metallic state. When combined with muriatic acid, it makes the corrosive sublimate; in which state it can be easily discovered by mixing it with lime water, which occasions a precipitate of an orange colour. It is found in nature in the metallic state;—combined or mineralised with sulphur;—united to oxygen and also to acids.

Its general matrix is calcareous spar—argillaceous shistus—bituminous shistus—ferruginous and white quartz—marle—petrosilex, &c. from which it is separated by trituration and distillation, or when combined with sulphur, by decomposing it with iron, by the process of distillation.

DIVISION

## DIVISION I.

*Mercury in the metallic state. Soluble in nitric acid, and is separable from its matrix, or admixture by mere heat, without emitting oxygenous gaz, or sulphureous vapours.*

## SPEC. I.

## NATIVE MERCURY. MERCURIUS NATIVUS

Germ. *Gediegen quicksilber.*

Fr. *Mercurie vierge.*

Hung. *Termes eleven kénye sö.*

Dan. *Naturlig gueg solv.*

Ital. *Mercurio nativo.*

Wallerius. *Mercurius virgineus.*

It is found in most of the mercury mines in the state of small globules exhibiting a bright lustre, and all the properties of pure mercury, adhering on the surface of cinnabar ores, from which it is easily separated by trituration and distillation.

It



It is thus found in the mines near Sahlberg in Sweden, at Almaden in Spain, at Idria, in Bohemia; in the Palatinate near Wolfstein and Moersfeld, in the Duchy of Deux-ponts, on the mountain *Stahlberg*, and near Moschellandsberg, &c.

## SPEC. II.

### NATIVE AMALGAM.

#### MERCURY UNITED WITH SILVER.

Germ. *Natürlich amalgam.*

It may be easily distinguished by its consistency, and when exposed to heat, it parts with the mercury, and leaves the silver pure behind, which is entirely soluble in nitric acid, and possesses all the properties of metallic silver.

Its colour is generally the medium between tin and silver; it is found partly liquid, partly more or less solid, sometimes exhibiting oblong polygons; it is shining, and soft enough to suffer impressions with the nail of a finger. It gives a creaking noise when cut with a knife. It is not frequently found, nor in large quantities; but if it should be found, both the  
silver

silver and the mercury can be perfectly separated from each other, after the amalgam is first separated from the matrix, by distilling it in close vessels; by means of which, the mercury being of a volatile nature in fire, distills over into the receiver with water, and the silver being fixed in fire, remains behind.

Native amalgam is found on Moschellandsberg, and Stahlberg, in the duchy of Deux-ponts; near Sahlberg, in Sweden; near Zlana, in Hungary; in those mercurial mines only where the veins are attached to silver, which accounts why it is not found at Idria, and at Almaden, as in those places no silver is found attached to the veins of mercury.

The matrix is generally grey indurated clay. The amalgam found in Hungary, contains generally a little mixture of lead.

## DIVISION II.

*Mercury in the state of calx or oxyd, pulverisable, yields fixed air when heated with charcoal in close vessels, and the mercury recovers without emitting sulphureous vapours.*

## SPEC. III.

## OXYD OF MERCURY. CALX OF MERCURY.

## RED NATIVE PRECIPITATE.

Fr. *Precipité rouge natif.*Gerin. *Rother natürlicher queckfilber kalch.*

It was first noticed by Mr. Kirwan; it has a red colour, is compact and heavy, has a granular texture, and is generally mixed with globules of mercury.

When exposed to heat in a close vessel, it yields oxygenous gas or pure air, a little fixed air, or carbonic acid gas, and the mercury becomes recovered.

It was found mixed to sand, near Alicante; in the mercury mines at Idria, and Busachino:

## DIVISION III.

*Mercury mineralised by sulphur, emits a sulphureous smell when heated, and is also entirely volatilised by heat; is not readily soluble in diluted nitric acid.*

## SPEC. IV.

## NATIVE CINNABAR. MERCURY MINERALISED BY SULPHUR.

Fr. *Cinnabre natif ou oxyde de mercure sulfuré rouge.*

Germ. *Zinnober.*

Cronstedt. *Mercurius sulphuré mineralitus.*

In this state the mercury is found more generally, and in greater quantities than in the metallic state.

Its component parts, the mercury and sulphur, may be discovered by mixing it with iron filings, and exposing it afterwards in a close earthen distilling vessel or retort, to a sufficient heat; by which means, the sulphur leaves the mercury, and unites with the iron; the mercury not being fixed in fire, is then separated in the state of very minute particles or vapours, which on cooling reunite, and collect in the receiver in the state of perfect running mercury, and the sulphur united with the iron, forming pyrites, remains in the retort.

Instead

Instead of the iron filings, pure lime (or quick lime) is often employed in the proportion of one third of lime to one part of the ore, which occasions a decomposition on the same principle as the iron.

Those two ways are chosen for obtaining the mercury from this ore.

The cinnabar is not soluble in nitric acid; when pure, it is entirely volatile in a close subliming vessel.

It exhibits different shades of red, as scarlet, cochineal, deep ruby colour, often lead grey. The deeper kind exhibits a lighter colour when scraped with a knife.

It is generally more or less shining; of various texture, as lamellated, fibrous, granular, earthy, and often also compact.

Its specific gravity is generally  $\approx 7000$ . It can easily be scraped with a knife, and the softer kind stains the fingers red. Its variety of colour is derived mostly from the different proportion of the component parts, and from the different degrees of heat, to which it must have been exposed. So we find (though rarely) the mercury in the state merely mixed with the sulphur, exhibiting a greyish black powder, called *Æthiops mineral*, near *Kirchheim*, in *Nassau*, and *Idria*, accompanied by lamel-

lated cinnabar, and in Deux-Ponts, upon sulphur pyrites; it has not been chemically combined by the assistance of heat, which is necessary for exhibiting the red colour.

The perfect combination of mercury and sulphur or the CINNABAR, is found in compact masses—in radiated pieces—in masses composed of scales—in grains, and also crystallised: In three and four sided pyramids; in three sided prisms with three sided pyramids; in double four sided pyramids joined at their bases; these are generally truncated at the points, which make them exhibit an octaedron. The crystallised kind is scarce, and is always more or less transparent, and generally of a deep colour.

The cinnabar yields mostly about 80 per cent. mercury, and the rest sulphur.

The matrix is generally indurated clay; white and ferruginous quartz; calcareous spar; argillaceous shistus; sometimes heavy spar and pyrites.

It is found near Chilopan, in New Spain; near Nertschinsk, in Siberia; Joachimsthal, in Bohemia; at Almaden, in Spain; on Monte Niso, in Sicily; in the Dutchy of Deux Ponts; in Transylvania; at Siegersberg and Schemnitz, in Lower Hungary; at Wolfstein and  
Mörsfeld,

Mörsfeld, in the Lower Palatinate in Germany.

Sometimes the mercury, united with sulphur, is found mixed with iron, and also with other heterogeneous substances, which gives it a different appearance and quality—hence the following species.

### SPEC. V.

MERCURY MINERALISED BY SULPHUR,  
AND MIXED WITH OXYD OF IRON,  
OR FERRUGINOUS CLAY.

#### HEPATIC MERCURY.

Germ. *Quecksilber-Lebererz.*

The iron in this ore, may be ascertained by exposing a little of the powdered ore in a flat earthen vessel to a sufficient heat, so as to volatilise the sulphur, and also the mercury preventing the sulphur to fuse and to combine with the iron, which is then left behind, and which may be dissolved in muriatic acid, and precipitated by prussiate of alkali, or phlogisticated alkali.

There are two kinds of this species.

VAR. 1. *Compact Hepatic Mercury.*

Its colour is the intermediate betwixt deep blackish—lead grey and cochineal red. Sometimes greenish and variegated.

It has a compact texture. It is shining, and takes a polish. It can be cut with a knife, and gives a cochineal red trace upon the *touch-stone*.

The other kind.

VAR. 2. *Sibstous Hepatic Mercury.*

This kind exhibits chiefly the different shades of cochineal red. It is also a little shining.— It has generally a curved lamellated texture.

There is another kind which may be placed here, and which has a nodulous appearance, and is called in German *Korallenerz*.

These mentioned varieties are found at Idria, and yield generally 50 or 60 per cent. of mercury; the rest sulphur and ferruginous clay.

SPEC.



## SPEC. VI.

MERCURY AND COPPER MINERALISED BY  
SULPHUR.

Cronst. *Mercurius cupro sulphurato mineralisatus.*

## CUPREOUS MERCURY.

This ore is either blackish or greyish. It is compact, brittle, and heavy; and has a vitreous appearance when fresh broken; it decrepitates in fire, and melts with borax before the blow-pipe in a green glass.

The copper in this ore may be ascertained by digesting the residuum, left, after the pulverised ore is torrefied, and the sulphur and mercury separated, with volatile alkali, which dissolves the copper in a blue colour.

It is found in the mines which produce cubical cinnabar, near Moschellandsberg.

Its matrix is lapis ollaris—quartz and gangues of shistus.

## SPEC. VII.

MERCURY COMBINED WITH HEPAR OF  
SULPHUR.*Cinnabar Alcalin* of BORN.

This species was first noticed by BORN. It was found in Idria. It has a fine red colour, is more or less transparent, and has a spatous form. When broken, the fragments are rhomboidal; when rubbed, it emits a smell of hepar of sulphur, or *alkaline sulphur*.

It is found in white calcareous spar.

## SPEC. VIII.

## MERCURY COMBINED WITH BITUMEN.

## BITUMINOUS MERCURY ORE.

Fr. *Mercuré bitumineux.*

Gmel. *Mercurius foetens.*

Its colour is dark brown; it has an earthy texture; it burns with a flame when kindled, and the vapours have the smell of bitumen.

It

It yields from 15 to 20 per cent. mercury.

It is found at Idria.

## SPEC. IX.

MERCURY OXYDATED AND UNITED  
WITH MURIATIC ACID, AND A LITTLE  
SULPHURIC ACID.

CORNEOUS MERCURY. NATIVE SUBLIMATE.

Germ. *Natürlicher Sublimat.*

This kind is found of different colours:—  
smoak, ash and yellowish grey, yellowish white,  
lemon-yellow and greenish.

It is found in small cubes—in four sided  
pyramids, in four and six sided prisms.

The crystals have a pearl lustre, they are  
semitransparent, and soft. When thrown upon  
red hot charcoal, they discover a smell like  
garlic. When mixed with lime water, they oc-  
casion a precipitate of an orange colour.

It yields 70 per cent. mercury.

It was found in the cavities, and on the sur-  
face of indurated martial clay, in certain mines  
of Deux-Ponts.

## SPEC. X.

MERCURY MIXED WITH SILVER, IRON, AND COBALT, MINERALISED BY ARSENIC AND SULPHUR.

MERCURIUS MISTUS, *Monnet System Miner.*

Germ. *Vermischtes Quecksilbererz.*

It was found in the mines of Dauphiny, in the state of white lumps. By analysis 100 parts yielded 1 part mercury,  $\frac{1}{3}$  silver, and the rest was iron, cobalt, arsenic, and sulphur.

The arsenic and sulphur in this ore are easily discoverable by the smell, when the ore is heated in an open vessel; the mercury distills over when the ore is exposed to a sufficient heat in a retort. The remaining iron—silver and cobalt may be further separated by dissolving the residuum in nitric acid, and separating, first, the silver by marine acid in the state of luna cornua—then the iron by phosphoric acid, and the remaining cobalt by an alkali.

DIVISION

## DIVISION II.

## IMPERFECT METALS;

*Or metals also malleable, but more or less destructible or vitrifiable in fire.*

## GENUS V.

## IRON.

*FERRUM.*

Germ.	<i>Eisen.</i>	Dan.	<i>Jernet.</i>
Fr.	<i>Fer.</i>	Hung.	<i>Vas.</i>
Ital.	<i>Ferro.</i>	Span.	<i>Yerro.</i>
Swed.	<i>Jeren.</i>		

Of all the metals, there is no one which is so copiously and so variously distributed through the Earth, or which answers so many purposes, either for ornament or use, in common life, as iron:

The great utility of this metal arises, partly, from certain qualities which are peculiar to it, partly from other qualities, which it possesses  
in

in a more eminent degree than the rest of the metals; and, lastly, from its great abundance.

If we take a view of it in all its different states, and the many uses to which, in each of these, it is applied, we may pronounce it to be one of the most important products of nature. Its various uses are not confined to it merely as a metal: though in this state it is fitted not only for the grossest purposes in mechanical and œconomical machinery, but for other purposes which are the nicest and most delicate, as we see in the instruments of anatomists, engravers, &c. for which the other metals, from their inferior hardness, cannot be employed. Though in its metallic state, we see it capable of being impregnated with that peculiar and still inexplicable property; which we call the magnetic power, thereby forming that important instrument, which has opened worlds of glory, industry, and wealth to nations—*The Compass*. Yet in its non-metallic state, are its uses many and valuable.

Thus, for instance, united with vitriolic acid, or in the saline state called martial vitriol, it affords, with the astringent principle of galls, that universally known and useful black liquid, by means of which we are enabled to preserve the collected ideas of ancient time, and to  
communicate

communicate these and our own to each other, at any distance.

In another saline state, that is mixed with the Pruffic acid, it produces the beautiful blue colour, called Pruffian blue.

In the state of calx or oxyd; what a variety of colours does it not produce for glass and oil painting?

Almost all the common coloured stones and earths, gems or jewels, owe their different colours mostly to the calx of this metal, according to its different states and proportions.

In short, there is hardly any colour, which is not, or which might not, be exhibited by this metal, in one or other of its different states.

To this general praise of iron, we may add its worth as a medicine, which time and experience have now established to be very valuable in many diseases.

There are philosophers who have suggested the idea, that iron is a production from organised bodies; from this it must follow, that it is of a later origin than the primitive rocks, such as granit. But this notion is not well founded, as the mica, which is considered as one of the principle component parts of granit, contains iron in a considerable proportion, and  
very

very frequently feldspar is ferruginous. Primitive schistus also, which very lately has been suggested to be of a prior origin to primordial granit, contains a certain portion of iron.

Though iron is found in all parts of the Earth, yet nature has divided it unequally, as to its quantity and different states; hence it is found in some places in greater abundance than in others. England, Sweden, Germany, Russia, &c. produce the greatest quantity.

We find iron naturally in its metallic state, though very scarcely; more frequently it is mineralised by sulphur; sometimes united with acids, but most generally we find it in the state of calx or *oxyd*.

When iron is in its perfect metallic state, it is of a livid whitish grey colour, somewhat inclining to blueish grey; it has a fibrous, a lamellated, or a granular texture; according to its different state; it is lighter than gold, platina, silver, copper, lead, &c. Its specific gravity is = 7,800.

It is the hardest of all metals, and when united with a due portion of plumbago, it becomes so hard as to strike fire with quartz or flint.

It is brittle when fused, becomes malleable by repeated glowing and hammering, and acquires



quires a high degree of hardness by sudden cooling; it is very refractory in fire, and requires 1620 degrees of heat, (Fahrent. scale) to melt; when perfectly fused, and gradually suffered to cool, it exhibits octoedral figures on its surface. Its tenacity is very considerable, it can be stretched out into very thin wire, as is seen by the thinnest strings used for harpsichords. It is attracted by the magnet, and is the only substance which acquires the magnetic power; a bar of iron becomes magnetic when kept for a long time in an erect position, or in the direction between north and south; or when two pieces of iron are rubbed for a long time, in the same direction; or when struck by lightning, as has been observed.

It does not readily combine with mercury.

It is easily acted upon by the atmosphere, less by water, but it decomposes the latter when perfectly red hot, and brought into contact with it, by which it absorbs the one component part of the water, and acquires the state of calx, separating the other component part, the hydrogen, in the state of inflammable air.

Iron has a strong affinity to the basis of pure air or *oxygen*, which explains why it is generally

rally found in the state combined with that principle; and the various colours which iron in that state reflects, arise probably from the different proportion in which it is united with it. The more it has combined with that principle, the more it loses the property of being attracted by the magnet. It has a stronger affinity to oxygen than silver and copper, because it recovers those metals when in the state of calces, by depriving them of the oxygen.

The great quantity of copper thus recovered from the cement water at Arklow, in the county of Wicklow, in Ireland, and at Anglesey, in Wales, give very striking instances of such operation.

Iron has an affinity to sulphur, and when combined with it, it is called pyrites, in which state, the sulphur is prepared to absorb oxygen, and to become an acid, when in contact with water. If this mixture absorbs the oxygen from the surrounding air, a great quantity of heat is set free at the same time, which occasions the mixture often to break out in fire. When sulphur has absorbed a sufficient quantity of the oxygen, and is thus become an acid, it re-acts upon the iron, and sometimes at the same time, upon the clay, and composes both martial vitriol and alum.

Iron is soluble in most acids, in which state, it can be easily discovered when saturated, on adding a small portion of what is called prussiate of alkali, formerly phlogisticated alkali, with which it produces a blue precipitate, called Prussian blue, and with the astringent principle it makes ink.

Saturated with vitriolic acid, and crystallised, it exhibits rhomboid crystals of a pale green colour, which do not deliquesce by exposure to the atmosphere, and which are not soluble in spirits of wine.

With muriatic acid it is soluble in all states, and the crystals formed by evaporation, are yellowish green, deliquesce easily in the atmosphere, and are soluble in spirits of wine. The calx of iron, when melted with borax before the blow-pipe, produces a brownish green glass.

Iron is volatilised by sal ammoniac, or muriate of ammonia. The most general matrix of the iron ores, is clay.

#### DIVISION I.

*Metallic iron, or ores of iron, nearly in the metallic state, attractable by the magnet, and transmitting the electric fluid.*

## SPEC. I.

## NATIVE IRON.

FERRUM NATIVUM.

Germ. *Gediegen eisen.*Fr. *Fer natif.*

Many mineralogists still doubt the existence of native iron, without being able to give any reason against the possibility. From repeated and well supported accounts, there remains hardly any doubt, that the specimens in Mr. Margraaf's collection of ores, which had been found near Eibenstein in Saxony, were real native iron; they were found inclosed in a matrix of brown iron stone, in the state of small pieces, flexible, perfectly malleable, and fusible *per se*, in fire; their colour was the medium between silver and steel grey; other specimens had a ramified and spongy appearance, discovering no regular shape.

At *Kamtsdorf*, in the territories of *Neustadt*, there has been found a piece of two pounds weight, which is preserved in the cabinet there,

there, as a great curiosity. The cellular mass of iron of 1600 pounds weight, mentioned by Mr. Pallas, found on the river Denisei, near Krasnojarsk in Siberia, and the other mass of 300 pounds, found on Parana in Paraguay, seem to be coated with a natural varnish, which has prevented the surface being oxydated, or rendered in the state of calx. The specimens possess all marks and qualities of metallic iron. Specimens of native iron have also been found in Iceland, and in Africa, on the river Senegal.

## SPEC. II.

### BLACK METALLIC IRON-STONE.

This ore contains the iron united to a small portion of oxygen.

Its colour is greyish black, sometimes resembling the appearance of steel; it is compact and shining in its fracture, seldom ductile, generally more or less pulverifiable, the powder appears black; it is attractable by the magnet, not quite soluble in vitriolic acid; it is sometimes found in grains, generally amor-

phous; it contains from 60 to 80 per cent. of iron. It is found in the iron mines of Sweden, at Taber in Smoland, at Bitzberg in Hungary, Transylvania. Its matrix is generally granitous, magnesian, or argillaceous, rocks, and sometimes white marble, often accompanied by shörl, garnits, and quartz.

## SPEC. III.

## OCTAHEDRAL IRON ORE.

Cronst. *Minera ferri calciformis inaurata octaedra.*

Waller. *Ferrum mineralisatum crystallisatum.*

This ore has the form of octahedrons, which are isolated and dispersed in a gangue of argillaceous shistus, or calcareous stones, as in the marble of Carara; in steatitical stones, and in ferruginous sand. The crystals are grey, or greyish black, very regular in their form, and of different size, generally strongly attached to the matrix.

They are reducible to powder, and moveable by the magnet.

They are found in Corsica and Sweden.

To

To this kind belongs the *native martial æthiops*, which is found in the state of black, grevish, or brown powder, which is attractable by the magnet, and difficultly soluble in acids.

## SPĒC. IV.

## EMERY.

Waller. *Firrum Smiris.*

Fr. *Emeril.* Ital. *Smeriglio.*

Germ. *Smirgel.*

This stone is exceedingly hard, so as to cut all stones except the diamond.

It is attracted by the magnet; its specific gravity varies, generally = 3922.

Its colour is greyish black, when reduced to powder, the powder appears reddish grey; it has a granular texture; it contains from 20 to 30 parts of iron per cent.

It breaks with lapis ollaris, and quartz, blende, and often with magnetic iron-stone.

It is found in South America, at Guernsey, in white steatite.

There is another kind of ferruginous stone, also called emery, but which is not so hard, and the iron which it contains, is not attracted by the magnet; its matrix approaches the nature of tripoli.

The MANACANITE-SAND described by Mr. Gregor and me, in Crell's Journals, which contains a great portion of iron, and is attractable by the magnet, belongs also to these species. It is found in the state of small grains resembling gunpowder.

It seems to contain a substance of a peculiar nature, as Mr. Gregor has first observed.

#### SPEC. V.

#### SPECULAR IRON ORE. MIRROR ORE.

Gmel. *Ferrum speculare.*

Cronst. *Minera ferri calciformis indurata  
coerulescens.*

Fr. *Mine de fer specularz.*

Germ. *Eisen glanz.*

This iron ore bears some resemblance to the octahedral iron ore, but it has a finer lustre and colour;



colour; in appearance it resembles steel, sometimes its surface is variegated, exhibiting the colours of the neck of a certain kind of pigeons. It is found as dodecahedrons, with triangular plains, truncated at two extremities—sometimes lenticular, or in double flat three sided pyramids, or cubical, but seldom of six sided plates, frequently in solid masses of an indetermined shape. It is hard, but pulverisable; it is slightly attracted by the magnet, but it transmits the electric fluid.

It contains generally from 60 to 70 per cent. iron.

It is found at the island Elba, also in Norway and Sweden.

### SPEC. VI.

#### MICACEOUS IRON ORE.

Fr. *Mine de fer micacé.*

Germ. *Eisenman.*—Werner. *Eisenglimmer.*

*Ferrum ochraceum speculari micaceum.*

Cronst. *Haematites caerulefcens squamosus.*

Waller. *Ferrum mineralisatum, minera micacea squamosa colore griseo seu ferrenitens.*

It has a fine brilliant steel colour and lustre; it is composed of thin laminæ like mica, has generally little reddish spots from the hæmatites, which adheres or accompanies it; it contains more oxygen, and is therefore little moved by the magnet; it is brittle. Sometimes it is found exhibiting six sided plates.

It is found near Suhl, in *Henneberg*; in Lower Hungary, Sweden, Dauphiné, and Auvergne in France.

#### SPEC. VII.

#### NATIVE MAGNET, or LOADSTONE.

##### FERRUM MAGNES.

Fr. *Aimant natif ou mine de fer magnetique.*

Waller. *Ferrum mineralisatum, minera ferrum attrahente et polos mundi ostendente.*

Ital. *Calamita.*

*Lapis nauticus,—minera ferri attractoria & retractoria.*

This iron ore attracts metallic iron.

Its specif. gravity is = 4,243.

It

It contains often above 70 per cent. iron. Its colour is generally iron black. It is very hard, and difficult to pulverise.

It is mostly found in Norway, Sweden, *Danemark*, Lapponia, Siberia, Peru, Hungary, Bohemia, and at Johannegeorgenstadt, and Ehrenfriedersdorf in Saxony.

Mr. Werner mentions three varieties :

VAR. 1. COMMON MAGNETIC IRON-STONE.

Germ. *Gemeiner magnetischer Eisenstein.*

*Ferrum magnes vulgaris.*

It is of an iron black colour ; it has a granular texture ; it is found in solid masses, or in small particles dispersed, and sometimes in double four sided pyramids—in six sided flat prisms—cubical, and more or less shining ;—when broken, it resembles metallic iron.

It contains from 50 to 80 per cent. iron.

VAR. 2. LAMELLATED OR FOLIATED MAGNETIC IRON-STONE.

*Ferrum magnes lamellosum.*

Germ. *Blättriger magnetischer Eisenstein.*

Its colour is iron black; it is found solid, shining, and has a lamellar texture.

It is found in Norway—Russia—Siberia—India—Mexico.

VAR. 3. FIBROUS MAGNETIC IRON-STONE.

Germ. *Fafriger magnetischer Eisenstein.*

Its colour is steel or greyish black; it is solid or compact, and has a fibrous texture, and is found in Sweden.

VAR. 4. MAGNETIC IRON SAND.

*Ferrum magnes glarcosum.*

Germ: *Magnetischer Eisen Sand.*

Waller. *Ferrum mineralisatum in formam arenae collectum.*

Its colour is deep iron black, a little glittering; internally shining—it has a conchoidal texture, and is found generally of octahedral bodies. It contains often half its weight of iron.

Its specif. gravity is = 4,600.

It is found near Spandou in Germany, and in Virginia.

## DIVISION II.

Ores of iron more or less oxydated, or in the calcliform state; not attractible by the magnet, and not transmitting the electric fluid; not fusible per se—they generally effervesce with acids, but are hardly acted upon by nitric acid. They exhibit different colours according to the degree of oxydation or colcination, and the quantity of fixed air or carbonic acid which they are combined with; when exposed to heat, they obtain a deeper colour, and approach to the state to be attracted by the magnet; they are soluble in muriatic or marine acid, and the solution inclines more to yellow. The ores must be recovered by heat and charcoal, during which they yield a great quantity of fixed air, arising from the combination of the charcoal with the oxygen of the ore. They seem to originate from the other metallic iron ores, which have decomposed the pure air or the water, or from the deposition of martial vitriolic waters; or from the mutual decomposition and attraction of carbonate of lime (or calcareous earth containing fixed air) and martial vitriol, by which operation the iron attracts the fixed air, and the vitriolic acid having a stronger affinity

*affinity to the lime, combines with it, and composes selenite. These calces or oxyds are seldom pure, they are frequently mixed with earth and stones, as lime-stone, clay, sand, &c.*

*The iron is in this state more frequently found than in any other state.*

The following nine species differ from each other by colour, coherency, texture, shape, and proportion of iron.

A. *Red calces, or oxyds of iron.*

### SPEC. VIII.

#### RED IRON GLIMMER.

*Ferrum ochraceum rubrum inguinans.*

Fr. *Mine de fer micacée rougeatre.*

Germ. *Kother Eisenrahm.*

It is found of different shades of the cherry red colour; it is composed of small shining scaly particles; it stains the fingers; is rather greasy to the touch, and astringent to the taste. It is found in compact masses, and sometimes covering other stones; it changes in time into  
micaceous

micaceous iron stone, and in hard, red, and compact iron stone.

It is found at Ehrenfriedersdorf, in the Erzgebürge, and in various other places.

## SPEC. IX.

## RED CALCIFORM OR OXYDATED IRON-STONE.

Germ. *Okkriger rother Eisenstein*, or *rother Eisen-okker*.

It is found of a variety of shades of red; it is found compact and sometimes very friable; has an earthy texture, no lustre; it is soft to the touch, and stains the fingers. It generally accompanies the next following iron stones.

## SPEC. X.

## COMPACT RED IRON-STONE.

*Ferrum ochraceum rubrum densum*.

Its colour is steel grey and cherry red; its texture is compact; it gives a blood-red trace upon

upon the touch-stone; it may be cut with a knife; it is found globular—kidney shaped—feldomer of regular figure, as cubical in four sided pyramids, or as secondary crystal exhibiting six sided pyramidical figures.

It is frequently found in Bohemia, and in different other places.

### SPEC. XI.

#### COMPACT RED FIBROUS—HAEMATITES BLOOD-STONE, OR IRON STONE.

Fr. *Haematites.*

Ital. *Pietra de Sangue, or Ematita.*

Swed. *Blodsteen.*

Germ. *Blutstein, also Rother Glaskopf.*

Dan. *Straalig Rod Blodsteens malm.*

Cronst. *Haematites ruber & nigrescens flav.*

Its colour is generally the intermedium between steel grey, and blood red or cherry red.

It is found in solid irregular masses—kidney shaped—botrioid—tubular-cellular; it is a little shining—has a fibrous texture, breaks in cuneiform



form pieces; it gives a blood red trace; it contains generally from 40 to 50 per cent. iron, sometimes 70.

It is found in many parts of the world; in Transylvania—Schneeberg—Carinthia—Bohemia—in England, near Durham—Workington, near Cambridge—in Gloucestershire and Cumberland—in Derbyshire—in Scotland, near Aberdeen.

It is used in the art of burnishing gold and silver; also, when soft enough, for drawing, and for polishing iron.

B. *Brown Iron-Stones.*

SPEC. XII.

BROWN IRON GLIMMER.

Germ. *Braun Eisen glimmer—braun Eisenrahm.*

*Ferrum ochraceum brunum inguinans.*

Its colour is generally the intermedium between tombac brown and steel grey; it is found frequently coating other iron ores; it is strong glittering—scaly—greasy to the touch, and stains the fingers.

SPEC.

## SPEC. XIII.

## EARTHY BROWN IRON-STONE.

Germ. *Okkriger brauner Eisenstein.*

*Ferrum ochraceum brunum terrosum.*

Its colour is brown inclining to yellow; it is found compact—friable and staining; it has an earthy texture without lustre.

It is generally found accompanying some of the next species of iron stones.

## SPEC. XIV.

## COMPACT BROWN IRON-STONE.

Germ. *Dichter Brauner Eisenstein.*

*Ferrum ochraceum brunum densum.*

Its colour is chocolate brown or yellowish, and tombac brown and blackish brown. It is found in solid masses—stalactitical—arboresecent—pyramidical—as secondary crystals, sometimes coating other substances. It has a dull appearance,

appearance, seldom shining; it gives a yellowish brown trace; it accompanies often brown *glaskopf*.

It is found near Kamsdorf—near Suhl—near Gethlitz, and near Schleusingen, &c.

## SPEC. XV.

BROWN FIBROUS IRON-STONE, OR  
HAEMATITES.

*Ferrum ochraceum brunum haematites.*

Fr. *Hematite brune.*

Germ. *Brauner Glaskopf.*

Its colour is deep brown or iron black, internally chocolate brown.

It is found of various shapes, like the red haematites; it is very shining, and has a fibrous texture. It breaks into cuneiform pieces;—it gives a yellowish grey trace;—it is sometimes found covered with dendritical figures of manganese.

It is found in Kärnthen, near Eibenstock—Schmalkalden and Könitz.

## SPEC. XVI.

## BLACK IRON-STONE.

Waller. *Ferrum haematites nigrescens.*

Germ. *Schwarzer eisenstein.*

Its colour is the medium between steel grey, and blueish black.

It is found solid, in kidney shaped pieces, botrioid or tuberculous; it becomes shining when rubbed; it has a conchoidal texture; it is brittle and hard.

It contains a little manganese. It is found frequently near Schneeberg.

There are other kinds of stones which contain iron in an oxyd or calx state, of the siliceous stones, such as the garnits, jasper, trapp; others of the magnesian genus, as serpentines; but these are mentioned already in the class of stones, in the first volume.

C. *Calcareous iron-stones.*

SPEC.

## SPEC. XVII.

CALCAREOUS IRON-STONE. SPATOUS  
IRON-STONE.Germ. *Spathiger eisenstein.*Fr. *Mine de fer spatique.*Dan. *Forenspat staalstein.*Swed. *Whit fermalm.*Hung. *Spatos vas föld.*Cronst. *Terra calcarea marte intime mixta.*

This stone is yellowish, greyish white, brown, greenish grey, or cream yellow. It is found in solid masses, interspersed in other stones, cellular, with cubical impressions, rhomboid, in saddle shaped crystals, in double four sided pyramids; it is shining, sometimes exhibiting a pearl lustre, or a fat lustre; it breaks in rhomboid pieces; it can be scraped with a knife; it effervesces with nitric acid; its original colour is light, but becomes darker in time on exposure to the atmosphere; its specific gravity is = 3,600, or 4,000,

By analysis it yields oxyd of iron, manganese, carbonic acid, or fixed air, calcareous earth and water.

It is found near Freiberg, Kamsdorf, Könitz, Huttenberg in Corinthia.

In England there is a great quantity of ferruginous lime-stone found, which effervesces with acids.

The stalactitical calcareous spar, when containing a little portion of iron, has been called flos ferri.

D. *Argillaceous iron-stones.*

Germ. *Thonartige eisensteine.*

*Ferrum ochraceum argillaceum.*

*They do not effervesce with acids.*

SPEC. XVIII.

STALACTITICAL ARGILLACEOUS IRON-STONE.

*Ferrum ochraceum argillaceum scapiforme.*

Its colour is generally the medium between brownish, blood red and cherry red.

It

It exhibits generally thin separate stalks which are curved; it has a fine earthy texture, is very brittle, gives a blood red trace, but stains very little; it adheres to the tongue, and is sonorous when hollow.

It is found in Bohemia, and Bayreith.

SPEC. XIX.

LENTICULAR GRANULAR ARGILLACEOUS IRON-STONE.

Fr. *Mine de fer argilleuse lenticulaire.*

Germ. *Linienförmig körniger thonartiger eisenstein.*

Its colour is either reddish, brownish, greenish black, &c.

It is very shining; has a close earthy texture, and is soft.

Sometimes it occurs in small lenticular pieces.

It is found in Sweden in large quantity.

## SPEC. XX.

BROWNISH RED ARGILLACEOUS IRON  
STONE.*Ochra ferri rubra.*Germ. *Röthel.*

Its colour is generally brownish red. It is found compact, and flaty; and breaks or separates into orbicular plates; it gives a blood red trace; does not soften easily in water; stains much, and is heavy.

It may be considered as a ferruginous argillaceous shistus.

## SPEC. XXI.

## COMMON ARGILLACEOUS IRON STONE.

Werner. *Ferrum ochraceum argillaceum vulgare.*

Germ. *Gemeiner thonartiger eisenstein.*

Its colour is various, yellowish, reddish, chocolate brown, and blackish brown.

It



It is found compact, as botrioid, cellular, generally containing or exhibiting conchoidal petrifications.

It has a dull appearance, and a close earthy texture; and adheres to the tongue. It is found in Saxony, Upper Lusatia, in the county of Suffex, &c.

## SPEC. XXII.

KIDNEY SHAPED, OR NODULAR IRON  
STONE.

Germ. *Eisen niere.*

*Ferrum ochraceum argillaceum reniforme.*

Its colour is yellowish brown; it is generally found in tuberculous masses; it has somewhat of a metallic lustre when broken, but the surface is dull.

It is found in Saxony and Poland.

## SPEC. XXIII.

## PISIFORM IRON-STONE.

*Ferrum ochraceum argillaceum pisiforme.*

Germ. *Bohnerz.*

Its colour is yellowish, reddish or blackish brown; its shape is nearly globular, or roundish; sometimes it is found in the state of small kernels; it is composed of concentric curved coatings, resembling *calculi*. It gives a light brown trace, and is soft enough to be scraped by a knife.

It is found in the principality of Hesse, near Würtemberg, and in the Alsace.

When these stones are of a considerable hardness and magnitude, they are called rattelstone, in German *klapperstein*; lapis aetites, or eagle stone,—the latter name has arisen from a notion formerly entertained, that eagles placed it in their nests, to facilitate the laying of their eggs.

*E. Calciform ores of iron, probably originating from the deposition of ferruginous waters, which has collected in swamps, or bogs, whence they are also called BOGGY IRON ORE. Certain authors suggest, that these iron ores originate from the decomposition of animal and vegetable substances, which have been long under stagnant waters or bogs. They contain mostly a small portion of phosphoric acid, and hence*

hence the iron obtained from these ores, is brittle, and is called COLD SHORT IRON. These ores do not effervesce with acids, or at least very seldom. They exhibit no regular shape.

They yield sometimes from 30 to 40 per cent. iron.

They generally form strata, and are found in great abundance in the Highlands; in Provence in France, in Spain, and in Bohemia, where it is known by the name, *mine de fer limoneuse*. In German, *rafeneisenstein*.

The following Species are denominated from the places or situation where they are found.

#### SPEC. XXIV.

#### MARSHY, OR SWAMPY IRON ORE.

Germ. *Morasterz*,

Its colour is yellowish brown, seldom of a light ochre colour.

It is found compact and earthy; it is brittle and staining.

It is found under moor grounds, or in bogs.

SPEC.

## SPEC. XXV.

## SUBAQUEOUS IRON ORE.

Germ: *Sumpferz.*

Wall. *Minera ferri ochracea subaquosa.*

*Ferrum ochraceum cespititium paludinare.*

Its colour is deep yellowish, and blackish brown. It is found compact and solid, but generally perforated or spongy; sometimes in round balls, or roundish flat pieces; it has a dull appearance, an earthy texture, gives a yellowish brown trace, and is rather soft.

It contains generally 30 parts of iron, and the rest fixed air, phosphoric acid, and volatile alkali, or ammonia.

It is found in brook waters, or stagnant lakes.

## SPEC. XXVI.

WIESENERZ, by the German. (*Werner.*)

*Ferrum ochraceum cespititium pratense.*

Its

Its colour is deep black, or yellowish brown. It is found compact, generally spongy; it has a little lustre, and a conchoidal earthy texture; it gives a yellowish brown trace. This kind is the richest of the bog ores.

## SPEC. XXVII.

BLUE EARTHY IRON ORE. NATIVE  
PRUSSIAN BLUE.

Germ. *Natürliches berliner blau, or blaue eisen erde.*

Fr. *Prussiate du fer natif.*

Lat. *Ferrum ochraceum cœruleum.*

*Oxyd or calx of iron, united with prussic and phosphoric acid, and argillaceous earth.*

This substance never exhibits a regular shape, is always found in an earthy state of a slight coherency; its colour is generally approaching to indigo blue, sometimes the colour of smalte; it is very friable, not shining; it has a dull earthy appearance; it stains the fingers blue; it is light; when exposed to heat,

heat, it burns, becoming brownish red, and melts at last into a black slag; its colour is destroyed by alcalies and acids, but when the colour is taken away by the one, on adding the other, the colour always re-appears, in which it differs from the artificial Prussian blue. It is found in Siberia, in Schonen, in Saxony near Eckardsberg, and Weiffenfels, in layers of clay and lime, also in swampy or boggy iron ores.

It has been found in the moors of Livonia, near Heidekendorf, in Ingermanland, and in the walls of the city of St. Petersburg.

By analysis it yields 25 per cent. of iron.

### SPEC. XXVIII.

GREEN IRON EARTH. (*Discovered by Werner.*)

*Ochra ferri viridis.*

Fr. *Terre verte ou de verone.*

Germ. *Grüne eisen erde.*

It is in an earthy friable state, having a dull appearance; sometimes compact, solid, or like a corroded stone. It is found of various shades  
of

of the green colour, frequently pea green, and yellowish green; it is difficultly soluble in acids; its matrix is quartz, sulphur pyrites, and clay.

It has been found in the mine *Neue Hoffnung Gottes*, at Braundorf, near Schneeberg; and in the mine Kalb, and Frisch Glück.

## SPEC. XXIX.

ARSENICAL IRON ORE. MISPICHEL,  
*Or Speifs of the Bohemians.*

Its colour is generally steel grey, yellowish grey, &c. It has a metallic lustre; it is found granular, in cuneiform, prismatic, and rhomboidal pieces; is not magnetic; and is soluble in acids.

It is found in Spain, containing from 30 to 40 per cent iron.

## SPEC. XXX.

## BITUMINOUS IRON ORE.

Germ. *Eisenbranderz, or Kohlen ähnliches eisenerz.*

Fr. *Fer bitumineuse.*

Wall. *Ferri minera carbonaria.*

Its

It is composed of calx of iron and bituminous matter; it burns and emits a bituminous smell, leaving a black coaly matter behind.

It resembles gagat coal; after burning, it is attractable by the magnet; it yields from 20 to 30 per cent. iron.

It is found in Saxony; &c.

### DIVISION III.

*Ores of iron in the state mineralised by sulphur, or sulphurated iron ores. They emit sulphureous vapours when torrefied; they are not soluble in marine acid; they have a metallic lustre, but a different colour from the metal. The colour is yellowish grey, paler than the copper pyrites.— When in contact with air and moisture, they decompose, produce heat, and the sulphur becomes an acid, which then re-acts upon the iron, and forms thus martial vitriol; when in contact with a clayey matrix, it forms also, and at the same time alum.*

*When the iron is to be extracted from these ores, the sulphur must be separated by a gentle heat possible to prevent the sulphur from becoming acidified, and charcoal is added to carry off the calcining principle from the iron.*

SPEC.



## SPEC. XXXI.

SULPHUR PYRITES—SULPHUREOUS  
MUNDIK.Germ. *Schwefelkies.*Fr. *Pyrite martiale.*Ital. *Ferro pyritoso.*Hung. *Kovakö.*

Its colour is straw yellow, with a metallic lustre. It is found in solid masses—in smaller particles dispersed in different matrixes, deposited upon various stones, or of regular shape, as in cubes—as dodecahedrons—in double four sided pyramids, or as icosedrons with rhombic faces; the alternate faces are striated; it is harder than copper pyrites, and strikes fire with steel.

It is found in various metalliferous mountains, and frequently in coal strata and indurated clay.

## SPEC. XXXII.

## RADIATED PYRITES.

Germ. *Strahlkies.*

*Ferrum mineralisatum pyrites radiatus.*

Its colour is also straw yellow; it is found in solid masses, as reniform—stalactitical—botrioid—with impressions of fluor—globular in dodecahedrons and cubes; less shining than the foregoing species; it has a radiated or fibrous texture, and is more brittle.

It is frequently found in Schneeberg and Freiberg.

## SPEC. XXXIII.

## HEPATIC PYRITES.

Germ. *Leberkies.*

Wall. *Pyrites fuscus.*

Werner. *Ferrum mineralisatum pyrites hepaticus.*

Its

Its colour is brown, steel—and yellowish brown. It has lost its metallic lustre by a slight degree of decomposition.

It is found in solid masses, tubular, arborescent, cellular, stalactitical, globular, and with pyramidical and conical impressions, in six sided plates, in cubes, as six sided prisms, and six sided pyramids.

It contains a little more iron than the foregoing species.

It is found frequently near Cremnitz in Hungary, and near Freiberg.

#### SPEC. XXXIV.

#### CAPILLARY PYRITES.

Germ. *Straalkies.*

*Ferrum mineralisatum pyrites Capillaris.*

Its colour is deep cream yellow; it exhibits long capillary shining crystals, and is found near Schneeberg—Annaberg—Johanngeorgenstadt, in the mine Adolphus, upon quartz, &c.

## SPEC. XXXV.

## MAGNETICAL PYRITES.

Germ. *Magnetischer Kies.*

Its colour is generally the intermedium between cream yellow and copper red. It is found solid, and dispersed in other stones; it is shining, and has a compact texture, is brittle, and is slightly attracted by the magnet.

Some mineralogists place plumbago amongst the iron ores, as it certainly contains iron; but I have described it amongst the inflammable substances in the first volume.

As to the manner of assaying iron ores, for the purpose of making a calculation of the quantity of metal which may be extracted from the ore; when to be wrought on a large scale, the following methods have been found to answer the purpose very accurately:

A certain quantity of the ore which is to be assayed, is first reduced to small particles, and torrifed by a gentle heat, not stronger than is required to separate the moisture, and to volatilise the sulphur, if the ore contains any, which is easily perceived by the smell during the  
the

the torrification. When the moisture and sulphur are separated, four parts of the remaining ore is to be mixed with an equal quantity of common salt, or *muriate of soda* (*which has been previously deprived of the crystallising water, by stirring it in an earthen flat vessel over fire*) and with the same quantity of a mixture of equal parts of fluor and pure lime, and half a part of charcoal. This mixture is kept red hot in a crucible covered with charcoal, for  $\frac{3}{4}$  of an hour, after which the iron contained in that quantity of ore, is found in a metallic state separated in the bottom of the crucible.

*Or in another way :*

Four hundred grains of calcined borax, forty grains of slacked lime, and two hundred grains of the ore to be assayed, are mixed together. The mixture is pulverised, and placed in a lined crucible, which is to be covered. The heat of a forge furnace is then sufficient to effect the reduction of the metal, which is generally done in the course of half an hour. This method Mr. Chaptal has also adopted.

*In the moist or humid way :*

This way of assaying the ores of iron, is attended with more difficulty. I found the following method the most simple one : A certain quantity of iron ore is reduced to powder, and digested with about six parts of marine acid, which takes up the iron, and such earths as are soluble in that acid, and leaves the filix and the sulphur behind ; after which, the solution is to be saturated with potash, (or if the ore contains any copper, with volatile alkali or ammonia) which precipitates the iron in the state of *calx* or *oxyd*, along with the dissolved earths ; the precipitate is then well dried, and strongly heated or calcined, after which, it is pulverised, and put in digestion with diluted nitric acid, which then takes up all the earths, together with the other heterogeneous substances, and leaves the iron behind, which, on account of its being so highly oxydated or calcined, loses its solubility in that acid ; it is then well washed, freed from acid, and afterwards recovered by charcoal, or any other inflammable matter of that nature, which has a stronger affinity to the oxygen than the iron, and which carries the calcining principle off ; the regulus thus found in the bottom of  
the

the crucible, in which the precipitate had been recovered by charcoal, indicates the proportion of the metal contained in a given quantity of the ore.

With regard to the process for working or treating iron ores, on a large scale, attention must be paid to the state and condition of the ore which is to be wrought, as well as to the nature of the heterogeneous substances which generally attend the ores, as iron is hardly ever found in its free or separate state.

The chief substances or mineralisers by which the nature and state of iron is differently altered, and which are particularly to be considered in the process of working the common and richest iron ores, are sulphur, oxygen, or *the basis of pure air*, carbonic acid, or *fixed air*; limestone and clay are to be considered as the general matrixes of the rich iron ores.

The principal object of the operator, in working the different iron ores, consists, therefore, first, in separating the moisture and sulphur, or all that can be volatilised by mere heat, by the process of torrification; for that purpose, the ore is first reduced to small pieces, and mixed with coals; the mixture is then raised up in large flat heaps or beds, about two

or three feet high, the outside or upper part is placed in a close manner, in order to prevent the accession of the pure air during the ignition and evaporation of the sulphur, &c.

The fuel is then kindled, and the moisture and sulphur gradually evaporate. After the sulphur is thus separated, the remaining ore is reduced to smaller pieces, and mixed with charcoal, or with coals freed from sulphur, and if the iron ore is mixed with clay, then burned limestone is also added; and if limestone is the matrix of the iron, then a certain portion of clay is to be added, in order to render the matrix more fusible, and to admit the metal to separate, which is recovered by the addition of charcoal, which separates the oxygen by uniting with it, and which, by the assistance of heat, is carried off in the state of carbonic acid or fixed air, whilst the metal on account of its superior specific gravity, subsides or sinks to the bottom of the furnace, and leaves the fused and scorified matrix floating on its surface in the smelting furnace. The heat in the furnaces is much increased by large bellows or blast works, which I have seen in great perfection at Mr. Wilkinson's iron-works in different places of England, who, by that contrivance, is capable of melting a larger quantity



quantity of iron ore, and also in a shorter time than in the usual manner.

When the metal is found separated from the slag, and running in the bottom of the furnace in a perfect fused and liquid state, an opening is made in the side of the bottom, to let the metal run out, which by other contrivances, is conducted into forms, moulds, or casts, which are to be filled with the metal.

The metal thus obtained is called pig iron, or cast iron, which is brittle, and does not admit to be hammered or extended, but it can be rendered so, by heating and hammering; for this purpose, the pig iron is melted again in a different furnace, and frequently stirred while in the state of fusion; after which, it is carried to the forge hammer, or which is more convenient and advantageous, in making large bars of cast iron, it is passed betwixt two large and heavy iron rollers, which Mr. Wilkinson has very ingeniously invented, and by which means, large bars of iron can be considerably extended. I saw bars of iron of four feet long, and from four to five inches thick, passing in the course of five seconds through the rollers, and which were extended to twelve feet long, and proportionally flat; during which, the iron was at the same time freed

I 4

from

from its impurities, like what takes place by hammering the heated cast iron, but which is a much slower operation.

The thus flattened bars about two inches thick, are cut even by a large pair of scissars directed by the power of the steam engine, which cuts it as a pair of common small scissars would cut a plate of lead. The flattened bars are then made to pass betwixt another pair of iron rollers, by means of which, they are still more flattened, and at the same time, cut into narrow and long thinner bars, in which state, the iron is malleable and ready for sale.

Cast iron is brittle, and has a granular texture, which is changed into a fibrous, when rendered malleable.

All iron contains charcoal, and a certain portion of oxygen, which gives it its hardness, and without which, iron would be a soft metal. From the different proportion of these two substances depend the different qualities of iron, for we find that crude iron urged by a violent heat in a close vessel, affords the carbonic acid or fixed air, and passes to the state of soft iron; the fixed air is thus composed, as the oxygen or the calcining principle unites with the carbone, and by assistance of heat, is brought into  
the

the state of gaz, which exhales and leaves the iron in a purer state.

That kind of iron which contains an excess of carbone, may therefore be improved or meliorated by stirring it, while in the state of fusion, and while it is running out of the furnace; or it may be exposed for a longer time to the action of the bellows or blast-work when melted, and the smallest quantity of charcoal made use of; but when the two before mentioned principles are mixed in a due proportion with the iron, the cast iron requires only the action of heat, to bring it to its proper state. When the calcining principle preponderates, the action of the bellows must be less applied, and the metal must be mixed or penetrated with a greater portion of charcoal, in order to carry off the superabundant portion of oxygen.

Steel only differs from iron, as it contains a great portion of carbone, and hence arises its being unalterable in fire when exposed to it in a vessel excluded from the accession of pure air; but when repeatedly heated, and exposed to the atmosphere, it returns to the state of iron again.

Some iron is malleable when red hot, but is brittle when cold; such iron melts easier than the malleable kind, and its being brittle, is probably

probably owing to a small portion of phosphoric acid, as other iron melted with phosphate of iron, becomes evidently brittle.

The iron obtained from pyrites, is more readily soluble in acids, and more magnetic; it is malleable in white heat, and also when cold, but it is brittle when red hot.

Steel is harder than iron, more elastic, not easily acted upon by acids, and takes a higher polish. The brown iron ores, which contain a small portion of manganese, are found to be the best for the process of making steel. This process is very simple;—bars of iron are placed in a stratified manner with charcoal, and exposed to a white heat, after which, they are reduced to thinner plates, and hardened by putting them suddenly into cold water. Or 12 or 15 pieces of iron plates are foldered together, after being exposed to a white heat; they are then hammered and extended again into bars, &c. In certain parts of Germany, it is done by cementation, that is, by placing iron in a stratified manner, with a mixture of 16 parts of lamp-black, 8 parts of charcoal, 8 of ashes, and 5 of muriate of soda.

## GENUS VI.

## COPPER.

## CUPRUM.

Fr. *Cuivre*.Germ. *Kupfer*.

The alchemists distinguished this metal by the name Venus, on account of the facility with which it unites with other metals.

Copper is not found either in so many parts of the earth, or in such abundance as iron.

From the many purposes in common life to which it is applied, it is a very valuable metal; but it should never be forgotten, that it is a poisonous one, and hence more caution should be used, than generally happens, in preparing culinary and pharmaceutical utensils of it. From the ignorance or negligence of cooks and operators in pharmacy, concerning the nature of many vegetable and other substances which they boil, or otherwise prepare, in copper vessels, much mischief often ensues,  
both

both food and medicine being thereby rendered nauseous, noxious, or poisonous.

For other purposes, copper is very safe and useful, such as for making distilling vessels; for covering the bottoms of ships, and the roofs of houses; for making brass; bell metal; coins, &c.

Copper is found in different states; in the metallic state—in the state of calx—mineralised by sulphur and arsenic—and united with acids, or in the saline state. It is also frequently found mixed with other metals. The mines of Siberia, of Cornwall, Anglesey, of Sweden, Lower Hungary, and Tuscany, are the most productive. The matrix of the copper ores is generally indurated clay, quartz, and more rarely, limestone.

Copper, when pure, has a peculiar red colour, and a very compact texture, with a nauseous taste, and a disagreeable smell on friction. Its specific gravity is = 7,788.

It is very malleable and ductile; it is less hard and less elastic than iron; melts by a heat = to 4587, (Fahr. scale) and burns with a greenish flame; it detonates in a red hot crucible with nitre, and burns with a continued violent heat to a vitreous mass. Exposed to the atmosphere, it is easily affected, and becomes  
covered

covered with a greenish coat; it is soluble in most acids, and also in volatile alkali, or ammonia, and exhibits then a blue colour. With the fluoric acid, it produces blue crystals, cubical and prismatic; and with the arsenical acid, green crystals. With the sulphuric acid, it produces blue rhombic crystals, called blue vitriol, used for black dyings, &c. With the marine acid, it also crystallises, but the crystals deliquesce in the atmosphere. With the acetic acid, it makes verdigris. When in the state of solution in acids, it can be separated from it in the metallic state, by a polished plate of iron. It unites difficultly with mercury, but adheres easily to its surface; it has an affinity to, and combines with sulphur; it has a stronger affinity to oxygen, or the calcining principle, than silver, and therefore separates and recovers the silver, when in the state of calx, as in solution in acids. It unites almost with all metals, and with many, very readily.

## DIVISION I.

*Copper in the metallic state, or possessing all properties of perfect metallic copper, free from sulphur, arsenic, and acids.*

SPEC.

## SPEC. I.

## NATIVE COPPER. CUPRUM NATIVUM.

Germ. *Natürlich gewachsen, or gediegenkupfer.*

Ital. *Rame nativo.*

Dan. *Naturlig kobberet.*

Fr. *Cuivre natif.*

Hung. *Termés röz.*

This species of native copper possesses all the qualities of pure copper; it is however never found quite pure, but generally mixed with a small portion of gold or silver.

It is found of an indeterminate figure, in solid and compact masses; as small particles dispersed in different stones; in lamellæ; in plates; arborescent; cubical, and in double four sided pyramids; in oblong octahedrons.

Its specific gravity is generally = 7,788.

It exhibits a bright lustre when scraped with a knife, but appears generally tarnished, as blackish, brownish, &c. tho' sometimes with its natural colour. It is soft, flexible, malleable, and



and fusible. It is frequently found disseminated in, or accompanied by brown or reddish iron ochre, which when hard and compact, is susceptible of a polish, and exhibits then a metallic lustre; or it is found mixed in red copper ore, and malachite.

Its chief matrix is calcareous spar, quartz, petrosilex, jasper, and shistus. The copper in this state, may be collected by the mere process of fusion, or smelting, after the matrix has been mostly separated.

It is found in very considerable quantities, in the Bannat of Hungary, Siberia, Tuscany, Sweden, Cornwall, near Hudson's Bay, and on the shore of the Copper Island, near Kamtschatka, and also in Transylvania.

Copper is also found in the metallic state, and obtained by the process of precipitation, when the copper being dissolved in vitriolic or sulphuric acid, is brought into contact with iron, which deprives the copper of the calcining principle, and thus recovers it. This copper is called cement copper. A great quantity of copper is thus recovered by art, as at the copper mines at Arklow, in the county of Wicklow, in Ireland; and also near the Paris mountain, at Anglesey, in North Wales.

## DIVISION II.

*Native copper, more or less altered by the combination with the calcining principle or oxygen, and mixed with different other substances, as fixed air, oxyd or calx of iron, ferruginous clay, and exhibiting various colours. The species belonging to this division, contain no sulphur, or at least not in such a proportion as to be mineralised by it; they are all more or less brittle, and reducible to powder. They require charcoal to recover the metal by fusion, but no torrification. The copper is easily discovered by fusing a little with borax upon charcoal, by means of the blow-pipe, or by dissolving a little of the powdered ore in sulphuric acid, in which the copper is discovered by means of a polished iron plate placed in the solution.*

A. *Oxydated copper ores with scarcely any fixed air, not effervescing with acids.*

SPEC.

## SPEC. II.

OXYD OF COPPER, OR COPPER COMBINED  
WITH THE CALCINING PRINCIPLE.

Werner. *Kupfer Ziegel erz.*

Lat. *Cuprum ochraceum lateritium.*

Fr. *Oxyde de cuivre.*

Cronstedt. *Minera cupri calciformis pura  
rubra.*

Wallerius. *Cuprum corrosum & solutum e  
mineris cupri destructis, &c.*

Also called *Copper-malm.*

Mr. Werner notices two varieties of this kind of oxyd of copper, which differ from each other as to coherency and colour; and which he distinguishes by the name *Kupfer Ziegel erz*, which signifies copper ore of the colour of red bricks.

VAR. 1. RED OXYD, OR CALX—OF COPPER OF AN  
EARTHY APPEARANCE.

Wern. *Erdiges Kupfer Ziegererz.*

*Cuprum ochraceum lateritium friabile.*

It is of a hyacinth colour, or reddish brown. It is found in compact lumps, sprinkled in the state of small particles—coating other copper ores. It is easily pulverisable, and stains paper considerably.

VAR. 2. INDURATED OXYD OF COPPER.

Warn. *Verhärtetes Kupfer Ziegel erz.*

*Cuprum ochrae. laterit. induratum.*

Wallerius. *Minera cupri picea.*

Swed. *Pecherz.*

Its colour resembles brown pitch, sometimes the colour of hyacinths, or also steel grey and brownish red.

It is found in various places : at Orrowizza, in the Bannats; at Kamsdorf, in Saxony. It seems to be a mixture of red copper ore, and brown iron stone.

It

It yields generally from 20 to 50 per cent. copper, and contains frequently a portion of silver.

To these varieties may be added the *Brown Copper ore*, or *Hepatic Copper*.

Germ. *Lebererz*. Fr. *Cuivre Hepatique*.

It is chiefly composed of oxyd of copper and iron, or of red vitreous copper mixed with oxyd of iron.

Its colour is brown; it is sometimes in an earthy and friable state, sometimes compact and hard. It is occasionally found stalactitical, has a shining texture, is met with in the Bannats in Hungary, and probably originates from copper pyrites.

It contains from 2 to 20 per cent. copper.

The BLACK COPPER; *Cuprum ochraceum fuliginosum*, Cronstedt. *Ochra cupri impura friabili ferro mixta*, seems to belong to the above species, and to be derived from the pyritical copper ore, which has undergone a certain change; its colour is generally brownish black; it is found in a friable, or in a powdery state, coating copper pyrites, or also in a compact state, accompanied by malachites.—

It is found in Hungary—at Freiberg in Saxony; and Fahlum in Sweden.

B. *Red copper ores, or oxyd of copper, containing fixed air or carbonic acid. They effervesce with acids.*

### SPEC. III.

RED, VITREOUS OR SHINING, COPPER ORE.

#### RED COPPER GLASS.

Germ. *Rothes Kupfer erz.*

Fr. *Chaux rouge de cuivre ou oxyde de cuivre rouge.*

Swed. *Red Kopper Malm.*

Dan. *Rod Kobberkalk.*

Hung. *Veres réz ásvány.*

Cronst. *Minera cupri calciformis pura & indurata colore rubro.*

Wallerius. *Cuprum minera solida, colore rubro, &c.*

This

This species of copper ore consists of copper, fixed air, and a small portion of oxygen. It is generally of a brown or brownish red colour, and has sometimes an earthy appearance; it is frequently mixed with other copper ores, as the green copper ore. It is found in small longish crystals—has a fine texture, and resembles cinnabar; when exposed to a strong heat, it becomes blackish. It contains frequently above 60 per cent. copper.

Its matrix is generally ferruginous clay; so it is found in the Bannats of Hungary,

The following three species seem to differ only by exhibiting a different texture, and by a different degree of coherency.

#### SPEC. IV.

##### COMPACT RED COPPER ORE.

Werner. *Dichtes rothes Kupfererz.*

*Cuprum ochraceum rubrum densum.*

Its colour is generally the intermediate between lead grey and cochineal red. It is found

K 3

solid—

solid—interspersed of an indeterminate shape—perforated, and exhibiting a lustre intermediate between vitreous and metallic.

It is not transparent, and gives a blood red trace when rubbed or scraped. It is generally accompanied by native copper, and contains often above 70 per cent. copper, and a great quantity of fixed air.

It is found in Cornwall—near Rhein Breitenbach in Colonia—Norway—and near Kamsdorf in Saxony.

## SPEC. V.

### LAMELLATED RED COPPER GLASS.

Germ. *Blättriges rothes Kupfer glasserz.*

Its colour is the intermediate between blood red and cochineal red; it is found in solid pieces, dispersed through other ores, in reniform detached pieces, in double four sided pyramids, in cubical crystals adhering to each other. It is strongly shining; has a lamellated texture; gives a blood-red trace, and is brittle. Its matrix is generally ferruginous quartz.

It is found in Siberia—Hungary, &c.

SPEC.



## SPEC. VI.

FIBROUS OR CAPILLARY RED COPPER GLASS.

*Cuprum ochraceum rubrum plumosum.*

Its colour is crimson red; it is found in the state of capillary crystals, and called *Kupferblüte*, in small flacky pieces. It is shining, and is found accompanied by brown iron ochre, malachite and native copper.

It is found in Siberia—Freiberg—Rheinbreitenbach, and in Hungary.

C. *Blue copper ores.*

## SPEC. VII.

BLUE COPPER ORE, AZURE COPPER ORE.

Germ. *Kupfer lasur, Blau Kupfererz.*

Fr. *Mine de cuivre azurée, ou cuivre minéralisé par l'acide aerien, petite portion d'air pur & d'eau & une grande quantité de matière de la chaleur—chaux bleue de cuivre.*

K 4

Oxy

Oxy—carbonate of copper.

Ital. *Rome lazzureo.*

Hung. *Lazur köves réz ásvány.*

Swed. *Koppar-lazur.*

[ Dan. *Blaae kobberkalk.*

Wallerius. *Cuprum lazureum.*

In this species of ore, the copper has combined with the calcining principle—with carbonic acid and water. It is soluble in nitric acid, and the ore requires only heat, and a small portion of charcoal, to recover the metal.

This species appears in different states, as to compactness and shape, which are described under the two following varieties.

#### VAR. I. BLUE FRIABLE COPPER ORE.

*Cuprum ochraceum azuleum friabile.*

This kind has generally an earthy appearance: its colour is sky-blue, or smalt-blue. It is generally found in a powdery state, seldom compact; it stains a little; is found coating different stones, &c. and has yielded by analysis, 69 parts of copper, 29 of carbonic acid, and 2 of water.

It

It is found in Poland, Saalfeld in Thuringia, and in Siberia.

VAR. 2. COMPACT RADIATED, OR FIBROUS AZURE COPPER ORE.

*Cuprum ochraceum azureum radiatum solidum.*

Its colour is generally smalt—blue, or azure blue. It is seldom found in large solid masses, but frequently in small particles dispersed through different stones—stalactitical—botrioid—often also exhibiting a regular figure, as flat rhombic crystals, or the rhombic octahedron—flat rhombic tetrahedral prisms, terminating in dihedral summits—lenticular, &c. It is shining; has a radiated texture; leaves a sky blue trace; is brittle, and effervesces with acids.

It is found at Kamsdorf, in Tyrol, at Saalfeld, Zellerfeld, &c.

#### D. Green copper ores.

The following three species differ from each other, as to compactness, appearance of texture, &c. and differ from the foregoing blue copper ores, in the colour, and different proportion of component parts. They contain more carbonic acid, and less oxygen.

SPEC.

## SPEC. VIII.

COMPACT MALACHIT.—GREEN COPPER ORE; COPPER COMBINED WITH CARBONIC ACID, WATER, AND A SMALL PORTION OF THE BASIS OF PURE AIR.

Fr. *Cuivre mineralisé par l'acide aerien, l'air pure & l'eau; ou mine de cuivre verte.*

Germ. *Grün kupfererz.*

Lat. *Cuprum ochraceum malachites.*

This ore generally exhibits a very fine grass green, emerald green, or apple green colour, sometimes approaching to the colour of verdigris.

It is found in solid masses of an indeterminate shape—in small particles interspersed with different matrixes, in kidney shaped pieces, or botrioid, composed of concentric layers—stalactitical. It has a silky lustre, and is hard enough to take a fine polish like marble. Its texture is generally fibrous or radiated; it effervesces strongly with acids, recovers before the blow-pipe, without any additional substance;

substance ; and seems to be formed from a gradual deposition of water, containing calx or oxyd of copper, in the manner stalactitical calcareous spar is formed. Its specific gravity is generally = 3,641. It contains often from 60 to 70 per cent. copper.

The matrix is chiefly quartz.

It is found in Siberia, Hungary, and in Wales,

### SPEC. IX.

#### SATTIN-LIKE GREEN COPPER ORE, OR RADIATED MALACHIT.

Lat. *Cuprum ochraceum malachites setaceus.*

Germ. *Sammt-erz.*

Fr. *Mine de cuivre soyeuse.*

It is also frequently of a very fine emerald green colour, and is found in fibrous compact masses, or in small particles dispersed through, or deposited upon various stones ; but mostly fascicular, or in small bundles composed of thin needle shaped crystals dispersed in a radiated, or diverging manner.

The crystals have a silk lustre. They effervesce with acid.

It

It is found near Freiberg, Saalfeld, near Zellerfeld, and Lauterberg on the Harz, in Hungary and Tyrol.

## SPEC. X.

## MOUNTAIN GREEN COPPER ORE.

Lat. *Aerugo nativa?* *Chrysocola.*

Fr. *Verd de montagne ou chaux de cuivre verte.*

Ital. *Verde di montagna.*

Swed. *Kopper grönt.*

Dan. *Gron kobberkalk.*

Its colour resembles verdigris, sometimes approaching to emerald green. It is found solid or in compact masses—in small particles dispersed in stones—or coating various ores; it has a dull appearance, very seldom any mark of lustre; its texture is conchoidal; it is soft, and does not effervesce with acids. It yields from 60 to 70 parts of copper, the rest is chiefly oxygen, or the calcining principle.

It is found in Siberia, at Nertschinsk.

SPEC.

## SPEC. XI.

## FERRUGINOUS GREEN COPPER ORE.

*Cuprum ochraceum ferruginosum.*

The ferruginous copper ore is found in two different states; as earthy, and in the state resembling slags.

The first kind is the earthy ferruginous copper ore.—*Cuprum ochraceum ferruginosum terrosum.*

It has generally an olive green colour, and no lustre, an earthy texture, and is very friable. It is found in compact lumps, and also frequently in the state of small particles dispersed through various stones.

It is soluble in muriatic acid with effervescence, and the solution occasions a blue precipitate with prussiate of potash, or phlogisticated alkali, owing to the mixture of iron.

It is composed of copper, iron, oxygen, and carbonic acid.

It is found near Saalberg.

The other kind of ferruginous copper ore—*Cuprum ochraceum ferruginosum scoriaceum*—exhibits

hibits generally a leek green colour, or the green colour of pistachio nuts.

It is found solid and interspersed in different stones; it is a little shining with a fat lustre; has a conchoidal texture; no transparency, and is soft; it leaves an olive green trace on rubbing.

It is found near Kamfdorf, and Saalfeld.

## SPEC. XII.

WHITE COPPER ORE. COPPER ALLOYED WITH  
IRON AND ARSENIC.

Germ. *Weiss kupfer-erz.*

Gmel. *Cuprum albidum.*

Wallerius & Cronst. *Cuprum ferro & arsenico sulphure, &c. mineralisatum.*

Fr. *Mine de cuivre blanche.*

Swed. *Weisserz.*

Hung. *Fejer réz ásvány.*

Its colour is the intermediate between silver and tin; it has a metallic lustre, is compact, brittle, and when rubbed emits the smell of arsenic; it also strikes fire with steel.

Its



Its component parts are copper, iron, and arsenic. It is seldom found but at Lorenz Gegentrum; near Freiberg, and Schneeberg.

## DIVISION III.

*Copper ores mineralised by sulphur, not soluble in acid. They must be torrified to separate the sulphur, in order to collect the metal. They are easily fusible by heat; emit a sulphureous smell; when exposed to the blow-pipe, melt into a vitreous mass, and are thereby easily distinguished from the other ores of copper.*

## SPEC. XIII.

## VITREOUS COPPER ORE.

Cronstedt. *Cuprum sulphure mineralisatum.*

Fr. *Mine de cuivre vitreuse.*

Germ. *Kupfer-glass, or glanz.*

Werner. *Cuprum nitidum.*

Swed. *Kopper glass erz.*

Dan. *Kobber glas, or malm.*

Hung. *Uveg réz ásvány.*

Its

Its colour is generally lead grey, purple and brown; sometimes variegated; it has a metallic lustre, and a conchoidal texture. When compact, its specific gravity is = to 4, or 5,000.

It is soft enough to be cut with a knife; and melts easily before the blow-pipe.

It is found of regular shape, as in six sided prisms acuminate with three faces; or in simple three sided and four sided pyramids.

It contains from 60 to 80 per cent. of copper, the rest is chiefly sulphur, and a small portion of iron.

The matrix is chiefly limestone, quartz, and clay.

It is found in Bohemia, on the Harz, near Freiberg and Marienburg; also in Scotland, near Erskine; in England, near Middleton Lyas; in Siberia, Norway, and Hungary.

#### SPEC. XIV.

#### COPPER PYRITES.—YELLOW COPPER ORE.

Cronst. *Minera cupri pyritacea.*

Germ. *Kupferkies.*

Ital.

Ital. *Rame piritoso.*

Fr. *Mine jaune de cuivre.*

Swed. *Gublkoppar malm.*

Hung. *Réz kőva.*

This is the poorest, yet the most common of the copper ores; it contains a larger portion of iron than the foregoing species, and the copper is perfectly mineralised by sulphur.

Its colour resembles brass, sometimes approaching to the colour of gold. The deeper the colour, the richer in copper.

It is found in solid masses of an indeterminate shape, but also frequently of a regular one, as in simple three sided pyramids, in double four sided pyramids, in six sided plates:

It has a strong metallic lustre, and when broken, exhibits generally a conchoidal texture. Its specific gravity is = 4,160. It fuses easily, and is at last converted in a black slag. When moist and exposed to the atmosphere, it absorbs the acidifying principle from it, which is accelerated by the assistance of heat; the sulphur it contains, becomes thereby an acid, which is diluted by the moisture, and re-acts upon the copper, which it dissolves,

and with which it forms a salt, namely, the sulphate of copper, or vitriol of copper.

From this, the copper can be separated and obtained in its metallic state, by metallic iron. This process is carried on, on a very large scale, in Wales, at the Paris mountain, and at Arklow, in the county of Wicklow, in Ireland; where the metallic salt, or cement water is partly found collected in the bottom of the mine, from the rain water dissolving and washing down the salt.

At the Paris mountain, the miners separate first the sulphur, which they collect in a subliming apparatus, by heating a large quantity of the pyritical ore; after this, they lixiviate or wash the remaining ore with water, which takes up the thus formed saline copper; the copper is afterwards separated by iron plates, so as to be recovered by the iron, which deprives the copper of the oxygen, or acidifying principle.

The thus collected copper is called cement copper, which is afterwardsedulcorated with water, gently dried and fused.

The ore which remained from the first lixiviation or washing, is then fused, and is, in that state, sent to Liverpool, where it is further refined.

Siberia,

Siberia, Hungary, and Sweden, produce a considerable quantity of the pyritical copper ore. The matrix is frequently bituminous shifstus, heavy spar, and indurated clay; sometimes, petrofilex.

## SPEC: XV.

## VARIEGATED COPPER ORE.

Germ. *Bunt Kupfererz.*

Lat. *Cuprum mineralisatum variegatum.*

*Peacocks tail copper ore.*

*Cuprum Psittacinum.*

This ore when fresh broken, appears copper red, or tombac brown, red tarnished, purple, azure blue, sky blue or green. It is shining, and has a conchoidal texture; it yields from 40 to 60 per cent. copper; from 20 to 30 per cent. iron; and from 10 to 20 sulphur.

It is generally mixed with yellow copper pyrites, or vitreous copper ore.

It is found particularly fine in Siberia, also in the principality of Fauer.

It contains often a portion of silver; it seems to derive its variegated colour from the common copper pyrites, having parted with some of its sulphur, *which has occasioned the colour.*

## SPEC. XVI.

## GREY COPPER ORE.

Cronstedt. *Pyrites cupri griseus.*

Fr. *Mine de cuivre grise.*

Germ. *Kupfer Fablerz (Weissgülden or Harz.)*

Swed. *Fahl Koppererz.*

Dan. *Morkegraae, or grynig Kobbermalm.*

Hung. *Sárga réz ásvány.*

Wallerius. *Minera cupri grisea.*

This kind of ore is chiefly composed of copper, sulphur, arsenic, and silver; sometimes it contains also antimony, iron, lead, and flux.

Its general colour is whitish grey, steel grey, lead grey, iron grey, and sometimes variegated. It is found compact, either in lumps or in small particles dispersed in stones, and not unfrequently

unfrequently exhibiting a more or less regular shape, as simple three sided pyramids, six sided prisms. It shines with a lustre, is brittle and difficult to fuse *per se*.

It yields sometimes from 20 to 60 per cent copper; and is generally accompanied by yellow copper pyrites.

It has been analysed; and the following substances were separated:

16 parts copper, 34 lead, 16 antimony, 13 iron, 20 sulphur, 2 silver and 2 flux, in a hundred weight.

It is found in Siberia; Saxony; Sweden; Scotland near Erskine; in Saxony, at Romsdorf and Freiberg; on the Harz; in Hungary; Tyrol, at Catharinaberg in Bohemia; at Köp-  
nik in Transylvania; and also in Cornwall.

### SPEC. XVII.

#### BITUMINOUS COPPER, OR INFLAMMABLE COPPER.

Cronst. *Minera cupri phlogistica.*

Wallerius. *Cuprum mineralisatum materia  
bituminosa involutum facie carbonaria.*

Germ. *Kupferbranderz.*

Fr. *Cuivre mêlé avec matière bitumineuse.*

This ore is chiefly a mixture of bituminous coal and oxyd of copper ; it burns with a flame, and emits a bituminous smell.

It has never been found of a regular shape.

It is met with at Dalecarlie in Sweden ; in gary ; in the Elfaz ; and Siberia.

#### SPEC. VIII.

#### ARGILLACEOUS COPPER ORE—SHISTOUS COPPER ORE.

Fr. *Cuivre avec sulphur, fer, & d'argile.*

This ore seems to consist of vitreous copper ore mixed with argillaceous shistus. Its colour is brown or blackish ; it has a lamellar texture ; is difficult to fuse, except by the addition of lime-stone ; and yields sometimes from 6 to 10 per cent. of copper.

SPEC,



## SPEC. XIX.

## BELL METAL of RASPE.

This ore is composed of sulphurated tin, copper, and iron.

It was found in Cornwall, near Whealrock, by Mr. Raspe.

It is very scarce.

## DIVISION IV.

*Copper combined with acids.*

## SPEC. XX.

COPPER COMBINED WITH MARINE ACID, OR  
MURIATE OF COPPER.

Fr. *Muriate de cuivre.*

Germ. *Salzsaures Kupfer.*

Its colour is greenish; it is composed of micaceous, quadrangular, shining lamellæ, and is soluble in nitric acid. The copper is dis-

covered by iron and ammonia, and the muriatic acid by a solution of silver in nitric acid. It contains generally a little clay; it has been brought from Peru in the state mixed with sand, by Mr. Dombey. I have never seen it; from experiments, I made to combine copper with muriatic acid, I found that the neutral salt always deliquesced on exposure to the atmosphere.

## SPEC. XXI.

COPPER COMBINED WITH SULPHURIC ACID,  
OR SULPHATE OF COPPER.

It originates from the decomposition of the pyritical copper ore; and as it is a perfect saline substance, I have mentioned it already amongst the metallic salts in the first volume.

## SPEC. XXII.

COPPER COMBINED WITH THE ACID OF  
ARSENIC, ARSENIATE OF COPPER.

Germ. *Olivenerz*, or *arsenikal Kupfererz*.

It

It was analysed by Klaproth.

It has a deep olive green colour, sometimes the colour of emerald; it is found in the state of needle shaped crystals—in oblong tetrahedral prisms; the crystals are transparent.

It is found at Carrarack, in Cornwall, in clefts of ferruginous and brittle quartz; also in Silesia, near Jonobach.

To assay a sulphureous copper ore, two drams, for instance, of the pulverised dry ore, are mixed with one dram of nitre, the mixture is thrown into an ignited crucible, and thus detonated, by means of which, most of the sulphur is dissipated; the remainder is kept on a stronger heat, until the rest of the sulphur is separated. After this the mass is still more strongly urged, until the ore enters into fusion; a mixture of half an ounce of tartar, and one dram of common salt, and a small portion of charcoal, is to be added in equal proportion.—When the effervescence, which takes place, has ceased, the crucible is to be covered, and a stronger heat applied for half an hour, to occasion the copper to flow into a mass; after which the metal contained in that quantity of ore, is found in the bottom of the crucible, adhering to the slag from which it is separated by the hammer.

Or,

*Or,*

A certain quantity of the sulphureous ore is previously freed from sulphur, by a gentle torrifaction; the remainder is then weighed, and mixed with an equal portion of a mixture composed of 2 parts of pounded glass, 1 part of calcined borax, and 8 parts of charcoal, and fused; after which the metal is found in the bottom of the crucible.

To work the pyritical copper ores on a large scale, the ore is first picked or sorted; afterwards it is reduced to small pieces, and washed, to separate the gangue and the other foreign lighter substances. It is then roasted, to drive off the mineraliser; after which it is fused in the blast furnace. The result of this process is the black copper; which is again fused in the refining furnace, to dissipate all the sulphur. When it is very pure, it is poured into a broad vessel or test; the surface is then cooled by throwing a little cold water on it, which occasions it to separate from the rest. This is the copper in rasetles, which is then worked by the hammer. This is one of the general processes of working the sulphureous copper ores, which Mr. Chaptal has also mentioned.

The

The grey copper ore, or *Kupfer Tablerz* of the Germans, which contains a portion of silver, is treated in the following manner: The ore is first torrifed by a gentle heat, to separate the sulphur which is collected in close vessels; the remainder is fused *per se*, during which the earthy parts scorify, and the metal separates in an imperfect state; it is again torrifed by a stronger heat in the open air, to separate the remaining sulphur, whereby the iron becomes scorified, and the copper and silver separate in the state of a black mass; it is afterwards mixed with four parts of lead, fused and poured out into flat plates. These plates are again placed upon iron plates, and covered with charcoal, and only such heat is applied as will melt the lead; the lead, together with the silver, melts and runs from the plates, leaving the copper behind, which is then further recovered, and reduced to a perfect state, by being fused with charcoal. The silver is afterwards freed from the lead, by the process of cupellation.

## GENUS VII.

## TIN.

## STANNUM,

Germ.	<i>Zinn.</i>	Fr.	<i>Etain.</i>
Swed.	<i>Tenn.</i>	Ital:	<i>Stagno.</i>
Dan.	<i>Tinnet.</i>	Hung.	<i>Fejer ón.</i>

This metal is employed for various purposes, and therefore may be classed among the valuable ones.

It is used for covering the surface of copper vessels, to prevent the copper from communicating its nauseous and hurtful quality to food or medicine which is boiled in such vessels—it is used in the making of looking glasses—dissolved in marine acid for callico printing—for coloured glasses—for enamel—when in the  
state

state of calx, for polishing purposes—and in medicine, against worms, &c.

Tin is found in very few parts of the world, in comparison to most of the other metals.—Cornwall in England, and Bohemia in Germany, are almost the only parts where it has hitherto been found and wrought.

It is generally found in the state of calx or oxyd, seldom with sulphur.

It is the lightest of all the entire metals; its specif. gravity is = 7,291.

It is a very soft metal, and requires less heat for fusion than any other of the solid metals; melting by a heat = 410 of Fahr. scale. It is very flexible, and produces a crackling noise when bent; its colour is the intermediate between silver and lead; it is not easily affected by the atmosphere, nor by pure water; combines very readily, and without the assistance of heat, with mercury, and also with sulphur by fusion.

It is soluble in sulphuric, muriatic, and acetous acids, most readily in nitro-muriatic acid, forming a purple precipitate when mixed with a solution of gold; it is likewise soluble in nitric acid, but it separates again in the state of a white calx, owing to its having deprived the acid of its basis.

The

The matrixes in which tin ores are found, are chiefly quartz, lithomarge, grey grit, indurated clay, and also some of the primitive and secondary rocks.

## SPEC. I.

## NATIVE TIN.

*Stannum nativum.*

Fr. *Etain natif.*

Germ. *Gediegen zinn.*

It is still much doubted, whether the specimens which are kept in a few collections of ores, are really native metallic tin. Mr. Quist, it is asserted, discovered a specimen in Cornwall, in the year, 1766, which had a lamellar, and something approaching to a regular form; it was embodied in quartz, accompanied by tin-spar. I saw a specimen in Mr. Parkinson's collection, which I examined and tried, and which was really metallic tin; but whether it was a product of nature, I cannot assert; it was a detached piece.

Mr.



Mr. Sage also possessed a specimen of native tin.

## SPEC. II.

## NATIVE TIN-SPAR.

Waller. *Minera stanni spatosa.*

Germ. *Weisser zinn-spath.*

Fr. *Mine d'etaïn blanche.*

This ore has been often confounded with tungsten. It has a milky white colour, semi-transparent, resembling white heavy spar; it has a vitreous lustre, and frequently a fibrous or lamellar texture. It is found of irregular shape, and also of pyramidal form, and in octohedrons.

When fused with borax, it produces a milk white glass. Its specific gravity was found = 6,007. It has been found in Cornwall.

SPEC.

## SPEC. III.

## BROWN TIN-STONE, OR SPAR.

Germ. *Zinnstein.*

Fr. *Étain vitreux ou oxyde d'étain.*

Hung. *Barriás or feketes üveg fejér on ásvány.*

By analysis it has been found to consist of calx of tin, calx of iron, and acid of tungsten. Its colour is generally brown, blackish, reddish brown, cream yellow. It is found in solid masses; when of considerable size, it is called in Germany, *zinngrauen*, and when in small pieces, *zinnzwitter*.

It exhibits often a regular shape, as double four sided pyramids—four sided prisms, the angles of the pyramids are sometimes truncated. The crystals are shining, and often semitransparent, like pure brown colophony, and exhibit a conchoidal texture; it is also called resin-like tin. Its surface can be scraped with a knife. Its specific gravity is = 6,900. Sometimes it is so hard as to strike fire with steel.

It

It contains from 70 to 80 per cent. of tin; that found in Cornwall contains frequently a small portion of arsenic, which can be ascertained by dissolving it in marine acid; that deposits the arsenic in the state of a black powder.

Tin ores of this kind, are found in Cornwall, in Bohemia, at the *Schlaggenwalde* and *Zinnwald*; at Altenberg, in Saxony. The matrix is quartz—fluor—lithomarge—grey grit—and pyrites.

#### SPEC. IV.

#### STREAM TIN.—CORNISH TIN ORE.

Fr. *Etain limoneux*.

*Stannum ochraceum cornubiense*.

Its colour is generally hair brown. It exhibits no regular shape, and is perfectly opaque. Its specific gravity is = 6,450.

It is found in the state of small reniform pieces, rounded or approaching to the globular shape; sometimes composed of concentric layers, and of a fibrous or radiated texture, resembling the colour and appearance of a

piece of wood cut from a knotted tree, whence it is called wood-tin, in German, *holz-zinn*; but this kind is now very scarce.

This species of tin ore yields often above 60 per cent. of tin.

It is found only in Cornwall.

### SPEC. V.

#### SULPHURISED TIN.—TIN PYRITES.

Germ. *Zinn-kiefs.*

Fr. *Etain sulfureux.*

This ore was first ascertained by Bergman.

It is easily distinguished from the other ores of tin, by the sulphureous smell which it emits when sufficiently heated. It exhibits a steel grey colour, inclining to brass yellow. It has a metallic lustre, a fibrous or lamellated texture; sometimes it exhibits the colours of the rainbow.

Its specific gravity = 2,356. It is found in solid masses, and in the state of small particles dispersed in copper pyrites. It has yielded by analysis, 34 parts of tin, 30 of copper, 25 of sulphur, and 3 of iron, besides the matrix.

It

It is found in Silesia, near Gieren; and near St. Agnes, in Cornwall.

In order to assay a tin ore in the moist way, a certain quantity of it is pulverised, and put in digestion with six parts of concentrated sulphuric acid, for six hours; the liquid is then decanted, diluted with distilled water, and filtered, and afterwards precipitated by potash; if the ore contains any copper, it is to be precipitated by ammonia, which keeps the copper in solution. The precipitate is then sufficiently lixiviated, dried, and reduced by fusing it with charcoal.

To assay a tin ore in the dry way, frequently a mere fusion of the ore, surrounded by pounded charcoal, is sufficient to recover, and to collect the metal. Or a certain quantity of the ore is first freed from sulphur and arsenic, by torrefaction; after which, it is mixed with equal parts of potash, one half of common resin, and two parts of tartar, this mixture is fused in a crucible covered by charcoal, by means of which, the metal is recovered, and separated in the state of regulus.

In the working of tin ores, the ore with the matrix is first carefully sorted; after which, it is to be pulverised, and washed upon tables covered with cloth. By agitation with a stick

or broom, the gangue is suspended, or carried away by the water, and the tin ore remains alone.

The furnace made use of in Saxony, for the fusion of tin ore, is a kind of blast furnace, on the hearth of which, is a groove to receive the metal, and convey it into a basin; whence it is taken to be cast, in moulds of copper, or of iron.

The tin ore of Cornwall is frequently mixed with copper, and arsenical pyrites; the quartz, which is the gangue, being very hard. The operation is begun by torrefaction of the ore, before it is pulverised. After the ore is washed, a separation of the iron is effected by loadstones, and the ore is usually fused in the reverberatory furnace.

GENUS

## GENUS VIII.

## LEAD.

*PLUMBUM. SATURNUS.*

Germ. *Bley.* Fr. *Plomb.*

This metal is found in considerable quantity in many parts of the earth.

Its various uses are sufficiently known. It is the softest and least tenacious of all metals; it is not sonorous or elastic, but one of the heaviest metals. Its specific gravity is = 11,552.

Its colour is a blueish white, when fresh broken; it is malleable, but brittle in a strong cold; it is easily affected, and becomes soon tarnished in the atmosphere; it may be easily cut with a knife, and stains the fingers blueish grey when rubbed; it fuses easily by a heat = 540° of Fahrenheit's scale, and renders other

more refractory metals, as silver, &c. more fusible; on this account, it is used for extracting silver from its matrix, or other ores, when in the metallic state; it becomes vitrified, *per se*, in a strong and continued heat, and vitrifies also other imperfect metals; hence it is used for the process of cupellation.

It is easily soluble in nitric and acetic acid, and the solution obtains a sweetish taste. It is precipitated from its state of solution in those acids, in the metallic state, by zinc, on account of the stronger affinity which the zinc has to the calcining principle. When prepared for calcination or oxidation, it unites in different proportions with the calcining principle or oxygen, and forms thus the massicot, when it exhibits a yellow colour—the minium, or red lead, &c. When in the state of calx, and united with carbonic acid, or fixed air, it makes the white lead. It combines very readily and without heat, with mercury, unites easily with sulphur, and is soluble in fat oils.

It is not readily soluble in sulphuric and muriatic acid, but has a stronger affinity to those acids, than to the nitric and acetic acids, and can therefore be separated from the latter, by the former, when in the state of solution.

Combined



Combined with acetous acid, it forms the sugar of lead—with muriatic acid, &c. Turner's yellow.

It is used in the composition of flint glass.

The use of it for culinary and pharmaceutical utensils, it is to be hoped, will be entirely abolished, as well as the custom of glazing the surface of earthen ware; much mischief has been done by sweetening wines with it, which had turned sour. Fortunately, chemistry has provided us with accurate tests, to discover such pernicious adulterations.

It is found in nature in different states, seldom, if at all, in the metallic state—most generally united with sulphur—sometimes combined with carbonic acid—with sulphuric acid—with phosphoric acid.

## DIVISION I.

*Lead in the metallic state.*

## SPEC. I.

## NATIVE LEAD. PLUMBUM NATIVUM.

It has been, and is still doubted, whether lead has ever been found in a perfect metallic state; though it is said to have found so in Poland, Silesia, and near Karthen, and in Monmouthshire. There is a specimen kept in the late Dr. Hunter's collection, of native lead. Wallerius mentions three pieces of native lead. It has also been affirmed by some authors, that it has been found native in Villach, in Carinthia—in Vivarais—Poland, and Silesia.

## SPEC. II.

LEAD AMALGAM, OR LEAD COMBINED  
WITH MERCURY.

Lat. *Amalgama plumbi.*

DIVISION

## DIVISION II.

*Lead in the state combined with the calcining principle or oxygen, soluble in nitric acid, easily pulverisable, free from sulphur, and recoverable by fusion with charcoal, without a previous torrification, yielding fixed air on reduction. The following species belong to this division; they differ from each other owing to the different substances with which they are mixed, and which occasion their different appearances, as fixed air, iron, &c.*

A. *Oxyds of lead, or calciform lead ores, not effervescing with nitric acid, almost free from fixed air.*

## SPEC. III.

RED LEAD ORE, OR FERRUGINOUS  
OXYD OF LEAD.

Fr. *Oxyde de plombe rouge, or mine de plomb rouge.*

Lat. *Ochraceum plumbum rubrum nativum.*

Germ.

Germ. *Roth bley-erz.*

Cronst. *Minera plumbi calciformis pura indurata rubra.*

Wallerius. *Plumbum sulphure & arsenico mineralisatum.*

Ital. *Spato di plombo rosso.*

Swed. *Röd bly malm.*

Hung. *Veres spátos fekete on.*

Its colour is aurora red, resembling red arsenic, or realgar. It is found in small lumps of an indeterminate shape, also crystallised, exhibiting four sided rhomboic prisms, terminating in three sided pyramids; the angles of the prisms are from 62 and 118°. The crystals are shining, a little striated on the surface; semitransparent: They have a compact and even texture, and give an orange coloured trace.

By analysis it has yielded = 36 parts of lead, 37 oxygen, 24 iron.

Its matrix is generally quartz, gneiss, &c.

A certain kind has yielded on analysis, lead, molybdenic acid, nickel, calcareous earth, iron, copper, cobalt, and flux.

It is found near Beresowsky, in the mines of Catharineburg in Siberia—and in Hungary.

B. *Oxyds of lead containing fixed air effervescing with acids of an earthy appearance.*

SPEC. IV.

WHITE OPAQUE LEAD ORE, OR NATIVE  
WHITE LEAD.

Lat. *Cerussa nativa.*

Its colour is generally white, sometimes yellowish or greyish, owing to a small mixture of iron. It does not exhibit a regular figure; it is very friable, and has an earthy appearance, and perfectly opaque; becomes red when exposed to a sufficient heat; effervesces with nitric acid, and yields fixable air or carbonic acid gas.

It contains generally from 60 to 80 per cent. lead.

It is found at Bleyberg.

C. *Oxyd,*

C. Oxyd, or calxes of lead combined with fixable air, and of a sparry or crystallised appearance.

## SPEC. V.

WHITE CARBONATE OF LEAD; WHITE TRANSPARENT LEAD ORE, OR WHITE LEAD SPAR.

Germ. *Weiß Bleyerz.*

Lat. *Plumbum ochraceum album.*

Fr. *Mine de plomb blanc.*

Swed. *Hwit Bleyalm.*

Hung. *Fejer spatos fekete ón.*

Gmelin. *Plumbum spatosum album.*

Cronstedt. *Minera plumbi calciformis indurata alba.*

Waller. *Plumbum terrestre vel lapideum, minera spatiformis alba & grisea.*

Its colour is whitish or colourless. It is found solid and in small particles, dispersed in, or deposited upon stones of an indeterminate shape; sometimes of a cellular appearance; also  
of

of regular shape; in six sided prisms, in four sided prisms, and variously modified, frequently of the shape of rock crystal, sometimes in needle shaped crystals of a silk lustre, seldom in cubes.

The crystals are all shining, more or less transparent; have an even texture, sometimes conchoidal, frequently a vitreous appearance. They effervesce with nitric acid, and are soluble in it. They crackle when exposed to heat, and recover *per se*, when exposed in a close vessel to heat.

By analysis, it has yielded 60 per cent. lead, 20 fixable air, 6 oxygen, and 3 of water.

Sometimes it is mixed with a little calcareous earth or clay; this admixture is generally found in the opaquer kind of white lead ore.

It is found near Freiberg—Marienberg—Zellerfeld—Tschopace—in Siberia—Bohemia—Nassovia—near Schemnitz, in Hungary—near Silvermine, in the county Tipperary, in Ireland—at the Lead-hills in Scotland—also in Somersetshire, generally in the cavities of decomposed galena.

## SPEC. VI.

## BLACK LEAD SPAR.

Fr. *Mine de plomb noire.*

Germ. *Schwarzes Bleyerz.*

This species is found in the same state and shape; it seems to differ from the foregoing species, only by its blackish colour, which probably has been occasioned by sulphureous vapours, which have tarnished the surface, or have more or less penetrated towards the internal parts of the crystals; it is found in the same places among the white lead spar.

## SPEC. VII.

## BLUE LEAD SPAR.

Germ. *Blau Bleyerz.*

This has generally the colour of Indigo blue or Prussian blue, sometimes a lighter shade; it has its colour from copper and iron.

It



It is found exhibiting six sided prisms variously modified, and otherwise resembles the foregoing species.

It is found at the Lead-hills in Scotland, formerly at the *Dreyfaltigkeit*, at Zschopau.

## SPEC. VIII.

## GREEN LEAD SPAR.

Germ. *Grünes Bleierz.*

Its colour is generally yellowish green; also the colour of verdigris. It is likewise found crystallised, and differs from the afore-mentioned species of lead spar, only in the modification produced by the colouring principle, as copper or iron. Its general shape is a truncated hexahedron.

It is equally easily reduced, as the white lead spar, by mere heat; and is also found on the Lead-hills.

SPEC.

## SPEC. IX.

## BROWN LEAD ORE.

Germ. *Braun Bleierz.*

Its colour is chocolate or reddish brown; it is chiefly found in long four sided prisms, or in needle shaped crystals; the crystals are semi-transparent.

It is found at Zschopau; also in the County Tipperary, at the lead mines.

## SPEC. X.

## NATIVE GLASS OF LEAD.

Lat. *Vitrum Saturni nativum.*

Germ. *Natürlicher Bley glafs.*

Its colour is generally apple green. It is found compact, and exhibits a conchoidal texture when fresh broken; has a vitreous appearance, and is found near Zellerfeld on the Harz.

Sometimes

Sometimes it is found deposited upon calcareous spar, resembling silver like mica, such as is met with at Bergmanstrost, near Andreasberg.

## SPEC. XI.

## ANTIMONIAL LEAD ORE.

Germ. *Antimonialisches Bleierz.*

Cronst. *Plumbum antimonio, & argento sulphurato mineralisatum.*

Wallerius. *Plumbum antimoniali mineralisatum argento mixtum.*

Gmelin. *Plumbum stibiatum.*

This ore has a greyish or iron grey colour. It is compact, and has a striated texture. It is chiefly composed of lead, silver, antimony, and sulphur; and is found at Sahlberg, in Sweden; in Siberia; at Lautenthal on the Harz, and in Hungary.

## DIVISION III.

*Lead in the state mineralised by sulphur. It is discovered by its lustre, and by its emitting a sulphureous smell when torrified; the ores are not perfectly soluble in nitric acid, as the sulphur is left behind. When nitric acid is poured on these ores, the acid becomes partly decomposed, parting with some of its acidifying principle to the lead, and hence nitrous gas is produced. On separating the lead from these ores, the ore must first be separated from the sulphur by torrification.*

## SPEC. XII.

GALENA, OR SULPHURATED LEAD  
ORE.

Germ. *Bleyglanz.*

Fr. . *Sulphure de Plomb.* also *galena.*

Cronstedt. & Wallerius. *Plumbum sulphure mineralisatum.*

Ital. *Galena di Plombo.*

This

This is the most common of the lead ores, and is found in many parts of the Earth.

It is generally mixed with some other substance besides the lead and sulphur, containing often silver, sometimes iron and antimony.

Its colour is a deep lead grey, having a metallic lustre, the intermedium between lead and steel; it may be cut with a knife.

Its specific gravity is generally = 7000.

It is found in solid masses of an indeterminate shape, also frequently exhibiting a regular figure as cubes—double four sided pyramids—four and six sided prisms, and variously modified. Its texture is lamellar; it breaks generally in cubical pieces; it is also frequently met with in the state of small particles dispersed in, and sometimes deposited upon various stones, frequently tarnished.

It contains often from 70 to 80 parts of lead, from 16 to 20 sulphur, and sometimes  $\frac{2}{3}$  of silver.

Its matrix is generally heavy spar—fluor—quartz—coals—spatous iron ore—shistus and gneifs.

It is found at Bleystedt in Bohemia; near Freiberg in Saxony; Siberia; at Sahlberg in Sweden, and in Derbyshire; a certain kind of galena, which has a steel lustre and texture,

is called by the Germans, Bley-schweif Lead-rail.

Knitted galena has been found at the isle Ilay, composed of rectangular four sided prisms and plates, in all directions intermixed with white calcareous spar in grey lime-stone, which when longitudinally broken, exhibits a beautiful appearance.

### SPEC. XIII.

#### PYRITICAL LEAD ORE.

Its colour is brown or yellowish brown; it exhibits often a stalactitical form; is very friable; has a striated texture, and contains from 18 to 20 per cent. lead, the rest being martial pyrites.

It effloresces when long exposed to air and moisture, and affords sulphate of lead.

SPEC.

## SPEC. XIV.

GALENA COMBINED WITH PHOSPHORIC  
INFLAMMABLE AIR.

Called also *Slickenside*.

It has the appearance and lustre of galena; it is found in the lead mines of Derbyshire, where the veins are close together.

It produces a violent explosion when suddenly broken, and when in contact with atmospheric air.

## DIVISION IV.

*Lead ores combined with acids.*

## SPEC. XV.

VITRIOLATED LEAD—SULFATE OF LEAD, OR  
LEAD COMBINED WITH VITRIOLIC ACID.

This seems to originate from the decomposed pyritical lead ore.

It is generally found exhibiting octohedrons, sometimes variously modified.

It is not soluble in nitric acid; its colour is yellowish brown, and the matrix chiefly ferruginous quartz and shistus.

It is found in Anglesey in Wales, mostly in ferruginous strata, above the pyritical copper ore; also near Strontian in Scotland.

It was first ascertained and noticed by Dr. Withering.

#### SPEC. XVI.

PHOSPHORATED LEAD ORE, OR LEAD COMBINED WITH PHOSPHORIC ACID.

Germ. *Phosphor saures Bleyerz*, or *grünes Bleyerz*.

Cronst. *Minera plumbi calciformis pura indurata crystallifata viridis*.

Waller. *Plumbum terrestre vel lapideum minera spatiforme viridi*.

It was first ascertained by Gahn and Mongés. It fuses easily, and crystallises instantaneously  
in



in dodecahedrons or polygon crystals, with a striated surface; is soluble in nitric acid, from which it is precipitable by sulphuric acid.—Klaproth found it melt into a vitreous mass when exposed to the blow-pipe.

Its colour is generally green, or yellowish green, or olive green.

It is met with stalactitical, and also of regular shape, in six-sided prisms, and variously modified by truncations, sometimes in small perfect pyramids.

It is shining—semitransparent, and gives a greenish trace.

It is chiefly composed of lead, from a phosphoric acid, and is found near Freiberg—Zschopau—Johanngeorgenstadt—Zellerfeld—and on the Lead-hills in Scotland. A greyish and reddish kind is found at Huelgoet in Bretagne, and in Bohemia.

### SPEC. XVII.

#### YELLOW LEAD ORE, OR LEAD COMBINED WITH ACID OF TUNGSTEN.

Gmelin. *Stannum flavum.*

Germ. *Gelbes bley-erz.*

Its colour is wax—lemon—yellow— or orange colour. It is found in solid pieces, sometimes of a regular shape, in four and eight sided plates, and variously modified by truncation, seldom in cubes. It has a lamellar texture, and is generally semitransparent. Mr. HEYER found it containing the acid of tungsten, and Mr KLOPROTH the molybdenic acid. It is met with on Bleiberg in Corinthia—near Villach—near Zellerfeld, and in the Lead Hills in Scotland.

Yellow earthy lead ore is found near Tschopau, and Freiberg; also in Siberia.

Grey earthy lead ore is also found near the Lead Hills, coating galena, and effervescing with acids.

In order to assay lead ores, different ways are made use of, according to the nature or composition of those ores. When in the state of calx, or combined with oxygen, it may be dissolved in nitric acid, and precipitated from it in the metallic state, by zink. If the ore contains silver, the solution is to be much diluted with distilled water, and the silver separated first by marine acid; after which the lead may be precipitated either by zink, or by alkali.

*Or in the dry way;*

When in the state of calx, it may be merely fused with charcoal, which separates the oxygen, and sets the lead free.

If the lead is combined with sulphur, a certain quantity is reduced to powder, and put in digestion with nitric acid, which takes up the lead, and leaves the sulphur behind; the lead may then be separated from the acid, by alkali, the precipitate dried and weighed; 132 parts of the dry precipitate contains generally 100 parts of lead; or the lead may be separated from the nitric acid, by muriatic acid, when the muriated lead is separated in the state of white crystallised particles, which when dried, contain generally 72 parts of lead in a hundred.

In the dry way, the sulphurated lead ores, or galena, are first deprived of the sulphur by torrification, and afterwards fused with 2 parts of black-flux, and  $\frac{1}{2}$  a part of iron filings, in a covered crucible, for half an hour; by this means, the iron takes up the remaining sulphur; the alkali from the flux promotes the fusion, and the carbone in the flux, carries off the oxygen; and thus the metal is recovered and obtained.

Near

Near the silver mines in the county of Tipperary, the lead ore, which is chiefly oxyd of lead combined with fixed air, is only fused with coal.

But in other places where the galena is wrought, the ore is first sorted, to separate the rich or purest ore from the vilest parts, and the gangue which contains no metal. The sorted ore is then reduced by hammering into small parts, and the gangue separated by washing and sifting; after which, it is roasted in a reverberatory furnace, with occasional agitation, that it may present all its surfaces to the air; when the external part begins to assume the form of a paste, it is covered with charcoal, the mixture is stirred, and the heat increased; the lead then runs on all sides, and is collected at the bottom of the furnace, which is pierced, so as to permit the metal to flow into a receptacle properly defended by a lining of charcoal. The scoriæ which still retain some lead, are fused by a blast furnace. The lead is cast into pigs for sale.

If the lead contains a considerable portion of silver, the silver is then obtained by cupellation.

## GENUS IX.

## ZINC.

## ZINCUM.

Germ. *Zink*.Ital. *Peltro*.

This metallic substance, which was first noticed by *Albertus Magnus* in the year 1280, and after him by *Henkel* and *Lawson*, has generally been classed with the semi-metals, on account of its imperfect malleability. It admits to be extended into very thin and flexible plates, by the equal and gradual pressure of the flattening mills, which *Mr. Sage* first observed, and it may therefore be considered as the intermediate substance between metals and semi-metals.

It is found in various parts of Europe ; never, as far as I could ascertain, in the perfect metallic

tallic state, but generally in the state of calx or oxydated—frequently also combined with iron and sulphur—seldom in the saline state, or combined with acids. When freed from heterogeneous substances, it has a whitish, inclining a little to blueish grey, appearance.

Its specific gravity is = to 6,800.

It has a considerable hardness, and can only, with great difficulty, be reduced to small particles by the hammer. Its texture is fibrous; it requires 700 degrees heat of Fahrenheit's scale to fuse it; it has a bright lustre when fresh broken, and retains its lustre for a very long time in a pure atmosphere.

It has a strong affinity to oxygen, and deprives most metals of that calcining principle, and thus recovers them when they are in the state dissolved in acids, for which reason it is often used in chemistry as a precipitant; it is by this virtue of zink, as a component part of brass, that pins become easily coated with tin. It combines readily with mercury, and without heat, and with sulphur only, by means of iron. It burns with a beautiful blueish green flame, when it becomes red hot in a crucible, or when in very thin laminæ, and held in the flame of a candle.

It is soluble in nitric, sulphuric, and muriatic acid, and produces by the two last hydrogen gas or inflammable air. It detonates with nitre when mixed and thrown into an ignited crucible. When fused with glass, it gives no colour to it; when exposed to a strong heat in a crucible, it is gradually converted into a white calx, which rises a considerable distance out of the crucible, on account of its lightness. This calx, which is called flowers of zinc, is used internally as a medicine against certain disorders, and also externally in surgery.

When neutralised by sulphuric acid, it produces a white salt called vitriol of zinc, which is used particularly to remove inflammation of the eyes, &c.

## DIVISION I.

*Zinc in the metallic state.*

SPEC.

## SPEC. I.

## NATIVE ZINC.

Mr. Bomare mentions native zinc having been found in mines, where calamine is found in the Duchy of Limburg, and near Goslar on the Harz, in the state of small pliant filaments; but, as I mentioned before, it is much doubted whether those specimens were originally native.

## DIVISION II.

*Zinc in the state of calx or oxyd. It is very brittle, and easily reduced to powder, and the metal must be recovered by means of charcoal without torrification.*

SPEC.



## SPEC. II.

## CALX OR OXYD OF ZINC. CALAMINE.

*Lapis calaminaris.**Zincum calciforme.*Fr. *Chaux ou oxyde de Zink.*Germ. *Galmey,*Ital. *Calce de linco.*Hung. *Kö-Tzin.*Wallerius. *Zincum pulverulentum terrestre.*Cronst. *Minera Zinci calciformis pura indurata.*

It seems to originate, as we learn from very instructive specimens, from the sulphurised zinc or blende, which has been deprived of the sulphur by a gentle heat, after which the metal has combined with oxygen, and been thus brought into the state of calx. The calx of zinc so formed, is always found mixed with more or less of ferruginous clay, and filix.—

It

It is met with in different degrees of hardness or coherency, and of various colours; sometimes also of regular shape, or crystallised.

The following varieties are known:

VAR. I. COMMON OPAQUE CALAMINE, OR  
OXYD OF ZINC.

Werner. Germ. *Gemeiner Galmey*.

Its colour is yellowish grey and brownish, also whitish grey; it has an earthy appearance; it is found in compact masses, cellular, stalactitical, perfectly opaque, and of different degrees of coherency. When digested with sulphuric acid, it is mostly dissolved, emits heat, but occasions hardly any effervescence; the acid takes up the metal and clay, and the filix is left behind. The iron which the solution contains, is discoverable by a little prussiate of potash, or phlogisticated alkali.

It yields by analysis: 84 parts of zinc, 0,3 iron, 12 filix, and 0,1 of argillaceous earth.

It is found in stötz mountains of lime or shistus, as near Bleyberg in Carinthia—in the mountain Stollberg in Sweden—near Beüthen  
in

in Silesia—near Hohenhan in Saxony—Bohemia—Austria—in Flintshire and Somersetshire, and near Wirkefworth in England. A purer kind is found in New Spain between Chilapan and Troizlan—near Nertschinsk in Siberia—near Olkush in Poland—near Tornowiz in Silesia, &c.

It is used for the making of brass.

VAR. 2. SPATOUS CALAMINE, OR SPATOUS  
CALCIFORM ZINC ORE.

Germ. *Spathiger galmey.*

Lat. *Zincum ochraceum calamina spatosa.*

Its colour is yellowish grey; it has a spatous and lamellar texture; generally semitransparent. It is frequently found of regular shape: in rhomboid four sided prisms—rectangular six sided plates—in three and six sided pyramids. The crystals have a lustre, generally accompanied by galena and brown oxyd of iron.

Sometimes it is found exhibiting two hollow six sided pyramids, which seem to be an incrustation deposited upon calcareous spar, and originating in this manner: The liquid sul-

phate, or vitriol of zinc, one of the component parts of the sulphurised zinc ore, becomes, by the absorption of oxygen, an acid, namely, the sulphuric: this acid coming into contact with calcareous spar, unites with the earth of the spar, and the fixed air thereby disengaged, combines with the oxyd of the zinc, and forms the incrustation, which consists chiefly of calx of zinc and fixed air.

The common crystallised calamine is found near Bleyberg in Carinthia—on the mountain Schwarzenberg—in Austria—at Nottingham, and in Somersetshire in England.

There is another kind of oxyd or calx of zinc found, which is chiefly composed of calx of zinc and siliceous earth, called by Gmelin *Zincum Siliceum*.

It has the appearance of zeolithes, with which it has been often confounded. When dissolved in acid, it makes a gelatinous mass. It is white; its texture is fibrous, generally diverging or radiated. It is found as an incrustation, or mammillated with a radiated texture; sometimes of regular shape, as in small thin crystals—in hexadral flattened prisms, terminating by two facets.

Mr. Pelletier found it containing, by analysis, 36 parts of zinc, 50 of siliceous earth, and 12 water.

It has been found near Friburg, and near Wanlok-head in Scotland, where I met with very fine specimens.

## SPEC. III.

OXYD OR CALX OF ZINC, COMBINED WITH,  
OR MINERALISED BY FIXED AIR.

CARBONATE OF ZINC.

*Vitreous zinc ore.*

Fr. *Mine de zinc spathique.*

Germ. *Zink-spath.*

This ore is perfectly soluble in sulphuric acid, without emitting heat. The fixed air is discovered by the effervescence, &c. which takes place when dissolved in the sulphuric acid, and the zinc combined with the acid, makes the vitriol, or sulphate of zinc.

Its colour is generally greyish, inclining to blueish, greenish and yellowish, which arises from a small portion of iron. It is found of various degrees of transparency. It is sometimes so hard, as to emit sparks when struck with steel. When broken, it resembles quartz; when exposed to fire, it becomes yellow. It is found in solid masses, sometimes in six sided compressed prisms, both ends being covered by pentagons, frequently also as capillary crystals.

It contains chiefly 65 parts of zinc, 28 of fixed air, and 6 of water, sometimes a little iron and siliceous earth.

It is found in Flintshire and Somersetshire—in Carinthia—near Freiberg—that from Siberia has a mammillary appearance, and a fibrous texture.

## DIVISION II.

*Zinc and iron mineralised by sulphur, or sulphurised ores of zinc—emit a sulphureous smell when torrifed.*

## SPEC: IV.

BLENDE. (From the German language, in which it signifies blinding or deceitful.)

## SULPHURISED ZINC.

In German also, *Geschwefelter zink*.

Lat. *Zincum mineralisatum blenda*.

Ital. *Zinco sulfureo*.

From the resemblance which it sometimes bears to galena; it has also been called *Pseudogalena*; when of a blackish colour, it is called *Black-jack*.

Cronst. *Zincum calciforme cum ferro sulphuratum*.

It is found of various colours: brown, yellow, hyacinth, sometimes resembling chrysolith, or the colour of melted yellow wax.— Sometimes it exhibits a metallic lustre. The sulphur may be separated by digesting the

pounded ore with sulphuric acid, which takes up the zinc and iron.

It is found in various shapes and mixture; it has a lamellar texture, and the lamellae can be easily separated, easier indeed than in the galena, from which it differs by its inferior specific gravity, as well as by its losing the lustre when moistened, but which it recovers when dried again. When exposed to sufficient heat, it burns with a blueish flame, and frequently emits a phosphorescent light when scraped with a knife in a dark place. When digested with sulphuric acid, it emits hepatic air which may be explained; when the sulphuric acid comes in contact with the sulphur of the ore, it is deprived of a portion of oxygen which combines with the sulphur, and consequently a part of the sulphur is set free—a portion of water is also decomposed, and hence a quantity of hydrogen becomes free, which latter, assisted by the heat which is likewise produced, occasions it to take up a portion of sulphur, and goes off in the state of hepatic air. Some chemists suppose that the hepatic air was produced by the acid having acted upon the sulphurised ore which contained lime, as it was frequently found in calcareous matrix. I have examined  
many



many specimens of blende, but never found calcareous earth a constituent part of it.

The phosphorescent kind contains less iron.

By means of nitro muriatic acid, the metal may be extracted from the ore, and the sulphur separated. It is frequently found mixed with silver, copper, lead, and arsenic, also flint and clay. It is found detached, and also dispersed or embodied in galena, and yellow copper ores. It is often found to be a good indicator of the veins of noble metals; in many ores it is hurtful, as it prevents the separation of other metals from their mineralifer. When mixed with lead, it is called *Tuttanago*. Its primitive figure seems to be the regular tetrahedron, which is variously modified by truncation, making it appear as octohedrons or hex-octohedrons.

The following varieties of blende are known :

#### VAR. I. YELLOW BLENDE.

Germ. *Gelbe Blende*.

Its colour varies a little, as deep brimstone yellow, inclining to olive and asparagus green, reddish brown, and aurora red.

It is found in solid masses, and also dispersed in different matrixes, sometimes crystallised; the crystals are generally embodied, and on that account it is difficult to ascertain their perfect figure. They are strongly shining, and have a parallel lamellated texture; the fragments indicate dodecahedrons, generally transparent; it leaves a light yellowish grey, almost greenish white trace; when rubbed, it discovers a sulphureous smell, and a phosphorescent light; it is almost soluble in nitric acid.

By analysis, it yields = 64 zinc, 20 sulphur, 05 iron, 04 fluoric acid, 01 siliceous earth, and 06 water.

#### VAR. 2. BROWN BLENDE.

Its colour is reddish and yellowish brown, sometimes inclining to blackish, hyacinth red.

It is found solid and interspersed, also of regular shape: in rectangular four sided prisms, in octohedral crystals, and variously modified by truncation. The outside is brightly shining; when fresh broken, it exhibits a lustre the intermediate of a vitreous and fat lustre.— Its texture is lamellar; it is found opaque, and also

also semi-transparent; it emits a sulphureous smell on rubbing.

It has yielded by analysis = 44 zinc, 17 sulphur, 24 siliceous earth, 05 argillaceous earth, 03 water.

It is found near Freiberg, &c.

### VAR. 3. BLACK-BLENDE. BLACK-JACK.

Germ. *Schwarze Blende.*

Its colour is dark and brownish black, and sometimes blood red on the points.

It is found solid, and also in small particles deposited upon ores of regular shape: in simple three sided and double four sided pyramids, variously modified. It has a lustre; a lamellar texture, and is generally opaque. It gives a greyish and reddish brown trace, and a hyacinth red colour to nitric acid on digestion; it is generally accompanied by arsenical pyrites.

It yields by analysis = 45 zinc, 29 sulphur, 09 iron, 06 lead, 01 arsenic, c4 flux, 06 water.

It is met with near Freiberg—near Bleyberg in Carinthia—near Joachimsthal and Przibram in Bohemia—in Transylvania—near Sahlberg in

in Sweden—near Scharffenberg in Saxony, and in Hungary, also in different parts of Wales, often accompanied by fluor.—A reddish blende is found near Königsberg in Lower Hungary; and near Freiberg. Greenish blende is found in Pacherstollen, near Schemnitz in Lower Hungary.

#### DIVISION IV.

*Zinc combined with acids, or in the saline state, soluble in water.*

#### SPEC. V.

SULPHATE OF ZINC. VITRIOL OF ZINC.

*Zincum vitriolatum.*

Germ. *Zink-vitriol.*

This species originates from blende, having become acidified by the absorption of oxygen, and thus forming the sulphuric acid, which has afterwards combined with the calx, and composed the sulphate or vitriol of zinc.

It is found near Sahlberg in Sweden—near Cremnitz. When perfectly crystallised, its shape is a rhombic prism, terminating in four sided pyramids. This operation in nature proceeds very slowly, and as the product has been found useful for many purposes, the operation is supplied by art on a large scale. Almost all the vitriol of zinc (in German called *Weisser Vitriol*) which is met with in commerce, is prepared as the Rammelsberg near Goslar on the Harz: for which purpose, after having roasted the galena which is mixed with blende, it is thrown, when still ignited into cisterns full of water, where it is left for 24 hours, which roasting and extinguishing is repeated in the same water; after which the lixiviated saline liquor is strained, evaporated, and put into coolers. At the end of 14 or 15 days, the liquid is decanted to separate the crystals. The thus obtained crystallised masses, are melted in iron vessels, and then poured into other coolers, where the whole is stirred until it becomes solid.

### *Brass.*

The manner of making brass is generally done in the following way :

Equal

Equal parts of pounded and sifted calamine, or calciform ores of zinc, and pounded charcoal are mixed, and a little moistened; it is then placed in a stratified manner, with the fourth part of its weight of copper, either in plates or in small pieces, in a crucible which is to be covered; there are generally several of such filled crucibles placed at the same time in a blast furnace upon an iron grate; and covered with coals. When in 12 or 14 hours, two coverings of coal have been consumed, and that the large flames, which rise out the opening, diminish, and appear with a clear blueish opalescent like colour; it is considered as a mark or indication of the mixture having undergone a perfect combination. The crucibles are then taken out, and the metal is put into another crucible previously ignited; when the metal is perfectly fused, it is poured out, and cast into plates. This first smelting yields an impure brass, and the scoriae which are separated, contain still a portion of the metal which is further separated by another smelting with charcoal, calamine, and copper.

If the brass is meant for casting, a greater portion of calamine can be employed; but a less portion is necessary for brass, which is to be worked by hammering.

DIVISION

DIVISION III.

OF

SEMI-METALS,

*Not malleable, more or less brittle.*

GENUS X.

BISMUTH.

BISMUTHUM.

Germ. *Wismuth.*

Fr. *Bismuth ou Etain de Glace.*

Swed. *Askbly.*

This metallic substance was first described by Agricola, and by Schroeder in the year 1641.

It

It is not so frequently found as many other metals, and it serves for few useful purposes in common life. It is found in the earth in very few different states, more generally native or in the metallic state, than most of the other metals; sometimes combined with sulphur or arsenic; more seldom in the state of calx, and never, as far as I know, in the saline state.

When separated from heterogeneous substances, its colour is silver white, inclining to reddish. It is brittle, and can be easily reduced to small particles; it is soft enough to be cut with a knife; it has a lamellar texture; its specific gravity is = 9,800. It requires less heat for fusion than almost any other metal, melting by a heat = 460 degrees of Fahrenheit's scale; it is scarcely affected by the common atmosphere, or by pure water. When long exposed to the atmosphere, it obtains a purple tarnish. It can be volatilised by heat, and escapes in the state of greyish white vapours; it combines readily with mercury and with sulphur; when fused, it exhibits on cooling, cubical figures on the surface. It is soluble in sulphuric, nitric, and marine acid, most readily in nitric acid, less and more difficult with sulphuric and muriatic acid. When dissolved in nitric acid, it is precipitable by a mere



mere dilution with pure water. The precipitate is white, and is used as a pigment by hair-dressers to blacken the light hairs, also as paint for the skin.

The solution in certain acids may be used for sympathetic ink, as it becomes black when exposed to heat. When fused with borax, it produces a brown vitreous mass. It emits a blueish flame when burnt. When in the metallic state, it is used for the composition of types, in letter founderies.

#### DIVISION I.

*Bismuth in the metallic state, perfectly soluble in nitric acid.*

SPEC.

## SPEC. I.

## NATIVE BISMUTH.

*Bismuthum nativum.*

Germ. *Gediegen Wismuth.*

Swed. *Gedieget Askbly.*

Hung. *Termes Vismut.*

Dan. *Naturlig Vismut.*

Its colour is silver white inclining to reddish, sometimes variegated on the surface. It differs from the purified and fused metal, by exhibiting a larger lamellar texture.

It is found in solid masses, and also in small particles dispersed in, and frequently deposited upon different stones, in the state of plumous striated lamellae. Its regular shape is, cubes, simple four sided plates, sometimes octohedron. It is generally accompanied by cobalt ores; its matrix is red jasper, petrosilex, quartz, heavy spar, and cobalt ores.

It

It is met with at Schneeberg in Saxony—at Joachimsthal and Johannegeorgenstadt in Bohemia—in Dalecarlia in Sweden.

It is easily separated from its matrix by simple fusion, on account of its being easily fusible.

## DIVISION II.

*Bismuth in the state of calx or oxyd, having no lustre, being friable, of an earthy appearance, and emitting no sulphureous smell when ignited, but soluble in nitric acid.*

## SPEC. II.

## NATIVE CALX, or OXYD of BISMUTH.

*Bismuthum calciforme.*

Germa. *Wismuth Kalk:*

Fr. *Chaux ou oxide de Bismuth.*

Dan. *Vismut-mulm.*

Hung. *Földe Vismut.*

Cronst. *Bismuthum calciforme pulverulentum.*

Its colour is yellowish grey, greenish, and straw-yellow grey.

It is found compact, and dispersed in, generally coating the surface of other bismutic ores. Sometimes in cubical pieces, and in small lamellæ. It has no lustre, but an earthy appearance or texture. The metal can be recovered by fusing it with charcoal. It is chiefly composed of bismuth, oxygen, and a small portion of fixed air. It is mostly accompanied by sulphurised and native bismuth.

It

It is found at Johanngeorgenstadt in Saxony  
—at Joachimsthal in Bohemia.

Its matrix is sometimes argillaceous shistus.

DIVISION III.

*Bismuth mineralised by sulphur or arsenic; is not quite soluble in acids, and emits a sulphureous smell when ignited.*

SPEC. III.

SULPHURISED BISMUTH.

Germ. and Swed. *Wismutglanz.*

Ital. *Bismuto sulfureo.*

Fr. *Mine de bismuth sulphureuse.*

Hung. *Asványos Vismut.*

Cronst. *Wismuthum sulphure mineralisatum.*

Its colour is lead grey and blueish grey—  
sometimes variegated.

It is found in small particles, dispersed in various stones, needle-shaped and capillary; sometimes in lamellæ, forming small cells; it has a lustre; a radiated or lamellar texture; it stains a little, and may easily be cut with a knife; it does not effervesce with acids; emits sulphureous vapours when heated, and resembles sometimes galena or radiated antimonial ores.

The solution in nitric acid appears green;—it consists chiefly of bismuth and sulphur.

It is found near Altenberg in Saxony—near Schneeberg in Sweden—near Chuteniz in Bohemia.

#### SPEC. IV.

#### MARTIAL SULPHURISED BISMUTH.

Cronst. *Wismuthum ferro sulphurato mineralisatum.*

It has a yellowish grey appearance, resembling somewhat martial pyrites, and a radiated texture.

It is found near Gillabek in Norway.

SPEC.

## SPEC. V.

## ARSENICATED BISMUTIC ORE.

Germ. *Arsenikalischer Wismuth.*

It is of a yellowish white colour, having a brilliant lustre; it is harder than native bismuth; it emits a garlic smell when ignited; it is generally covered by oxyd of bismuth.

It consists of bismuth, arsenic, and sulphur, and is found at Schneeberg, generally in ferruginous jasper, accompanied by cobalt ore.

## GENUS XI.

## NICKEL.

## NICCOLUM.

Germ. *Nikkel.*

This metallic substance has only since the year, 1751, been ascertained to be a peculiar metal, by Mr. CRONSTEDT, though the substance from which he extracted it, had been already known to HIERNE, in the year, 1694, and was afterwards more noticed by HENCKEL, who considered the substance as a compound of copper, cobalt, and arsenic. Mr. Bergman afterwards ascertained more of its distinguishing properties.

This metallic substance is not found in great abundance, and as to its utility, very little has been ascertained yet.

It



It is found in nature, generally in the metallic state, more rarely in the state of calx. When free from heterogeneous substances, it exhibits a reddish white, or the colour of flesh; when fresh broken, it has a strong lustre; it has a fine grained compact texture; as to ductility, it admits a little to be flattened by hammering, similar to cast iron. Its specific gravity is = 9000; it requires a very intense heat for fusion and is fixed; it is not affected by pure water, but when for a long time it is exposed to the atmosphere, its surface becomes gradually altered, and covered with calx or oxyd of a greenish hue; this is sooner observed when the metal is heated, and at the same time, in contact with the atmosphere. When fused with borax, it produces a glass of a hyacinth colour. It is attracted by the magnet; this property was first ascribed to iron, which was thought to be a constituent part of this metallic substance.

It is soluble in sulphuric, nitric, and muriatic acid, most readily in nitric acid; the solution has a green colour; the crystals when saturated with nitric acid, and evaporated, exhibit rhomboidal cubes.

Volatile alkali or ammonia dissolves it, and exhibits a blueish green colour. A piece of  
P 4 polished

polished iron put into a solution of this metal, does not occasion a precipitate, by which we learn, that the blue colour does not originate from an admixture of copper.

The neutral salt formed with sulphuric acid, also crystallises, but the crystals effloresce on exposure to air; with muriatic acid, the crystals have an emerald green colour, and exhibit oblong rhomboidal octahedrons. When mixed with silver by fusion, it makes a white malleable mixture.

It is used by the Chinese for the making of white copper, which they call *Packfong*.

## DIVISION I.

*Nickel in the metallic state.*

### SPEC. I.

NATIVE NICKEL. KUPFERNICKEL.

*Niccolum metallicum.*

Cronst. *Niccolum ferro & cobalto arsenicatis  
& sulphuratis mineralisatum.*

It

It was first discovered by Hierne, in the year 1694. Its colour is copper red, deeper than the purified metal.

It exhibits a conchoidal surface when broken, as to lustre, it resembles the hepatic martial pyrites; it is more brittle than the pure metal; its specific gravity is generally  $\approx 7807$ . Volatile alkali extracts a blueish colour from it, and acids, a green. When thrown upon red hot charcoal, it emits a sulphureous and arsenical smell. It contains frequently iron—arsenic—cobalt, more seldom bismuth or copper, and very seldom silver or gold.

Its matrix is calcareous spar, and heavy spar. It is found at Joachimsthal, in Bohemia—at Schneeberg, and Johannegeorgenstadt, in Saxony—at Andreasberg, on the Harz—near Dauphiny—on the Pyrenean mountains—at Triego, in Cornwall—in Thuringia—Saalfeld, in Sweden, and in Siberia. The metal is obtained from the ore, by torrifying the ore first, to separate the arsenic or sulphur, and the residuum is fused with three parts of black flux, and a little charcoal.

## SPEC. II.

## MARTIAL NICKEL.

Germ. *Gediegen eisen nikkell.*

When fresh broken, it is yellow; it has a lamellated texture; when exposed to air, soon turns blackish; when heated, it emits no arsenical or sulphureous smell.

It is found sometimes in thin rhomboidal plates, which are placed in an irregular manner, one over the other.

It is found along with red arsenic, in argillaceous shistus, at Joachimsthal, in Bohemia.

## SPEC. III.

## NATIVE CALX, OR OXYD OF NICKEL.

Germ. *Kupfernikkell okker.*

Ital. *Calce di nikkell.*

Fr. *Fleurs de nikkell.*

Swed. *Nikkell-bloma.*

Dan. *Nikkellmulm.*

It seems to originate from the decomposition of kupfernickel. It is the metal combined with oxygen, and a little fixed air. Its colour is a pale green, or blueish green; it has an earthy appearance, and is very friable; it is found coating kupfernickel; sometimes interspersed in the matrix, seldom in compressed shining filaments.

It is found at Joachimsthal, in Bohemia—at Kofemüz, in Silesia—at Schneeberg, in Saxony.

Mr. Klaproth, and Heyer, found it mixed with siliceous, argillaceous, magnesian, and calcareous earth.

## GENUS XII.

## ANTIMONY.

*ANTIMONIUM.*

Fr. *Antimoine.* Germ. *Spießglanz.*

Swed. *Spitfglas.* Hung. *Pisgoltz.*

This metallic substance was noticed by Basil Valentin.

It is found in various parts of the earth. It is a very useful substance, particularly in medicine; it is likewise used for different metallic compositions, and in letter founderies. It is found in nature in the metallic state—in the state of calx—mineralised by arsenic, but most generally with sulphur, called crude antimony.

It is generally met with in flötz mountains. When free from heterogeneous substances, it exhibits a silver white colour with blueish shades; its texture is lamellated and radiated; it

it is brittle, and is not affected by water, or by the atmosphere. Its specific gravity is = 6,860. It can be volatilised by a strong heat; when perfectly fused, and exposed to cool gradually, it exhibits cubical crystals on the surface; it combines easily with sulphur, but very difficultly with mercury; it is not easily acted upon by sulphuric and nitric acid, but is very readily soluble in nitro-muriatic acid. With muriatic acid, it makes that liquid called butter of antimony, which is very corrosive. There are a great number of preparations made of it for medicinal uses.

## DIVISION I.

*Antimony in the metallic state.*

## SPEC. I.

## NATIVE ANTIMONY.

*Antimonium nativum.*

Germ. *Gediegener spießglanz könig.*

Fr. *Antimoine vierge ou natif.*

Dan. *Naturlig spids glass.*

Hung. *Termés pifgoltz.*

It

It was first discovered by *Swab*, in Sweden, in the year 1748.

Its colour is silver white, with a strong lustre; the texture lamellar; it is soluble in nitromuriatic acid, and separates again from it, when the solution is much diluted with water. It is generally mixed with arsenic and iron. Some mineralogists believe that it is always alloyed with arsenic. Mr. Sage mixed it with sulphur, and fused it together, and the product resembled realgar, or red arsenic. He says, that the native regulus contained 16 per cent. of arsenic.

Its matrix is generally calcareous spar. It is found near Allemont in Dauphiny, accompanied by red antimony, and near Sahlberg in Sweden.

## DIVISION II.

*Antimony in the mineralised slate, requiring torrifaction to obtain the metal; emitting when heated, sulphureous or arsenical vapours.*

A. *Mineralised by arsenic.*

SPEC.



## SPEC. II.

## ARSENICATED ANTIMONY.

Germ. *Arsenikalischer spießglanz.*

It has a white brilliant lustre, also a lamellar or scaly texture; it is found in masses of no regular shape. When heated, it emits only arsenical vapours.

I have put it down here as a separate species, as I examined a specimen of native regulus, which was not mineralised by arsenic, and was almost entirely dissolved in nitro-muriatic acid, and separated again on weakening the menstruum with water.

The arsenicated kind is found near Allemant, in Dauphiny—Hungary, and Saxony.

B. *Antimony mineralised by sulphur, emitting sulphureous vapours when torrifed.*

SPEC.

## SPEC. III.

## GREY SULPHURISED ANTIMONY.

Germ. *Grau spießglanzerz.*

Ital. *Antimonio solfureo.*

Fr. *Antimoine sulfuré.*

Lat. *Antimonium sulphure mineralisatum  
griseum.*

Its colour is lead grey—steel grey—blackish. It is found in compact masses, having a lamellar, radiated, or scaly texture. It is generally found in needle-shaped prismatic crystals, cohering more or less.

Its regular shape is the rhomboidal octahedron, the basis of which has angles of 88 and 92 degrees; it appears frequently in four-sided prisms, terminating in four-sided points—in six-sided prisms, terminating in a point with six facets—in truncated four-sided prisms, more or less shining, generally with a metallic lustre.

It

It is staining, and breaks generally into radiated fragments ; its specific gravity is generally = 4,200.

It is soft and brittle ; it melts in the flame of a candle by means of the blow-pipe easily, and burns with a blue flame ; it evaporates by a continued strong heat, in the state of grey vapours ; when digested with nitro-muriatic acid, the metallic parts are dissolved, and the sulphur separates and floats on the surface.

It contains often a small portion of gold, but which is not worth extraction. The proportion of component parts vary, sometimes above 70 per cent. metal, and above 20 sulphur.

It is found in Upper and Lower Hungary, at Cremnitz, and Schemnitz—at Nertschinsk, in Siberia—in Saxony—Spain, and England.

Its matrix is quarzous, and calcareous, more rarely heavy spar. I possess specimens in which long crystals pass through crystallised white semitransparent heavy spar.

## SPEC. IV.

## RED ANTIMONIAL ORE.

Germ. *Roth spießglanzerz.*

Born. Cat. Raif. *Antimoine coloré rouge.*

Fr. *Mine antimoine rouge.*

Dan. *Rod spids glasmulm.*

Hung. *Veres pifgoltz.*

This ore consists of antimony, sulphur, and arsenic; it is generally of a light crimson red colour; mostly in thin prismatic capillary crystals, which are accumulated and arranged in a diverging, or stellated manner. The crystals are opaque and friable. It is found in the antimonial mines of Bohemia, Hungary, and Transylvania.

I have specimens of antimonial ores, which are covered with a coat of reddish brown antimony, of an earthy appearance, and resembling the kermes mineral, which was given to me for native *kermes mineral*. I shall examine it in order to ascertain whether it contains arsenic,

or

or whether I shall place it, for the future, as a separate species.

## SPEC. V.

## PLUMOUS ANTIMONIAL ORE, OR ARGENTIFEROUS ANTIMONIAL ORE.

Germ. *Federerz.*

Hung. *Pisgoldzos ezust.*

It has a lead grey colour. It is generally found in thin capillary, or filamentous crystals irregularly mixed. It is very little shining, is friable, and stains the fingers. It consists chiefly of antimony, iron, arsenic, sulphur, and silver.

It is found with the common grey antimony, near Freiberg—in Hungary, and Tuscany.

It seems to be only a variety of the grey antimony.

## SPEC. VI.

VARIEGATED SULPHURISED ANTI-  
MONY.

Born. Catal. Raifon. *Antimoine coloré  
irisé.*

Germ. *Buntes or regenbogèn farbiges spies-  
glanzerz.*

It has a very beautiful appearance, exhibiting the colours of a rainbow, or those exhibited by the feathers round the neck of the blueish kind of pigeons.

It is composed of long fibres or filaments of the grey antimonial ore, whose surface has obtained that appearance by having lost part of its sulphur, occasioned by heat which had been extricated during the decomposition of other bodies surrounding it under the earth, and which sulphureous particles becoming acidified by the combination with oxygen, had thus re-acted upon its surface, and so produced that change. It is very scarce, and has not been found of late.

It

It was found in a certain antimonial mine of Hungary, in quartz and heavy spar.

*The following species are to be considered as oxydated antimonial ores, more or less altered by acids.*

## SPEC. VII.

WHITE ANTIMONIAL ORE OR OXYD OF ANTIMONY COMBINED WITH MURIATIC ACID.

*Muriate of antimony.*

Germ. *Weiß Spießglanz-erz.*

It is whitè, or greyish white ; it is found in oblong rectangular four sided plates, in capillary crystals joined at the basis and grown together. The crystals have generally a pearl lustre, a lamellar texture ; they are semi-transparent, resembling somewhat the white lead

Q 3

orc,

ore, or white zeolith; they crackle when exposed to heat. When fused with borax upon charcoal, the metal recovers. It consists chiefly of oxyd or calx of antimony and muriatic acid.

It is scarce, and found near Braunfsdorf—Freyberg—Przibram in Bohemia; generally accompanied by red blende, galena, grey antimony.

I have a specimen which contains the white antimony and red antimony, both in capillary crystals, placed in a stellated manner.

## SPEC. VIII.

### YELLOW ANTIMONIAL ORE.

This ore differs from the foregoing, in containing oxyd of lead, from which it has probably obtained the yellow colour.

It is found in four sided shining lamellæ.

It is very scarce, and was found in Hungary.

As to the working of antimonial ores, which are chiefly the sulphurised ores: the ore is first  
sorted



sorted and pounded, then torrified in an oven resembling that of the bakers. A hundred pounds of the torrified ore are mixed with fifty pounds of dried tartar and a little iron; the mixture is fused in proper crucibles; after which the metal is found in the bottom of the crucible. The metallic buttons or loaves, exhibit generally a star on their surface, particularly if the crucible be placed in a temperature so as to cool gradually.

Q4

GENUS

## GENUS XIII.

## COBALT.

## COBALTUM.

*Cadmia.*      Ital. *Cobalto.*

Germ. *Kobalt.*

This metallic substance was first discovered by Brandt, in the year 1735.

It is used for several purposes, but chiefly and particularly as a colouring matter in the art of painting blue in *fresco*, and on fayence ware, &c.

It is found in nature, mineralised by arsenic or sulphur, in the state of calx, and combined with or altered by acids, perhaps never in the pure metallic state.

It

It is met with in various countries. The mines of Saxony, Bohemia, and Sweden, produce a great quantity. Wherever it is found, it is generally accompanied by silver ores.

When freed from heterogeneous substances, it has a blueish grey colour, with a little shade of reddish, resembling in appearance mostly pure iron.

Its texture is the intermediate between granular and scaly.

Its specific gravity is = 7000.

It is brittle, and easily reducible to powder; is readily affected by the atmosphere, and a little moveable by the magnet, which has been ascribed to iron, from which it can scarce be perfectly freed. It requires a very strong heat for fusion, rather more than copper: when in the state of calx or oxyd, it appears generally of a rose colour; when fused with borax, it produces a glass of a fine blue, and this colour it occasions in most vitrifiable substances.—When fused with one part of pure sand, and two parts and a half of potash, it makes a blue glass, which is reduced by mills to a very subtle powder, and is then called *smalte*, a blue substance used for blueing by washer-women. It is soluble in nitric acid without the assistance of heat, and gives a rose colour to the solution.

tion. When evaporated, it crystallises in needle shaped crystals, which deliquesce in the atmosphere.

It is soluble in vitriolic acid, by the assistance of heat; and when saturated with that acid, and evaporated, it crystallises; the crystals are tetrahedral rhomboidal, terminating in a dihedral summit, and the combination is decomposed by ponderous, calcareous, and magnesian earth, and also by fixed alcalies. It is perfectly soluble in marine and nitro muriatic acid; and the solution, when much diluted with pure water, is used for sympathetic ink, which, when written with on paper, and held near the fire, turns blueish or greenish. Volatile alcali extracts a red colour from it. With nitric acid, it does not produce the sympathetic ink, only by means of the muriatic acid.

It does not combine with mercury.

#### DIVISION I.

*Cobalt in the mineralised state, with sulphur or arsenic.*

SPEC.

## SPEC. I.

GREY COBALT ORE. ARSENICATED  
COBALT.

Germ. *Grauer speifs Kobalt*, or *grau Kobalterz*.

Swed. *Gra Cobalt malm*.

Hung. *Hamu—Szinü ásványos, Kobalt*.

Dan. *Graau Kobalt malm*.

This ore is chiefly composed of cobalt and arsenic. Its colour is steel grey, resembling regulus of arsenic; sometimes the surface is variegated; it has a fine grained compact texture.

It is found in solid masses, or in small particles, dispersed in various stones, sometimes stalactitical; specular with a particular lustre, so as to reflect the images of bodies like looking glass, whence this kind was called *looking glass cobalt*. It appears sometimes dendritical, or resembling net work, of regular shape, as  
in

in cubical, prismatic, and octohedrical crystals, with a metallic lustre; the crystals are brittle, and turn blackish on long exposure to the atmosphere. It sometimes strikes fire with steel.

When thrown upon red hot charcoal, it emits a garlic smell, which characterises the arsenic; when melted with borax, it occasions a blue colour. When dissolved in nitro-muriatic acid, it makes sympathetic ink.

Its matrix is red heavy spar, calcareous spar, quartz, &c. it contains often silver.

It is found at Annaberg and Schneeberg, Freiberg, Johanngeorgenstadt in Saxony—at Joachimsthal in Bohemia—Saalfeld in Thuringia—and at Kongfberg in Norway.

B. *Mineralised by sulphur and arsenic.*

SPEC.

## SPEC. II.

## WHITE COBALT ORE.

*Galena Cobalti.*

Fr. *Mine de cobalt blanche.*

Born. Catal. Raifon. *Cobalt combiné avec arsenic le soufre & le fer.*

Germ. *Glanz kobalt, or weisser speifs kobalt.*

Swed. *Glants cobalt.*

Hung. *Tündöklö kobalt.*

Gmelin. *Cobaltum pyriticosum.*

It consists chiefly of cobalt and iron, mineralised by sulphur and arsenic; its colour is deep tin-white-grey, inclining a little to reddish, sometimes variegated.

It is found solid, dispersed, in groups, specular and knitted. Its texture is granular and lamellar; it has a metallic lustre. When  
thrown

thrown upon red hot charcoal, it emits both sulphureous and arsenical vapours ; it does not strike fire with steel, and is scarcely altered in the atmosphere.

It is also found of regular shape, as dodecahedral rhomboid. The surfaces are striated, the striae on one side are perpendicular to those of the opposite side.

When this ore is wrought, the pounded ore is torrified, by means of which the arsenic requiring less heat than the sulphur, is volatilised first ; afterwards the sulphur is separated, and the calx or oxyd is left behind.

This kind of cobalt ore is found at Schneeberg and Saalfeld. In Norway, the fortification-cobalt, so called from its appearance, is found near Riegelsdorf, and near Tunaberg in Sweden.



## SPEC. III.

## SULPHURISED COBALT.

Born. Catal. Raison. *Oxyde de cobalt combiné avec le soufre.*

This ore seems to contain no arsenic or iron, in which it differs from the foregoing species; it is also richer in metal; it is generally white, sometimes tarnished. When heated, it emits a sulphureous smell; it does not strike fire; and is found in cubical crystals without striae.

It is met with in Upper Hungary and Joachimsthal, generally upon quartz.

## DIVISION II.

*Cobalt ores in the calciform or oxyd state.*

A. *Oxyd*

A. *Oxyd of cobalt without acids.*

SPEC. IV.

BLACK OXYD, OR CALX OF COBALT.

Gerin. *Schwarzer Erdkobalt en cobalt okker.*

Ital. *Calce di cobalto nigro.*

Swed. *Cobalt jork.*

Dan. *Kobalt mulm.*

Cronstedt. *Ochra cobalti nigra.*

Fr. *Oxid de cobalt noir.*

This is the purest kind of the calciform cobalt ores. It emits no sulphureous or arsenical vapours when heated.

When fused with flint and potash, it makes a fine blue glass; it becomes shining when rubbed with the nail of the finger.

It is also found of a greater coherency or hardness, exhibiting reniform or botrioid pieces,

pieces, resembling flags, but never yet in the crystallised state, or of regular figure; from its vitreous appearance, it has been called in

German, *Glafsartiger kobalterz*.

Fr. *Mine de cobalt vitreuse*.

By Cronstedt, *Minera cobalti vitrea*.

Both kinds are found at Saalfeld, in Thuringia—at Annaberg, Schneeberg, and Kamsdorf, in Saxony. The vitreous kind particularly at Vitzbichel, in Tyrol.

## SPEC. V.

### BROWN EARTHY OXYD OF COBALT.

Fr. *Oxide de cobalt brun*.

Germ. *Brauner erd kobalt*.

This kind contains generally a little iron. Its colour is liver-brown—deep ash-grey—and straw yellow.

It is found only dispersed in various matrixes; it has an earthy texture; when in the compact state and broken, it appears on the inside reddish.

It is found with kupfernickel, at Saalfeld, and at *Grofskamsdorf*.

## SPEC. VI.

## YELLOW OXYD OF COBALT.

Its colour is a dirty straw yellow; it is found solid—interspersed, and has an earthy texture; its external characteristical mark is its appearing always cracked in various directions.

B. *Oxyd of cobalt combined with acids.*

## SPEC. VII.

## GREEN OXYD, OR CALX OF COBALT.

Germ. *Grüner erd kobalt, or grüner-kobalt beschlag.*

Fr. *Oxide de cobalt vert.*

It consists chiefly of oxyd of cobalt, of nickel, and a little arsenical acid. It has its colour

colour from nickel, with an earthy appearance, and is generally deposited upon ferruginous clay; when examined by a microscope, it appears in capillary crystals. It is found at Schmölniz, in Upper Hungary; and at Saalfeld, in Thuringia.

## SPEC. VIII.

## RED OXYD OF COBALT.

Germ. *Rother kobalt okker.*

It consists chiefly of calx of cobalt, and arsenical acid.

There are two varieties of it.

## VAR. I. EARTHY RED OXYD OF COBALT.

Germ. *Kobalt beschlag.*

Fr. *Fleur de cobalt superficielle.*

It has a red colour, like pale red roses, or the colour of the peach flower.

It is generally found in an earthy state, of a greater or less degree of coherency, coating

different stones—seldom botrioid. It has an earthy texture, but leaves a shining trace on rubbing.

It seems to originate from the arsenical cobalt ore, which has been altered by the absorption of the basis of pure air, and thus become acidified.

It is found on ferruginous indurated clay, and on quartz, at Oraviza, in the Bannat of Hungary—at Schneeberg, in Saxony—and at Joachimsthal, in Bohemia. I also found it in Ireland, near the lakes of Killarney.

VAR. 2. EFFLORESCENT RED COBALT ORE.

Germ. *Kobalt blüthe.*

Fr. *Fleur de cobalt striée comme l'amyant.*

Dan. *Kobolt blomster.*

Its colour is crimson—cochineal—and peach flower red. It is found dispersed in, or deposited upon different stones; generally composed of very thin capillary prismatic crystals, disposed in a stellated manner. The crystals are shining, semitransparent, and soft to the touch. Their regular shape is a rectangular four-sided prism.

It

It is found upon ferruginous-indurated clay—white quartz, and petroflox. It is met with at Schneeberg, and Saalfeld—in Silesia—in Sweden—Norway—Joachimsthal, in Bohemia—Saxony—Thuringia—Andreasberg, on the Harz—Allemont, in Dauphiny—Spain, near Guftoa, and Bielsa, in the province of Arragon.

## SPEC. IX.

## BLUE COBALT ORE.

Its component parts I have not ascertained yet; I shall examine, and give a more full account of it, in the supplement to this work.

Its colour is blueish black; it has an earthy appearance, and is accompanied by red oxyd of cobalt, in a matrix of indurated clay, and quartz. I found some very fine specimens of it, near the lakes of Killarney, in Ireland.

## SPEC. X.

VITRIOL OF COBALT, OR SULPHATE  
OF COBALT.

This being a perfect salt, soluble in water, I have already mentioned it amongst the metallic salts, treated of in the first volume.

THE common mineralised ores of cobalt, may be assayed by first torrifying the pounded ore, to separate the mineraliser, and afterwards fusing the remainder with black flux, in the proportion of 200 grains of the roasted ore, and one ounce and a half of black flux; by these means, the metallic parts are separated. If the metal be combined with iron, or bismuth, it may be mixed with muriate of ammonia, or sal ammoniac, and sublimed, by which means, the heterogeneous metallic parts are carried off, along with the salt, in the upper part of the subliming vessel; the sublimation



tion is repeated, until the salt assumes a greenish tinge.

The working of cobalt ores consists in roasting the ore in a reverberatory furnace, terminating in a long chimney, into which the vapours are received. The vapours adhere to the sides, forming a crust, which is cleared away by criminals, who are condemned to this work for crimes, that by the law deserve death. The cobalt ores of Saxony afford a great quantity of arsenic.

When the cobalt is freed from the mineraliser, it is called zaffer, which is used for the making of smalt, for painting, &c.

## GENUS XIV.

## MANGANESE.

## MANGNESIUM.

Fr. *Manganese.*

Germ. *Braunstein.*

This metallic substance seems, after iron and gold, to be the most frequently diffused through the earth, and even in vegetables. As a peculiar metal, it was first ascertained by GAHN, and SCHEELÉ, in the years, 1774 and 1777.

It is scarce ever found in, or approaching to the metallic state, but always in the state of calx, or combined with oxygen, probably on account of the great affinity, or attraction, which it seems to have to that principle; in this state, it has proved a useful substance.

It

It appears to be capable of combining with a greater portion of the basis of pure air, than any other metal, and parts with the greatest part of it again, by the mere application of heat, when exposed to it in close vessels; on this account, it is frequently used in chemistry, to procure a great quantity of pure air or oxygenous gas; it communicates that principle also to certain acids, particularly to muriatic acid, when distilled over it, which causes the same to escape, in the state of an elastic fluid, or gas, called furoxygenated muriatic gas, or *diphlogisticated muriatic acid*. This last has the property of depriving most vegetable substances of their colour, both in the state of gas, and also when mixed with water, by which it is absorbed; hence it is employed in manufactories for bleaching linen, and rags for the manufacturing of paper, &c. However it being found, that in the state of gas, it corroded or destroyed part of the stuff, this effect was mitigated, by combining it with pure potash, dissolved in the same water by which it was absorbed; by these means, it answers the purpose of bleaching much better, and is neither so noxious or destructive to the animal œconomy, of which we have experienced many bad consequences.

This

This substance in the state of oxyd, was also found to have the property of depriving certain earthy and metallic substances of their colour, when mixed and fused with them in certain proportions; for which reason, it has now been employed in glass manufactories, to remove the green colour of the common green glass. Lastly, it is used in the manufactories of certain earthen wares, as the black earthen ware of Mr. Wedgwood, to which it communicates the black colour. More of its qualities may in process of time be discovered.

The pure metal can only with great difficulty be obtained from the ore, that is, by frequent fusion with charcoal, and other contrivances. The metal requires also a stronger heat for fusion, than any other metal. When pure, it resembles iron as to colour. It is also harder than other metals. When exposed to the atmosphere, it soon absorbs oxygen, and falls into powder. Its specific gravity is found = 6,800.

When fused with borax, it produces a deep red glass; when mixed in a certain proportion with nitre, and exposed in a crucible for a sufficient time to heat, the mixture obtains the property, when thrown into water, of exhibiting three different colours one after the other,

as green, purple, and scarlet, and at last, all the colours disappear again; this mixture is called chameleon. It is soluble in acids, and is precipitated from the acid, by alkali, in the state of a white powder, which has also the peculiarity of turning black, when exposed to the atmosphere, and much sooner in pure air. When sulphuric acid is poured on it, it has been observed to throw out light. When fused with copper, it renders it white, and remains malleable. It does not combine with sulphur, or with mercury.

## SPEC. I.

## NATIVE METALLIC MANGANESE.

*Magnesium metallicum.*

It was found in the state of greyish white small globules, which when exposed to the atmosphere, fell to a black powder. The globules when first found, admitted to be flattened a little with the hammer; such was met with in the county of Foix, in France, and near Carinthia, and Hungary. I have never seen any, and can, therefore, give no fuller account of it,

it, than what I have found mentioned by other authors.

## SPEC. II.

## GREY OXYD OF MANGANESE.

*Magnesium ochraceum griseum.*

Germ. *Graues braunsteinerz.*

Born. Catal. Raifon. *Oxide de manganese, souillé de fer. Combiné avec une grande portion d'oxygene.*

Its colour is steel grey, with a metallic lustre. It is found solid with a lamellar texture; gives a black trace, and stains paper a little. It is found in lamellæ—in needle-shaped crystals, which are chiefly disposed in a radiated or stellated manner. The shape of the crystals exhibits six-sided prisms—tetrahedral rhomboidal prisms, which are longitudinally striated, the degrees of the angles are  $65^{\circ}$  and  $115^{\circ}$ . When heated in close vessels, they emit pure air.

It is found particularly fine at Piemont—at Ilfeld on the Harz—in Dauphiny—Bohemia—Carinthia—

Carinthia—Jamaica, and in various other countries.

It is often mixed with calcareous earth, ponderous earth, or baryt; magnesia, and fixed air.

## SPEC. III.

## BLACK CALCIFORM MANGANESE.

Germ. *Schwarzes braunsteinerz.*

Fr. *Oxide de manganèse noir.*

Its colour is black—greyish black, or iron black, resembling fuligo or soot. It is found in solid lumps, dispersed in different ores or stones—coating other minerals—cellular—dendritical, or upon glassy hematites—kidney shaped—botrioid, or stalactitical; and also, but more seldom, in acute angular octahedral crystals, which have a lustre, and a lamellar texture.

It is found near Kamsdorf, and Könitz—Piemont—Carinthia—Thuringia. In England  
and

and Ireland, it is found in considerable quantity, and rather more of a brown colour.

To this belongs also the substance called wadd, which is found in Derbyshire, and which discovers the peculiarity of becoming red hot, when mixed with linseed oil on exposure to air.

#### SPEC. IV.

#### REDDISH WHITE OXYDATED MANGANESE.

*Manganese combined with a less portion of oxygen.*

Fr. *Oxide de manganese blanc ou couleur de rose.*

Germ. *Röthlich weises braunsteinerz.*

Its colour is whitish, or that of roses; sometimes brownish red. It is found solid and interspersed—botrioid, and also in lenticular and pyramidical crystals. It is found in certain mines of Hungary, and Transylvania, mixed with flint, and constitutes the matrix of the



the auriferous ores. It is soluble in nitric acid, the solution being colourless, and the precipitate occasioned by alkali, white, which when heated, becomes black.

It was analysed by Ruprecht, who found it containing 55 of flax, 35 of manganese in the state of oxyd, and a little iron, and argillaceous earth, in a hundred parts.

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THE following three metallic substances differ from the other metals, in assuming the property of acids, when combined with a sufficient quantity of oxygen, or the acidifying principle.

GENUS

## GENUS XV.

## MOLYBDENA.

This metal was first ascertained and described by *Hielm* in the year 1784.

The substance which contains it, had been often confounded with plumbago or black-lead, from which it differs considerably, as I shall point out. Several chemists have not been able to succeed in the separation of the metal from the ore. Mr. *Hielm* says, it has a steel grey colour, and is very brittle; it is only soluble in the nitric and arsenical acid; when nitric acid is distilled over this metallic substance, it leaves a white calx or oxyd behind, which is called the molybdenic acid, and which has the property of decomposing nitrate and muriate of baryt; in the dry way, it disengages the nitric acid from common nitre, and the muriatic acid from common salt, when exposed together in a retort for distillation.—

The

The acid itself seems unalterable in fire, like the arsenical acid. Other acids have scarcely any effect upon this metallic substance.

The specific gravity of the acid is = 3460, and from analogy, that of the metal about = 6900.

It combines with sulphur, and the mixture is called sulphurised molybdena, in German *Wasserbley*.

It effervesces with alkali when fused by fire.

This metallic substance is only found in nature, combined with sulphur.

### SPEC. I.

## SULPHURISED MOLYBDENA, OR MOLYBDENA MINERALISED BY SULPHUR.

Germ. *Wasserbley glanz*.

Cronstedt. *Molybdena membranacea nitens*

Born. Catal. Raïson. *Acide molybdenique combiné avec le soufre.*

Its colour is lead or steel grey, with a lustre. It has a lamellar texture, and is composed of thin lamellæ, placed over one another; the lamellæ are curved, flexible, and stain paper with a lustre, more than plumbago.

It is generally found compact, and seldom in particles.

Its specific gravity is generally = 4,700.

It can be cut with a knife, is fatty to the touch, can be volatilised by a strong heat, and emits sulphureous vapours.

It is found likewise of regular shape, as in six sided plates, and in six sided prisms, terminating in six sided pyramids, by double truncation; such a specimen Mr. Raspe possessed, which I saw. Its matrix is feldspar, lithomarge, and quarzous rock.

It is found in Iceland—Sweden—Spain—at Altenberg in Saxony—at Schneeberg and Schlackenwald—in France—at Kolyan in Siberia. It is also found in rocks containing wolfram and tin ores.

The terra australis seems to be mixed with molybdena.

## GENUS XVI.

## ARSENIC.

## ARSENICUM.

That this substance is a peculiar metal, was first ascertained by Schroeder in the year 1641. Mr. Monnet in the year 1773, ascertained its properties more fully.

It is found in many different parts of the earth, both in the metallic state, and mineralised by sulphur, and also in the state of calx or oxyd.

It is used for several purposes, according to its different states, each of which I shall mention separately.

*Perhaps it would be laudable, if an express law prevented the selling of common arsenic to unknown people in the shops of druggists, where the purpose or pretence was so slender as that*

*of destroying rats, &c. at least more caution should certainly be impressed on the minds of those who sell, and of those who buy this pernicious mineral; for the former do not often consider the unhappy consequences, which may arise from even a careless use of it, while the latter are frequently so heedless in its application, by leaving it open, and in improper places, that however innocent intention has been, numberless are the instances on record, of the lamentable mischiefs which this poison has occasioned. It should be remembered, that there are other poisons more safe to man than arsenic, which might be used for destroying noxious animals, and that arsenic preys sufficiently upon human life, if we come to number the victims who are occupied, and by degrees destroyed, in its mines and several workings.*

When the metal is freed from other substances, it has a lead grey colour, a lamellar texture, and a slight lustre; it becomes blackish or purple when exposed to air.

Its specific gravity = 8,310.

It is not acted upon by water, but readily by nitric acid.

When exposed to heat, it may entirely be volatilised, during which it emits a garlic like smell; it is dissipated in the state of white vapours, which may be collected on a piece of polished

polished copper plate, held a little distant over the crucible in which it is ignited. When fused with common glass, it deprives it of colour; it renders copper white, and iron yellow, gold and zinc grey.

When the metal is perfectly fused, and suffered to cool gradually, it exhibits an octahedral shape. When mixed and fused with sulphur, it produces a red mixture, or the realgar or red arsenic, as it is called.

## DIVISION I.

*Arsenic in the metallic state, free from sulphur:*

## SPEC. I.

NATIVE METALLIC ARSENIC, TESTACE-  
OUS ARSENIC.*Arsenicum nativum.*

Germ. *Gediegener arsenik-könig*, also *scherben kobald*, & *Fliegenstein*.

Fr. *Arsenic natif*.

Dan. *Naturlich arsenic*.

Hung. *Termes egér kö*.

It consists chiefly of arsenic, and a little iron. Its colour is generally lead and iron grey. Its texture is lamellar or testaceous, the lamellæ are a little curved and sonorous.

Its specific gravity is generally = 8,308.

When fresh broken, it exhibits a lustre, but becomes soon tarnished in air.

It is brittle, and easily pulverifiable. When boiled with water, it communicates a sufficient poisonous quality to kill flies, for which purpose it is frequently used in Germany, and hence



hence it has probably obtained the name *Fliegenstein*. When exposed to a sufficient heat in a crucible, the arsenic flies off, and leaves an iron slag behind.

It is generally found in cobalt mines, as near Freiberg and Annaberg in Saxony—at Joachimsthal in Bohemia—at Kongsberg in Norway.

## DIVISION II.

*Arsenic in the state of calx or oxyd.*

### SPEC. II.

#### WHITE OXYD OF ARSENIC.

*Arsenicum album.*

Germ. *Weisser arsenik-kalch.*

Fr. *Arsenic blanc ou oxide d'arsenic blanche.*

This is scarce; its colour is naturally whitish, but when exposed to heat, it becomes blackish.

Its specific gravity is = 2477.

It is entirely volatilised by heat in the state of white vapour, which have a garlic smell.— It is the only oxyd of metals which emits a characteristical smell when exposed to heat.— It is soluble in nitric acid, but less in muriatic and vitriolic acid; it is soluble in water, and particularly when assisted by heat. When fused with sulphur, it produces, according to the proportion of sulphur, a yellow or a red mass.

It is generally found of an earthy appearance, or as an efflorescence, coating native or metallic arsenic; seldom in the crystallised state, exhibiting octahedral crystals, or tetrahedral truncated prisms, or three and four sided pyramids, which have probably been occasioned by subterraneous heat.

It is found at Schmölnitz in Hungary—at Andreasberg on the Harz—at Joachimsthal in Bohemia, and in Transylvania.

### DIVISION III.

*Arsenic mineralised by sulphur, emitting sulphurous vapours when thrown upon red hot charcoal, not soluble in nitric acid.*

SPEC.

## SPEC. III.

## SULPHURISED ARSENIC, OR ORPIMENT.

There are two varieties of this kind, which differ from each other by the different colour and solidity, or coherency, occasioned by the different proportions of its component parts, and by the different degrees of heat to which it has been exposed, and which are differently named.

## VAR. I. YELLOW SULPHURISED ARSENIC.

Lat. *Aurum pigmentum, or resigallum.*

Swed. *Rausch gelb.*

Cronst. *Calx arsenici sulphure mixta flava.*

This kind contains less sulphur than arsenic, generally 90 parts arsenic, and 10 of sulphur. Its colour resembles that of lemon or yellow brimstone, inclining sometimes to greenish, reddish, or orange.

Its

Its texture is generally lamellar, and the lamellæ are so soft as to be cut with a knife, and a little flexible, and have often a beautiful brilliant lustre, which is improved by the scarlet red shades.

Its specific gravity is generally = 5315.

When exposed to heat, it becomes blackish; and when fused in a close vessel, it becomes red; it is often semi-transparent in a light degree. When exposed to a long continued heat, it evaporates, leaving a small portion of earthy parts behind.

It is found stalactitical, globular, and testaceous, or in oblong and broad lamellæ, never as far as I have known, in the crystallised state.

It is found in the bannats of Hungary, and in various other parts.

When reduced to fine powder, it is used in paintings.

## VAR. 2. RED SULPHURISED, OR RUBY ARSENIC.

*Realgar. Arsenicum rubrum.*

Fr. *Realgar natif.*

Germ. *Rother arsenik.*

Cronst. *Calx arsenici sulphure mixta rubra.*

Gmelin. *Arsenicum sadaraca.*

This kind consists of a greater portion of sulphur; 84 of arsenic, and 16 of sulphur, generally form the proportion. Its colour is aurora red, or ruby red, generally of an equal colour, and it appears more as a homogeneous substance; it is more transparent than the afore-mentioned variety; it is shining, but not so bright as the yellow orpiment.

Its specific gravity is = 3,300.

It is found in compact solid masses, and frequently of a regular shape, as in tetrahedral and hexahedral rhomboidal prisms, longitudinally striated, and often terminating in tetrahedral summits, or variously modified.

It

It is common in China, where it is made into vases, pagodas, and other ornamental works. The Indians make use of these vessels to procure a purgative medicine; for such purpose they leave vinegar or lemon juice for several hours in the vessel, and afterwards drink it.

Red arsenic is commonly found near volcanos, as at the Solfatara near Naples—in the mines of Nagyag in Transylvania—in the mines of Felsőbanya in Upper Hungary—near Joachimsthal in Bohemia, and at Marienburg in Saxony. Its matrix is quartz, heavy spar, and ferruginous clay.

#### SPEC. XIV.

PYRITICAL ARSENICAL ORE, OR ARSENICAL MUNDIEK;

OR,

ARSENIC AND IRON MINERALISED BY SULPHUR.

Germ. *Mispickel & giftkies.*

Swed. *Arsenikalisch-kies.*

Hung. *Egér-kő kova.*

Cronstedt.

Cronstedt. *Arsenicum metalliforme ferro mixtum crystallisatum.*

Fr. *Pyrite blanche arsenicale.*

Born. Catal. Raison. *Arsenic combiné avec le fer & le soufre.*

Its colour is greyish or silver white, sometimes variegated. It has a slight pyritical lustre; it often strikes fire with steel.

It is found compact in solid masses, having no particular shape, deposited upon, or dispersed in different ores, but frequently also of regular shape, as in cubes, in rhomboidal four sided truncated prisms, which sometimes terminate in dihedral summits, with triangular plans,—octohedral; the surface is generally striated.

When exposed in a close vessel, it sublimes and forms orpiment, leaving the iron behind.

Its matrix is spatous iron ore, fluor, quartz, blende.

It is found at Altenberg, Schneeberg, Freiberg, and Ehrenfriedersdorf in Saxony—at Joachimsthal in Bohemia—in Silesia—Tuscany, and on the Harz.

GENUS

## GENUS XVII.

SCHEELIUM, WOLFRAM, OR  
TUNGSTEN.

That this substance is a peculiar metal, was first discovered by Messrs. D'ELHUIJARS, in the year, 1783. Mr. Scheele extracted this metal from the ore, commonly called wolfram.

Its specific gravity has been variously stated by authors, by some as 17,000, and by others, less; this arose from the difficulty or successfulness which they experienced in obtaining the metal in a pure state. The metal has a reddish brown colour—a lamellar texture, and is of the hardness of bismuth; its superficial lustre is rather yellowish.

Vinegar is said to extract a blue colour, when digested with it, by heat. It is less fusible than manganese. Its oxyd is of an acid nature,



nature, of a yellow colour, and enters into combination with all metals.

It is soluble in sulphuric-nitric, muriatic, and nitro-muriatic acid, and is converted by them into an oxyd. The oxyd combines also with alcalies, but is precipitated again from them by nitric acid. The oxyd assumes a blue colour with the muriatic acid.

This metal is never found in nature in the metallic state, only in the state of calx, combined chiefly with calcareous earth, and with manganese and iron.

Its use is not yet known.

#### SPEC. I.

#### SPARRY TUNGSTAT OF LIME.

Swed. *Tungsten.*

Dan. *Tung-spat.*

Germ. *Schweer-stein.*

Ital. *Pietra della tungstein.*

Fr. *Wolfram de couleur blanche ou mine d'etain blanche.*

In this ore the metal is combined with oxygen and calcareous spar. It is white, yellowish white, and yellowish grey, and has a sparry appearance, is shining, and has a lamellar texture; it is semitransparent; it is found solid, dispersed, and crystallised, as in acute angular octahedrons, or double tetrahedral pyramids. Its specific gravity is = 6066. It decrepitates, when exposed to the action of the blow-pipe; it effervesces with soda, becomes blue when fused with microcosmic-salt, or phosphate of soda. Digested with muriatic acid, it turns yellow.

It is found at Schonfeld, in Bohemia; near *Schlackenwald*; and in Cornwall, according to Mr. Raspe's account.

It is often confounded with the white tin ore, as it is also found in tin mines.

## SPEC. II.

### WOLFRAM, OR MANGANESEOUS WOLFRAM.

Fr. *Tungstate manganésié*, also, *Ecume de coup*.

Ital. *Cicafro wolfram*.

This

This ore is chiefly composed of oxydated metal of wolfram—oxyd of manganese, occasionally a little iron and quartz.

Its colour is dark black; it has a metallic lustre, and a lamellar texture; it is brittle, and when pulverised, the powder appears brown; it is very heavy; its specific gravity being generally about 6,835.

It is very refractory in fire.

It is found in solid masses in the state of layers, intersected by quartz, or a talcous substance; seldom in the state of small particles interspersed, but oftener of regular shape, as in six-sided broad compressed prisms, terminating in dihedral summits, or by four facets. The crystals are generally longitudinally striated; when fused with borax, it produces a greenish glass.

It is found in England—Siberia—Zinnwald, in Bohemia—at Ehrenfriedersdorf, in Saxony, &c.

To this may be added, the substance called *Kalin*, by the Chinese, which is a mixture of wolfram, and white tin-stone.

## GENUS XVIII.

## URANIUM.

*URANITES.*

Germ. *Uran.*

This new metal was discovered by that excellent, and expert experimental chemist, Mr. Klaproth, in the year, 1790. He first separated it from the mineral, called in German, *Peckblende*. Its colour is deep grey, with a slight lustre; its specific gravity is = 6440; it is soft enough to be cut with a knife; it is soluble in nitric, and in nitro-muriatic acid, from which it cannot be precipitated by metallic zinc. When fused with glass flux, it occasions a light brown colour.

It has, as yet, not been found in the metallic state, but in the state of calx or oxyd, and mineralised

neralised by sulphur. Its use is not yet ascertained.

## SPEC. I.

## SULPHURISED URANIT.

Germ. *Pecherz*—*Pechblende*.

Its colour is iron, or brownish black, greyish and greenish black, sometimes variegated on the surface.

It has a dull appearance, and is brittle; when fresh broken, it is a little shining; its texture is conchoidal; it is found solid and dispersed, but not yet crystallised; it is seven or eight times heavier than distilled water; it emits sulphureous vapours when exposed to fire. It is found at Johannegeorgenstadt.

## SPEC. II.

## CALCIFORM, OR OXYD OF URANIT.

T 2

There

There are two varieties known.

VAR. 1. EARTHY OXYD OF URANIT.

Germ. *Erdiger Urankalch.*

Its colour is lemon, or brimstone yellow; it has an earthy texture; stains paper a little; when thrown upon red hot charcoal, it emits no sulphureous vapours. It is found solid—dispersed through, and deposited upon other ores.

This, and the following variety, are found in the mine Georg Wagsfort, at Johannegeorgenstadt, and Joachimsthal, in Bohemia.

VAR. 2. SPATOUS URANIT.

*Uranium spatosum.*

Germ. *Uranit-spath, or chalcolith, or verhärteter urankalch.*

It has an emerald, or grass green colour, and is generally found crystallised in cubes—

in

in four-sided plates, bevelled on the edges—and in hexahedral prisms. The crystals are semitransparent, and give a greenish white powder.

It consists chiefly of oxyd, or calx of uranit—carbonic acid, or fixed air, and a little copper, from which it seems to have obtained its colour.

Whether the mineral called manakanite, by Mr. Gregor, will yield a new metallic substance, the continued experiments of that ingenious philosopher, will, no doubt, some time or other inform us.

REFLECTIONS  
ON THE EXAMINATION  
AND MANNER OF DESCRIBING  
MINERALS.

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A Practical mineralogist, who is in the habit of examining different mineral products, may sometimes, with little difficulty, procure such knowledge of a mineral, as will enable him to distinguish it, and to place it in his collection, arranged according to his own fancy or conveniency; but it requires a little more attention to the subject, in order to describe a mineral substance, both as to appearance and distinguishing property, in a manner to be well understood by others, to whom such knowledge



knowledge is to be conveyed. This deficiency I have often felt myself; and in order to remove some of the deficiencies, I have attempted to trace out a plan which I now make use of, and which I have taken the liberty to propose to those Students, who intend to make application to that part of the Science of Mineralogy.

## SEC. I.

*TERMS of expressing, and a methodical arrangement of the manner which may be used in describing the general appearances and qualities of mineral products, as they occur to our senses; or in the order as they may be ascertained, to point out their characteristical marks and distinguishing qualities.*

If the mineral which is to be described, prove to be a substance not noticed before, it should be distinguished by a name, which either expresses its principle component parts, if they can or have been ascertained, or such a name as expresses its characteristical mark or property, by which it differs from other bodies.

There is little propriety, and no use in naming a mineral after the person by whom it is discovered, as has been often the case.

## SEC. 2.

*FORMAL of describing the appearances and qualities of a mineral.*

*E. g.* It is a white, solid, transparent, or opaque substance; it is shining, or hath a lustre; its shape exhibits a tetrahedral, short, compressed, or flattened prism, which terminates in both ends, in a tetrahedral, short, or obtuse pyramid, the sides of the pyramid proceed from the side edges of the prism. The surfaces of the prism are longitudinally striated. It is greasy to the touch, and is heavier than fluor.

Its specific gravity is = weighed in distilled water of 60° or ——— temperature of Fahrenheit, or ——— scale; as to its hardness, it scratches rock crystal, or ———; it strikes fire with steel, or with flint; or it is scratched by ruby or rock crystal, or ———; or its surface can be scraped by a hand knife, and the particles

particles separated by scraping, appear white or ———; it leaves a shining yellow, or ——— trace on the touchstone, or it stains paper. It is malleable, or brittle. It is flexible and elastic; its texture is streight or curved, lamellar, and it breaks in rhomboidal pieces. It has a disagreeable, or ——— taste; it is electric when rubbed or heated, or it transmits the electric matter when isolated; it is magnetic, or it is attracted by the magnet. It emits a sulphureous, bituminous, or ——— smell when rubbed, scraped, or ignited, or a clayey smell on breathing on it. It emits a phosphorescent light when scraped with a knife in the dark, or becomes luminous when ignited upon a red hot iron held in the dark. It is seemingly affected or altered by the atmosphere.

It is soluble in water heated to 212 degrees of Fahr. scale, in the proportion as to ———. When exposed to, or heated with the blow-pipe, it crackles and splits asunder; it is volatile, or fixt in an ignited crucible, and burns with a green or ——— flame. It swells before the blow-pipe, or fuses; it deflagrates with nitre or with charcoal, when thrown into an ignited crucible. It recovers (if metallic) upon charcoal when ignited by the blow-pipe; it fuses, is dissolved, or is only divided when fused

fused with soda, borax, or with microcosmic salt, either with or without effervescence or ebullition.

It makes glass when fused with soda or borax, and gives a blue or — colour to the latter. It is not acted upon, or it is totally or partly dissolved in nitric-muriatic, sulphuric or nitro-muriatic acid, with or without effervescence, when heated only, or without: the gas separated by the effervescence, is absorbed by lime water. The solution exhibits a green or — colour, and has a bitter or sweetish taste when saturated.

Its principle component parts, and their proportion to each other, if they have been ascertained by chemical analyses, are —; its usefulness for technical purposes to which it may be employed, as in potteries, &c. or for manure, if in sufficient quantities. The country, place and situation where it is found, and what its matrix.

In this list of expressions, I think I have mentioned an example of most of those appearances and marks which a mineral may exhibit, and of which one may take notice in the examination and description of minerals in general. For more variations, Vide Vol. I. from page 21 to 34.

The

The application of the afore-mentioned list, may be understood by the following examples :

E. g. Yellow transparent FLUOR SPAR.

It is a yellow, solid, shining, and transparent substance, resembling, in some respects, yellow transparent amber. Its regular shape is a cube; its surface is naturally smooth and polished; its specific gravity is = 3,144 weighed in distilled water of 60 degrees temperature, according to Fahr. scale; as to hardness, it exceeds that of common calcareous spar; but its surface can be scratched with a knife, and does not strike fire with steel. Its surface can be polished; it is brittle, and has a curved lamellar texture, and breaks in cubical pieces. It is not acted upon, or altered by the atmosphere, nor soluble in water. When suddenly heated, it crackles and splits asunder, and becomes luminous, emitting a phosphorescent light. It is fixed, and fuses in fire *per se*, and so with borax before the blow-pipe, without effervescence. It is not soluble, nor acted upon by nitric or muriatic acid. When reduced to powder, and mixed with an equal quantity of concentrated

concentrated sulphuric acid, it emits strong suffocating acid vapours, which corrode and dissolve glass, and the remainder becomes ferrous. It yields by decomposition, fluoric acid and calcareous earth. Its matrix is generally calcareous or heavy spar. It is found near Freiberg in Saxony, but not frequently. It serves for ornamental work. (*Its place in the systematical arrangement of stones, is to be ascertained by chemical examination, which I shall illustrate hereafter.*)

*Example of a Metallic Substance.*

E. g. GALENA, or sulphurised crystallised  
LEAD ORE.

It is a metallic substance; it exhibits the intermediate colour betwixt lead and steel, with a bright metallic lustre. It is solid, opaque, and heavy.

Its specific gravity is = 7000.

Its regular shape is a cube; as to hardness, it can be cut with a knife; it is brittle, has a lamellar texture, and breaks into cubical pieces; when ignited, it emits sulphureous vapours, crackles and fuses easily. When tor-  
rified

rified and freed from the sulphur, it leaves about 60 *per cent.* of calciform ore, which when ignited with charcoal, yields the metal.

It is soluble in muriatic or sulphuric acid, but when digested with nitric acid, the sulphur is separated, floating on the surface, and the metal is dissolved by the acid, from which it is separated again by muriatic acid.

It is generally accompanied by fluor, calcareous, or heavy spar, and is found in metallic gangues in Flotz Mountains.

### SEC. 3.

*Specimen of rocks composed of different substances, distinguishable by the appearance without chemical decomposition.*

E. g. A certain species of GRANIT of an irregular mixture of constituent parts.

It is distinctly composed of three different substances, which are blended and cemented together, without any regular order or equal proportion, and form a compact mass; two of the constituent parts discover a regular shape  
more

more or less perfect; and the third appears to have been the cement which exhibits no marks of a regular shape.

*Substance 1.* FELDSPAR.

It is a greyish, white, shining, compact, and opaque substance of a rhombic shape; it is less hard than quartz, but harder than fluor; it does not strike fire like quartz, at least in a much less degree. Its surface can be scratched with a knife. Its specific gravity = 2.500. It is brittle, and has a lamellar texture; it breaks in rhombic shaped pieces; it is but slowly acted upon by the atmosphere, and not at all by water. When exposed to the blow-pipe, it does not crackle; it is fixed, but fusible *per se* in a strong heat; it also fuses with borax without effervescence; it is acted upon by, and part of it is soluble in nitric acid, when heat is applied.

*Substance*



*Substance 2. MICA.*

It is a greenish and yellowish grey, shining, semitransparent, and light substance, apparently composed of hexahedral thin plates, or lamellæ, which are flexible and elastic.

Its specific gravity is = 2,500.

It is tough, soft, or greasy to the touch; it can be cut with a pair of scissars, and easily be divided into thin lamellæ; it is not acted upon by the atmosphere, or by water, and not readily soluble in the sulphuric, nitric, or muriatic acid. When exposed to the action of the blow-pipe, it does not crackle, nor fuse *per se*; it is divided into smaller particles by soda, by means of the blow-pipe.

*Substance 3. QUARTZ.*

It is a milk white shining, solid, and semitransparent substance. It exhibits no particular shape; its specific gravity is = 2,680. It is very hard, and strikes fire with steel, and is harder than glass; it can be scratched by ruby, but  
not

not with a knife. It is brittle, and breaks in acute angular irregular pieces. It has a conchoidal texture; it is not acted upon by the atmosphere, or by water, or by any acid, except the fluoric acid, in which it is mostly soluble. When exposed to the action of the blow-pipe, it cracks; by a strong fire, it is not fusible *per se*, and is permanent. It fuses with soda and potash, with which it makes glass, and with a larger portion of potash, it makes also a glass, but which deliquesces by absorbing moisture from the surrounding atmosphere, and takes the appearance of a jelly. It incloses the two aforementioned substances, like a cement.

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ESSAY,

OF A

METHOD *for examining* MINERALS,

*By which we may be enabled to ascertain the distinguishing characters, and principal prevalent component parts, of a mineral substance; and to determine thereby, the class, division, order, genus, and species, to which it may accordingly belong, and be placed in the systematical arrangement, which I have adopted. This method will be found applicable by those who are acquainted with the rudiments of chemistry.*

**A**S many mineral substances are subject to undergo alteration, and mixture, whereby their appearance, and part of their qualities is

VOL. II.

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altered;

altered; and as likewise many minerals bear some resemblance to one another; it becomes sufficiently obvious, that very little can be expected and depended upon, from the appearance of minerals, in ascertaining and classifying them; and as there are several instances that have happened, even to old professors of mineralogy, who have been misled by the appearance, the more imperfect must such marks be for beginners in this science.—We must therefore have also recourse to such characters of minerals as are more constant, and may be easily ascertained.

## MINERAL SUBSTANCES IN GENERAL,

ARE DIVIDED

*Into four general Classes.*

1. Into SALTS.—2. EARTHS and STONES.
3. METALLIC SUBSTANCES, and—
4. COMBUSTIBLE BODIES.

We shall begin with distinguishing the first class, comprehending salts, which are the most  
simple

simple and easiest to be ascertained, and which are found in the earth in a concrete state.

## EXP. I.

We examine a substance whether it is soluble at least in 30 times its weight, or less, of distilled water of a moderate temperature, between 100 or 120 degrees, indicated by Fahrenheit's scale, whether it crystallises on evaporating the filtered solution, and the crystals do not burn with a flame, when thrown into an ignited crucible; it then belongs to the salts, which constitute the

## 1st CLASS.

## EXP. I.

We then have to ascertain the order to which it may belong. For that purpose, we first try, whether when dissolved in water, it changes the litmus paper red, or whether it occasions an effervescence with mild potash, (that is, potash containing fixable air) and if

U 2

when

when neutralised, or saturated with potash, no copious precipitate is produced, it is  
 ORD. I. distinguished to be an uncombined  
 ACID, which characterises the first  
 order in the class of salts, not neutralised.

### EXP. II.

We then have to ascertain the species. If it is soluble in spirits of wine, and can be volatilised by heat, we then have ascer-  
 SPEC. I. tained it to be the BORACIC ACID, and thus the first species.

### EXP. I.

If a saline substance dissolved in water, changes the blue colour of an infusion, or syrop of violets green, and the yellow turmeric paper brown: if it effervesces with nitric acid, or neutralises it; if it decomposes the solution of sulphate of magnesia, or alum, it is then distinguished to be an ALKALINE  
 ORD. II. SALT, and thus comes under the second order of salts, which are not neutralised.

EXP.

## EXP. II.

We then have to ascertain by its other properties, the species under which it is known.

If it does not diliquefce, when long exposed in a moist atmosphere; if, when saturated with muriatic acid, and evaporated, it is found not soluble in spirits of wine; if it is not volatile by heat; it is then distinguished to be **SODA**, or **MINERAL ALKALI**.

## EXP. I.

If a saline substance is found not to effervesce with acids, or with alcalies, or to change the colour of turmeric paper, it is then distinguished to be a neutral, or a compound salt, composed of an acid, and another basis, which are comprehended under the second general divisions of salts.

By these salts we have first to ascertain the order to which they may belong.

## EXP. II.

A little of the salt is dissolved in distilled water, and a few drops of a well saturated solution of prussiate of soda or potash, are added, if a copious precipitate takes place, and likewise with mild soda, it then turns out to contain metallic parts, and belongs to the salts called METALLIC SALTS, which constitute the first order of the neutral salts.

## EXP. III.

Next we have to determine the genus to which it belongs, by ascertaining the acid by which its basis is neutralised; for this end, we add to a little of the saturated saline solution, an equal portion of spirits of wine; if this occasions the salt to separate, and if a few drops of muriate of baryt, added to a little of the dissolved salt, occasion a copious precipitate, we then know, that the acid is sulphuric acid,  
and



and that the salt belongs to the genus called SULPHATES, of the GEN. I, metallic salts, which is the first genus of the first order of neutral salts.

## EXP. IV.

Lastly, we have to ascertain the basis, or with what kind of metallic oxyd, that acid has combined, by which we determine the species; for this purpose we add SPEC. first liquid mild ammonia to it, if this occasions a blue precipitate, which is redissolved again, by a greater portion than what is necessary to saturate the acid, we then place a small narrow and polished plate of iron, into the dissolved salt, which is put into a narrow wine glass, and let it stand for a little while; if the surface of the iron plate becomes covered with reddish metallic particles, then we have found that the salt had copper for its basis, and this being neutralised with the sulphuric acid, which was before ascertained, makes it to be that species SPEC. I. which is called SULPHATE OF COPPER.

This salt exhibits also a blue colour, which may be considered as one of the marks by which it may be suspected.

#### EXP. V.

But if these phenomena are not perceived, and the salt has a greenish hue, we add a few drops of prussiate of soda to the dissolved salt, when this occasions a copious blue precipitate, the basis is then supposed to be iron, and in this case, it also must produce a black colour, when mixed with infusion of galls. Thus we have ascertained the component parts which characterise it to be that species called

SPEC. 2. SULPHATE of IRON, or MARTIAL VITRIOL.

#### EXP. VI.

If neither of these phenomena is observed, and it exhibits a rose colour, we add a few drops of infusion of galls; if this occasions a blue precipitate, and occasions a precipitate with potash, which when fused with  
borax

borax before the blowpipe, produces a blue glass, we then have ascertained the basis of the salt to be cobalt, and this combined with the sulphuric acid before ascer- SPEC. 3.  
tained, makes it to be that species,  
called **SULPHATE of COBALT.**

**EXP. VII.**

But if neither of these marks is perceived, and the salt being white, we place a polished plate of copper into the dissolved salt, and this occasions a white metallic precipitate upon the surface of the copper, which can be volatilised again by ignition, and fresh lime water being added to a little of the saline liquor, occasions an orange yellow precipitate, we then know the basis to be mercury, having ascertained the principle component parts of the SPEC. 4.  
salt, which is distinguished by the name of **SULPHATE of MERCURY.**

**EXP.**

## EXP. VIII.

If the salt does not prove any of these mentioned properties of mixture, and it be a white salt, if prussiate of alcali added to it, produces a precipitate of a greenish white hue, and if, iron and copper placed in the solution, occasion no precipitate, we then suppose the basis to be zink, and consequently, the SPEC. 5. substance to be the species called SULPHATE of ZINK.

These are, as far as I know, all the metallic salts which have hitherto been found in the earth.

## EXP. I.

If the salt to be examined, is found to be of a different nature, we have then first to ascertain what order it constitutes, and for this end, we first add a solution of mild potash, or soda, and observe whether a copious precipitate takes place, if not, then the salt ORD. II. belongs to the ALKALINE NEUTRAL SALTS, which are comprehended under the second order of neutral salts.

We

We have next to examine the acid by which its basis is neutralised, and hence we ascertain the genus under which it may be comprehended, in our order for this purpose.

## EXP. II.

We first add a few drops of muriate of baryt, if this occasions a copious precipitate, and if spirits of wine added to a concentrated solution of the salt, occasion a separation of the salt, we then know, that the neutraliser is sulphuric acid, and consequently, the salt belongs to that which comprehends those salts called **SULPHATES** of **ALKALINE SALT**, and which constitutes the second order of the neutralised salts. GEN. I.

## EXP. III.

Next we have to determine the basis of the salts, by which the acid had been neutralised, and hence we ascertain the species; for this end, we mix an equal portion of pure lime, commonly called quicklime, or we may add pure  
or

or caustic potash, if it occasions a volatile, pungent, or strong sensation to the olfactory organ, the basis is then proved to be SPEC. I. ammoniac, commonly called volatile alkali, and the salt constitutes that species of alkaline neutral salt, distinguished by the name of SULPHATE of AMMONIA.

#### EXP. IV.

If the salt belonging to the second order, does not occasion a precipitate, on adding nitrate of baryt; and if it does not occasion a copious precipitate, when sulphate of silver is added to its solution, it is then supposed, that its basis is neutralised by nitric acid, and that it thus belongs to the genus called NITRATES.—In order to ascertain the species.

#### EXP. V.

A little of the salt is thrown into a red hot crucible, and observed whether it deflagrates

grates or dissipates, if not, it is then mixed with charcoal, and thrown into an ignited crucible, if it deflagrates, it then proves to be common nitre, or NITRATE SPEC. I. of POTASH, which constitutes the first species of the NITRATES.

## EXP. VI.

But if this salt produced no precipitate with the nitrate of baryt, but occasioned a copious precipitate, when mixed with the sulphate of silver, it is then proved, that the basis is neutralised by muriatic acid, and consequently, constitutes the genus, GEN.III. which comprehends the species called MURIATES.

## EXP. VII.

In order to ascertain the species, a little of it is mixed with pure lime, or caustic potash, and rubbed together in a stone mortar, with a little moisture; if it emits an elastic matter, which affects the olfactory organ strongly, if  
it

it precipitates a solution of platina, and if it is volatile when strongly heated in close vessels, it then proves that the basis of the SPEC. I. salt is ammonia, and constitutes the species called MURIATE of AMMONIA.

### EXP. VIII.

But if these phenomena are not perceived, and if it is not soluble in spirits of SPEC. 2. wine, the basis is then supposed to be soda, and constitutes the species called MURIATE of SODA.

### EXP. I.

If the salt to be examined, occasions no precipitate, by adding prussiate of alkali to it, nor any with metals, but a copious precipitate with a solution of mild potash or soda, it proves then to have an earth for its basis, and consequently, belongs to the third order, namely, the EARTHY NEUTRAL SALTS.

EXP.



## EXP. II.

In order to ascertain the genus, we must determine the acid by which the earth is neutralised; for this purpose, we first dissolve the salt in distilled water, as usual, and add to a little of it, a few drops of muriate of baryt, if this occasions a copious precipitate, and if spirits of wine occasion a separation when added to the solution, we then GEN. I. know that the neutraliser is sulphuric acid, which constitutes the genus called SULPHATES.

## EXP. III.

We next proceed to ascertain the earth, or its basis, to determine the species. There are two species of sulphates of earths found; the one contains a superabundant acid, affecting the colours of litmus paper, having an astringent taste, and when added to an infusion of certain vegetable substances, which contain much colouring matter, such as logwood,  
and

and the roots of the *rubia tinctorum*, its earthy basis is partly precipitated along with the colouring matter; and when the salt is decomposed by a solution of potash, the thus precipitated earth when calcined a little, becomes

afterwards insoluble in acetous acid, SPEC. 1. and also in diluted nitric acid. This species containing the argillaceous earth, is called ACIDULOUS SULPHATE of ALUMINA, or ALUM.

The other species has a bitterish taste, and has not that property of separating the fine colouring matter from vegetables. It is perfectly neutralised. Acid of sugar, or concentrated sulphuric acid added, forms no selenite; and when the salt is decomposed by a solution of potash, the earth thus separated, SPEC. 2. when calcined, remains soluble in nitric and acetous acid; and when rubbed with moistened rhubarb powder, it changes its colour reddish; this earth is called magnesia, and the salt, SULPHATE of MAGNESIA.

In this manner, we may ascertain the different salts which have hitherto been found amongst the mineral products. There are other salts found, contained in mineral waters, but they are generally mixed with several kinds

kinds of salts, and must be ascertained in a different way.

The salts which I have treated of, are only such as are found each in a separate state, and which appear homogeneous when crystallised.

We now proceed to the mineral products, which constitute the second CLASS, including in general, those mineral substances which are chiefly composed of earths.— They are not soluble in water, in the proportion like the perfect salts; their earthy component parts, when in a separate state, show hardly any, or no disposition to fuse *per se*, even after having been ignited with charcoal; nor do they produce fixed air, when ignited with charcoal, in close vessels, after having been ignited *per se*. They are not inflammable *per se*, nor consumable in fire, nor have they a metallic lustre, and their specific gravity never exceeds five times that of distilled water. All the substances belonging to this class, we shall divide into nine different genera, according to the nature of their prevalent component parts.

The earths which constitute the principal component parts of each of these genera, have been ascertained to differ from each other, in

certain properties, as mentioned in the beginning of the first volume.

But as we find that many substances belonging to either of these genera, bear some resemblance to each other, I have endeavoured to trace out some marks and properties, by which we may be enabled to ascertain certain mineral substances, (without resolving them into all their constituent parts) so far as to bring them under certain divisions, and in order to facilitate the investigation of a substance, which may occur to those who are beginners in the study of mineralogy, and who wish to arrange minerals in a systematical manner, according to the arrangement which I have now adopted.

I shall begin with those genera, which comprehend such substances, as on account of their superior degree of hardness, or coherency, &c. are least liable to natural decomposition, or alteration, and which are least acted upon by the nitric, muriatic, and sulphuric acid, and thereby distinguishable from the other six genera.

There are two substances lately ascertained, which turn out to contain an earth for their principal component part, differing from the other earths; but as these substances in their  
combined

combined state, bear some resemblance to certain substances belonging to the genus called the siliceous genus, and as these are very scarce and seldom occur, and there being only one species of each as yet known, we may therefore for the present, satisfy ourselves with the description which I have given of them, in the first volume, page 56 and 57, mentioning those marks by which we may distinguish them.

The first genus, the ZIRCON GEN. I. follows in hardness the saphyr, hyacinth and emerald, but is harder than rock-crystal, and in specific gravity, it exceeds all other stones which are of the same hardness; it is not fusible *per se*, in fire, nor acted upon by acids, nor soluble by soda. Its regular shape is the octahedron, but the tetrahedral pyramids on each end are separated by a prism. The principal earth of which it is composed, is found soluble in sulphuric acid, and the solution exhibits on evaporation, a gelatinous mass.

The other substance which constitutes the ADAMANTINE GENUS, GEN. II. is equal to the foregoing as to hardness, but it has a sparry appearance and texture, and differs also from the other stones which resemble

it, as to hardness and refractory nature in fire ; it is not so transparent, and only slightly semi-transparent, as far as I could observe of the various specimens, which are in the valuable collection of the Right Honourable Mr. Greville. It is not acted upon by the sulphuric, nitric, or muriatic acid, and has altogether a different appearance from the other stones, which it resembles as to specific gravity and hardness.

I shall now trace out some marks, and the qualities of those substances, which we may bring under certain divisions or sections, belonging to the siliceous genus, not the most accurate, because they may, according to certain analyses, contain not all a prevalent portion of the siliceous earth, but because their other appearances and quality coincide more with those in which the siliceous earth is found to predominate. If, for instance, the substance which is to be examined, is a very hard body, but differs from the appearance and quality of the two before mentioned substances, we then examine, whether it has all the appearances and qualities which are mentioned asunder, and which all those substances exhibit, as are comprehended in either of the sections of the siliceous genus.

SILICEOUS

## SILICEOUS GENUS. GEN. III.

## SECT. I.

They are transparent, have a colour and vitreous appearance, and a high lustre; they scratch rock crystal; their specific gravity exceeds three times that of distilled water of 60° temperature of Fahr. scale, which is taken for a standard as 1,000. They are not fusible *per se*, in a heat = to that required for fusing iron. They are not acted upon by the sulphuric, nitric, or muriatic acid, even when heat is applied in their entire state; they are not sensibly diminished by fusing them with soda.—Such are for example: *Saphyr*—*Ruby*—*Oriental Topaz*—*Hyacinth-chrysolith*, and *Beryl*.

## SECT. 2.

They are also transparent—are of an inferior specific gravity, not fusible *per se* in a heat = to that required for fusing copper; they are scratched by the ruby, but they

X 3

scratch

scratch flint and petrofilex, and strike fire with steel. They are not sensibly acted upon when entire, by the aforementioned acids. They effervesce with soda. Such are e. g. *Emerald—Olivin Rock Crystal*, and the *Transparent Quartz*.

### SECT. 3.

They are more or less fusible *per se*—they are scratched by rock crystal (except the perfect garnit)—they scarcely strike fire with steel; they scratch heavy spar and fluor spar—they are more or less inclined to opacity, and if they are more transparent, they all fuse or melt easily *per se*, by means of the blow-pipe, and may be further ascertained by the external appearance, &c. by which the different species differ from each other. They all exhibit a regular shape, or marks of it when entire.—They are more or less acted upon by the three aforementioned acids, when heat is applied, and when previously reduced to small particles—Such are—the *Garnit—Skorl-Zeolith*, the *Semitransparent Feldspar*, and *Horneblende*.

SECT.



## SECT. 4.

They are semitransparent in different degrees—they do not fuse *per se* in the heat which those of the third section fuse in—most of them strike fire with steel. They are not, or at least very little acted upon by acids. They have a cloudy or milky appearance. They exhibit no perfect crystallisation, or regular shape, or at least seldom—they are all less hard than rock crystal—they are not opalescent, or do not reflect light in different colours, e. g. *Calcedony Flint — Cornelian — Crysoprase — Solid Amorphous Quartz, and Shade.*

## SECT. 5.

They are opalescent, or reflect different colours on account of their peculiar texture; they are only semitransparent; they do not strike fire with steel, and their surface can be scratched by rock-crystal and calcedony. They become opaque in fire, and are a little acted

upon by acids when assisted by heat, e. g. *Opals*  
*Catseye*.

N. B. The *Labrador spar*, and *Adularia*, exhibit also these marks of opalescency; but these, with regard to their other qualities, belong more properly to the fieldspars.

#### SECT. 6.

They are of the hardness of calcedony, and more or less semitransparent; they are generally found in nodular pieces of no regular figure; they exhibit distinct clouds or stripes of different colours or shades—the stripes are rectilinear and parallel, or concentric, or otherwise curved, e. g. *Agats*—*Onyxes*—*Sardonyx*, &c.

#### SECT. 7.

They are opaque; strike slightly fire with steel, and when reduced to fine powder, and boiled with concentrated sulphuric acid, the acid becomes partly saturated, and when mixed with water, leaves on evaporation, alum or  
acidulous

acidulous sulphat of alumina, e. g. *Jaspers*  
*Pétrosilex*—*Basaltes*.

Neither of these mentioned species has a distinct foliated texture, nor are they elastic;—they are all more or less brittle, and do not adhere to the tongue, nor do they discover any clayey smell when breathed on (except the hornblende) nor do they neutralise potash when melted or boiled with it.

#### SECT. 8.

There are others which possess more properties of those substances which are comprehended under the Siliceous Genus, than of those which belong to the Argillaceous Genus, with which they are generally ranked on account of the prevalent component parts, but they differ from the other substances of the Siliceous Genus, in having a distinct foliated texture, which may be easily divided into thin leaves, which are flexible and elastic—they are not readily acted upon by acids, and do not strike fire with steel, e. g. *Mica*; and these may therefore constitute a separate Section.

(Many

*(Many other stones, or stony substances, may properly belong to the Siliceous Genus, but consist of different substances which have not intimately combined together, and which are only blended, cohering by simple attraction or power of cohesion; or they are cemented by other heterogeneous substances. These substances generally form rocks, and are to be separately examined, and treated.)*

If we find that the substance to be examined, does not exhibit the appearance and properties of the substances which were distinguished in the foregoing Genera, we then proceed to compare the appearance and qualities which characterise it to belong to another Genus of earthy substances, namely, **GEN. IV.** to the next Genus in our Order.

### ARGILLACEOUS GENUS.

Substances which we shall comprehend under this Genus, may be distinguished by the following general appearance and qualities :

They

They are almost entirely destitute of transparency; they exhibit no regular shape, or they have no crystallised appearance; they have mostly an arid and opaque appearance, and no particular or vitreous lustre like those of the foregoing genus. They emit all a peculiar smell when breathed upon, a smell, which we commonly distinguish by the name of a clayey smell; they are all more or less acted upon by acids, and the sulphuric acid extracts the argillaceous earth, of which they are mostly composed, in the state of alum. They are naturally not hard—none of them strike fire with steel—and their surface can be scratched with a knife, with fluor spar—and many of them suffer impressions by the nail of a finger; they become all hard, and more tough in fire; the softer kinds absorb water rapidly, and retain it strongly; but when exposed to a very intense heat, they contract, and many of them, particularly those of the purer kind, become so hard, that they strike fire with steel.

*There are other substances which are of a harder nature, and which form whole rocks, or part of rocks; but these being more of a heterogeneous nature, they are to be examined and distinguished by the means which I shall mention in the divisions of different rocks.*

If

If a substance is found, whose appearance and properties coincide, or at least nearly, with the description above mentioned, we then have to ascertain whether it may properly belong to this genus, respecting its prevalent earthy constituent part. For this purpose we take a small quantity of the substance, which is to be examined, and expose it in a crucible, with a smooth surface, and made of clay (such as are made at Mr. Wedgewood's manufactory); the crucible is then put into a furnace, and gradually heated, until the crucible and the substance become just red hot. It is then taken out and reduced to a fine powder. Two hundred grains are then put into a glass matrafs, and digested with nitro-muriatic acid, as long as the acid takes up any of the substance; the whole is then put upon a filtre, and the residuum collected, dried, and heated in the aforementioned way, and its weight ascertained.— It is marked A.

The solution is then mixed with prussiate of lime or soda, until no more precipitate ensues; the precipitate is then likewise collected upon a filtre, dried, and its weight ascertained, and marked B. it is the metallic part. The filtered liquid is then mixed with a solution of soda, until no more precipitate is perceived.

This

This is then likewise collected, and washed upon a filtre, and is then nearly dried and put into a matrafs, and digested with strong sulphuric acid, as long as it is found to take up any of the substance; the whole is then put upon a filtre, and washed with warm water, mixed with a little spirits of wine; the filtered liquor is then diluted with water, and the earth all separated from it, by adding a solution of potash to it; the precipitate thus produced, is again collected upon a filtre, and deprived of the saline parts by washing it upon the filtre with a little warm water, it is then dried and put into a crucible, and ignited for half an hour, after which it is taken out, put into a glass matrafs, and digested with two or three ounces of distilled vinegar for several hours; after this, the whole is put upon the filtre, and washed with a little water; the residuum is dried and heated, and its weight ascertained.— Its weight must exceed the half of the quantity of the substance which was thus examined; it is then the argillaceous earth, and the substance belongs thus to the Argillaceous Genus.

In order to bring the substances which belong to the Argillaceous Genus, under certain divisions, we must particularly attend to the texture,

texture, coherency, tenacity, hardness, and specific gravity, sensation to the touch, to the quantity of moisture which they absorb, and the retentive power useful for the examination of soils—to the taste—to the degree of smell which they emit when heated, and the alteration they undergo by different degrees of heat, whether they occasion a deflagration when mixed with nitre, and thrown into an ignited crucible—and to the proportion in which they are soluble in sulphuric, muriatic, and acetous acid, and the proportion of iron they contain, and in what state, and the mixture and proportion of heterogeneous bodies. If we find that a substance does not coincide with all or most of those marks and qualities, we then compare it with the characters of bodies which are comprehended under another Genus, namely, the

## MAGNESIAN



## MAGNESIAN GENUS. GEN. V.

The substances which belong to this genus, may be distinguished as follows :

As to appearance, they have almost all a more or less glittering or shining surface, seldom, if at all, an earthy appearance, except the earth which constitutes the principal component part of the substances belonging to this genus, when in a pure and uncombined state. They hardly ever exhibit a regular crystallised shape. Their texture is generally scaly or lamellar, fibrous, filamentous, lignious, or shivery, seldom they have an even texture, and seldom more than a semitransparent one, they are generally inclined to opaque. Their substance are almost all more or less smooth and soft, or soapy to the touch ; they do not generally adhere to the tongue, nor stain the fingers.— They may be cut with a knife, or with a machine ; they do not soften in water like clay ; they discover no clayey smell by breathing on them ; they do not generally exceed in specific gravity the rock crystals, but are commonly  
light.

light. They do not, or very seldom, effervesce with acids; but they are more or less acted upon by them, when reduced to powder, and boiled with the sulphuric acid; the acid then extracts the magnesian earths, and becomes thereby neutralised, forming a salt which has a bitterish taste, which has no disposition for deliquescency, and differs from alum as the salt, which is extracted from argillaceous substances by that acid—has an astringent taste, and contains generally a super-abundant portion of acid; the crystals of alum are also much harder, and when broken, have a more vitreous appearance.—The magnesian substances do not contract, or harden, or fuse in fire like clays, except they are mixed with siliceous matter, in which case they melt, or when mixed with any of the other earths; they do not effervesce with borax before the blow-pipe, and they give a milky appearance, and diminish the transparency of other vitrifiable stones or mixtures; they are not soluble in soda, nor produce glass with potash by fusion when freed from siliceous matter. When exposed to a strong heat and cooled, they are not soluble in water, nor emit heat like the calcareous stones. They do not discover any acid when fused with potash, like some substances  
belonging

belonging to the calcareous genus, viz. *Selenite*. These are the most general marks and qualities which the substances of the genus exhibit and possess.

In making different divisions of the various substances belonging to this genus, we must notice the texture, coherency, hardness, tenacity, the different degrees in which they are affected by different acids, and the proportion in which they are soluble, as well as the substances left behind by digesting them with acids, and the alteration they undergo in fire.

There are other stones belonging to this genus, which exceed all the other substances of the genus, both in hardness and gravity; but they form rocks, and come therefore under that head.

We then come to the examination of those substances which differ from all those mentioned, and which belong to another genus.

### *The* CALCAREOUS GENUS. GEN. VI.

The substances which this genus comprehends, contain calcareous earth as their principal component part; but this earth is

frequently found blended or combined with different substances which alter its appearance and quality greatly, and hence we find it difficult to bring the subjects under one general head. I shall therefore endeavour to point out the way, and the order in which they may be examined and ascertained; I mean such as may be brought under certain sections. We shall for that purpose divide this genus, 1st. into such substances as are readily soluble in nitric acid, with more or less effervescence; 2d. Into such as are not soluble in nitric acid, or at least more difficult than the foregoing, and which do not effervesce, and which have at the same time, almost generally a sparry appearance.

In order to ascertain those which belong to the first general division, we proceed in the following way :

1st. The substances which we find to effervesce with nitric acid, and to be soluble in it, and which are either of an earthy or of a sparry texture; these we have to examine whether they contain calcareous earth, as there are other substances which may resemble the calcareous substances in some appearance and quality; for this purpose we take a little of  
the

the nitrous solution, and dilute it with about 24 times the bulk of distilled water, and add gradually diluted sulphuric acid to it; if a copious precipitate is produced, we then know that the substance contained baryt earth; but if none or hardly any precipitate is thus produced, we then take another portion of the saturated nitrous solution not distilled, and add gradually concentrated sulphuric acid to it; if this occasions a copious precipitate, we then know that the substance contains calcareous earth, and may thus belong to the calcareous genus, and to those calcareous substances, which are combined with fixed air. In order to ascertain whether it may properly belong to this genus, we must ascertain the proportion in which the calcareous earth is contained in it, as it may be mixed with other earths. For this purpose we take a certain portion, *e. g.* 200 grains, these we digest with nitric acid, as long as the acid will take up any of the substance; we then filtre the solution, and collect the residuum upon the filtre, dry it, and weigh it—marking it A. After this we dilute the solution with 24 times the bulk of distilled water, and add gradually diluted sulphuric acid, as long as any precipitation ensues; when no more precipitation takes place (or perhaps

none); we then filtre the solution, and collect the precipitate upon the filtre, dry it, and ascertain its weight, and mark it B.

We then add as much of a solution of mild soda to the liquid, as any precipitation takes place—it is then put aside until the precipitate has subsided to the bottom of the glass vessel (the vessel may be of a conical shape, narrower at the bottom); we then decant the clear liquid, and wash it repeatedly out with warm water, until it discovers no more saline taste. After the water is nearly separated from the precipitate, we then add again as much concentrated sulphuric acid, as is necessary to saturate or neutralise the earth; after this, the whole is to be mixed with a mixture of three parts of distilled water, and one part of spirits of wine, in the proportion of 8 parts of this mixture to the quantity of the substance which was before dissolved in nitric acid; this mixture will dissolve all the saline parts, and leave the selenite or sulphate of lime behind, which is then collected upon a filtre, and edulcorated with a little of the same spirits of wine and water. The residuum upon the filtre is then well dried, and its weight ascertained, and is marked C.

The

The saline liquor which passed through the filtre, is now saturated and decomposed by a solution of mild soda, the precipitateedulcorated with water, well dried, and its weight likewise ascertained, and marked D. Now if the substance thus examined belong to the calcareous genus, the third part of the weight of the selenite marked C. must exceed the weight of the remainder A. and of the precipitate B. and D. together.

If the substance which is found mostly soluble in nitric acid with effervescence, bear a sparry crystallised appearance, it may be nearly distinguished by the specific gravity, as the barytic spar exceeds in specific gravity that of the calcareous; the specific gravity of the aerated barytic spar, is always found to be above 3,000; and that of the calcareous spar, always less than 3,000, however, for the sake of accuracy, the analysis may be performed.—The calcareous substances thus ascertained, may then be divided again, according to the different texture, shape, and mixture. Some kind is found impregnated with bitumen or petroleum.

*Other substances which are found not, or not easily soluble in nitric acid, and which have a regular shape or a sparry texture, and which can be scratched or scraped by the knife, and whose specific gravity is under 3,000; such we may examine in the following way:*

A. If the substance has a fibrous or a lamellar texture, or is crystallised, and the crystals are not cubical;

If its surface can be scratched by fluor, and scraped by a knife;

If it does not easily fuse or melt;

If its specific gravity is between 1,600, and 2,000;

If, when reduced to fine powder, and boiled in 500 parts of distilled water, it is found soluble, and the solution occasions a precipitate when mixed with nitrate of silver; and if ignited with potash, it neutralises the potash, and forms sulphate of potash; and if the residuum is then found to be calcareous earth; the substance is then ascertained to be sulphate of lime, commonly called *Selenite* or *Gypsum*, which may constitute a separate division of the calcareous stones.

B. If



B. If the substance has a cubical figure or fibrous texture ;

If it fuses easily *per se* ;

If it is not at all acted upon by nitric acid ;

If it emits strong suffocating vapours, which corrode glass when mixed with an equal portion of strong sulphuric acid—and heated ;

If it is not soluble in 500 parts of water ;

If its specific gravity is about = 3,144.

If it crackles and splits asunder, when suddenly exposed to a strong heat, and emits a phosphorescent light when ignited upon a red hot iron. If it scratches selenite and calcareous spar, it then is ascertained to belong to the calcareous substances combined with the fluoric acid, commonly called *Fluors*, which constitute another division of calcareous stones.

C. If the substance is partly soluble, when reduced to powder, and digested with pure nitric acid ; and if the solution, when saturated, is precipitated by adding nitrate of lead.

If it is fusible *per se*.

If it does not crackle when first exposed to the blow-pipe, like fluor ; and if it emits luminous sparks when scratched with a hand knife in the dark ; and its specific gravity is = 3,218, it then discovers the marks and properties of the phosphate of lime, called *Appatites*, which

belongs to another division of calcareous stones.

D. If a substance is fusible *per se*;

If it has a cubical figure with the angles or the edges, or both truncated;

If it does not crackle when suddenly exposed to heat;

If its specific gravity is about 2,560.

If it is partly soluble in nitric acid, when previously reduced to powder, and digested with it by heat; and when the solution saturated, and decomposed by a solution of alkali, the remaining liquid mixed with concentrated sulphuric acid, and evaporated to dryness by a gentle heat, then digested with spirits of wine filtered, and the spirits of wine evaporated; if then a salt is left behind, which turns the litmus paper red, then the substance exhibits the properties of borat of lime, called *Boracit.*

E. If a substance is found by examination to contain calcareous earth, distinctly blended with other substances, it comes then under the head of rocks, or other blended stones.

BARITIC

## BARITIC GENUS. GEN. VII.

The solid substances belonging to this class, are particularly distinguishable by their superior specific gravity, in which they exceed almost all other stones which are now known, and which are only of such hardness as will admit of being scratched with the knife; they emit no smell when breathed upon; they do not easily vitrify *per se*, nor with soda, and have a sparry appearance; they are less hard than quartz. All substances belonging thus to this genus, may be divided into two general sections. The one A, is totally soluble in nitric, and muriatic acid, but almost only when in the diluted state; they are not acted upon by sulphuric acid; when dissolved in nitric acid, the earth or basis can be separated from that acid, even when the solution is diluted with 24 times the quantity of distilled water, by diluted sulphuric acid. The earth when pure, and strongly ignited in a crucible, becomes very little soluble in water. When dissolved in nitric, or muriatic acid, and neutralised, it yields crystals on evaporation, which are not disposed to deliquesce like the earth of the  
afore

above mentioned three genera. The specific gravity of these sparry substances, is above 4,000. The other section of solid substances belonging to this genus, have a lamellar texture; their specific gravity is likewise above 4,000, or at least near to it. They are not acted upon by any acid; when fused with borax, they immediately discover a phosphorescent light. They are not soluble in 500 times the quantity of water.

They neutralise potash when fused, or strongly ignited with it in a crucible, and form thereby sulphate of potash, leaving an earth behind, which is soluble in nitric and muriatic acid, and which possesses the properties mentioned in the foregoing section.

The substances thus ascertained to contain baryt earth, must likewise contain a prevalent portion of that earth, to belong properly to this genus.—The different species may be distinguished according to the texture, shape, and mixture.—There is another substance lately found, whose principal basis proves to constitute a new genus of earth, which has some resemblance to the baryt earth, it is called

## STRONTHIONIT GENUS. GEN. VIII.

Of this genus, there is but one species as yet known. Its specific gravity is above 3,000; it is soluble in 800 parts of warm water. It is soluble in nitric acid of the specific gravity 1,300, or 1,200, with effervescence; also in the muriatic acid, and its basis can be precipitated from these acids, by diluted sulphuric acid, to which it has an inferior chemical attraction than baryt, but a stronger attraction than calcareous earth; when strongly and sufficiently heated, it loses its fixed air, and does afterwards no more effervesce with nitric acid.

When dissolved in acids, and precipitated again by a solution of potash, and strongly ignited, the earth is then soluble in water of 70 temperature, in the proportion at least, of 1 to 180, but much more so by boiling water, and in the latter case, part of the earth separates in the state of crystals, which are again soluble in water. Crystals procured from this earth, by the combination with nitric acid, detonate in an ignited crucible, and  
the

the earth fuses with an equal part of silica. The earth when strongly ignited, and mixed, when cooled, with cold water, emits a greater heat than baryt earth, and has a stronger attraction for fixed air than baryt, as Mr. Kirwan has observed.

Several of these mentioned, and other properties of this peculiar earth, have been observed by Dr. Hope, who has communicated to the public, an extract of his ingenious paper, in the last volume of the Edinburgh Transactions.

The next class of mineral products, includes the metallic substances. How these are to be distinguished from each other, and from other substances, I have already endeavoured to explain in this volume, and which, as well as the rest of this work, I shall endeavour to improve by prosecuting the plan, of which I have given a sketch in this appendix; and which I shall communicate in a supplement to this work.

OF  
ANALYSIS  
OF  
MINERAL SUBSTANCES  
IN GENERAL.

**I**N the examination of minerals we find sometimes earthy substances which contain different salts, blended or mixed, and partly in the state of such small parts, that their proportion to each other, cannot be determined by sorting and collecting them all in the mechanical way, or by picking, and these must therefore be ascertained by more accurate  
and

and chemical processes. How this may be done, I shall illustrate by a mere example.

Suppose we had ascertained by previous experiments, (in the way I have mentioned in the foregoing part, in which I have treated of simple and compound salts) that an earth contained a mixture of different salts, as *sulphate of magnesia*, *muriate of potash*, *sulphate of iron*, *sulphate of potash*, and *sulphate of soda*; we then may proceed in the following way: A certain quantity of such earthy substances which has been previously dried for two hours, in the heat of boiling water, is extracted and freed from the saline parts, by digesting it with about 50 parts of distilled water, in a glass matras; after which the whole is put upon a filtre, and the liquor thus separated, the remainder upon the filtre is washed with a little water, then dried in the same heat, and for the same time as before, and its weight ascertained, which indicates by the loss, the quantity of saline parts which were contained in it. A certain quantity of the saline liquid is taken, evaporated to dryness by a gentle heat; this is first digested with high rectified spirits of wine, as long as the spirits will dissolve any of the salt. This spirituous solution is then mixed with a little pure water, and freed from the spirits of wine



wine by distillation; the remaining aqueous solution is then evaporated nearly to dryness, and exposed to crystallise, the salt is then dried in the same degree of heat as the earth had been exposed to, its weight will indicate the proportion of the salt which was taken up by the spirits of wine, and which was MURIATE of POTASH; this salt may be again ascertained, by dissolving a little of it in pure water, when liquid sulphate of silver added, will occasion a precipitate which indicates the muriatic acid, and potash added to it, will occasion no earthy precipitation, if the salt was merely composed of muriatic acid and potash. The salt which was not dissolved by the spirits of wine, is then to be dissolved with a sufficient quantity of distilled water, and a little acetic acid added, then liquid prussiate of lime is gradually dropped into it, until it does not occasion any more blue precipitate. The precipitate thus formed, is collected upon a filtre, which is to be washed with a little pure water, dried and made just red hot in a small crucible, whose weight is previously ascertained, and which had been made red hot *per se*, before the precipitate was put in; after which, the crucible is taken out of the fire and weighed,

thus

thus the proportion of the calx of iron is ascertained.

The remaining liquid from which the iron was now separated, is gradually mixed with acetate of baryt, as long as any precipitate is thereby occasioned, which consists then of the baryt contained in the acetous solution which was added, and of the sulphuric acid contained in the salts; the whole is then put upon a filtre, the precipitate carefully collected, dried, and its weight ascertained, 100 grains of such precipitate, are very nearly calculated to contain 30 grains of sulphuric acid.

The remaining solution, consisting now of *magnesian earth, potash and soda, and acetous acid*, is then evaporated to dryness, and ignited in a smooth crucible, until the acetous acid has been driven off by the heat; the remaining substance is then extracted by distilled warm water, as long as the water takes up any of it; the whole is then put upon a filtre, and the earth, which was the magnesia, is collected, dried, ignited, and its weight ascertained.—The salt which the water has separated from the earth, is then again saturated with acetous acid, and if stirring the saturation, any earthy precipitate is observed, it is to be filtered again, and the earth collected  
upon

upon the filtre; it is the portion of magnesia which had been taken up by the alkaline salt, which is likewise to be dried and added to the weight of the first magnesia.

The filtered liquid is then evaporated by a gentle heat to dryness, and afterwards digested with spirits of wine. This will take up the potash combined with muriatic acid, and leave the soda behind; the dissolved salt, by spirits of wine, is then evaporated to dryness, and re-dissolved in distilled water; it is then mixed with acetate of lead, until all the muriatic acid is thereby separated; the precipitated muriate of lead is then separated by filtration, and the filtered liquid evaporated to dryness; afterwards ignited a little in a small smooth crucible, whose weight has been previously ascertained; when the acetous acid has been driven off by heat, the crucible is taken out, and when cooled, it is immediately weighed, and the overplus of the weight of the crucible, will indicate the weight of the potash. The muriate of soda, which was not dissolved, is likewise treated in the same way, and thus the quantity of the soda ascertained.

Now we may take each of the four separated ingredients, namely, the magnesia, soda, potash, and the iron, and saturate each separately with the sulphuric acid, and have them crys-

rallied; by that means we then can ascertain the quantity of each of the salts in the state as they were contained in the earthy substance, pretty accurately.

This being a nice process, requires great accuracy; yet it shews how such decomposition of substances can be proved, both by analysis and synthesis, and how much the improvement of chemistry has enabled us to do.

*In the analysing of earthy substances or stones, we may first attend to the sorting of such substances as have a sparry texture and appearance, or which exhibit a regular figure, and are less hard than Quartz, and to such as effervesce with nitric acid; there we have first to examine, whether they may owe their state and structure, &c. to an acid. For this purpose we may try them in the following way:*

1. We reduce a certain quantity to powder, and try whether it effervesces with nitric acid; if so, we then take, for instance, 100 grains, and put them into a retort, of as little capacity as possible, to which the small pneumatic apparatus is adjusted, with a graduated receiver to ascertain the bulk of the gas which is collected in it. Vide the annexed plate.

*N. B. The water with which the receiver is filled, may be previously mixed with a little sulphuric*

*phuric acid, to prevent the absorption of fixed air when this passes through the water, as it stands over it.*

A sufficient quantity of muriatic acid of a middling strength is then put at once through the opening at the top of the retort, and immediately stopped, so as to be air tight; when the effervescence which takes place, has perfectly ceased, then the air still in the retort, and in its neck, is also let into the other gas collected in the receiver over the water, and the bulk of the whole gas is ascertained by the measure which is indicated by the scale on the receiver.

A sufficient large piece of burned lime, such as does not effervesce with diluted sulphuric acid, is then put upon the perforated cover which is to be screwed to the mouth of the receiver (as exhibited by the figure in the annexed plates of the receiver) which is still kept under water, and shaken occasionally; as soon as the lime which is in contact with the water in the receiver, becomes dissolved in it, and absorbs the fixed air which is contained in the receiver above it, it falls to the bottom in the state of mild lime; by shaking the receiver a fresh part of the pure lime will be taken up by the

water, and thereby a fresh portion of fixed air absorbed. When no more absorption and precipitation takes place, and all is cooled to the temperature of the atmosphere, then the loss of the whole bulk of air in the receiver, will be observed by the scale on it, and the loss indicates the quantity of fixed air which had lodged in that quantity of the substance which had thus been examined. One cubic inch is very near equal to one grain of common medicinal weight, this way may be sufficient to ascertain the quantity of fixed air; and if we proceed in the same manner with different substances, the results must proportionally correspond; we may indeed calculate the quantity of fixed air of a substance thus tried already, pretty nearly from the quantity of gas which is first collected in the receiver, provided we are convinced that the earthy body thus treated, contains no other substance; as for instance, metallic parts, vegetable or bituminous matter, which might thus by means of the acid, yield also a different gas, and which would consequently make the calculation erroneous or inaccurate; we may expect metallic matter, if the substance is coloured, vegetable matter when it deflagrates with nitre in the way before mentioned, and

and bituminous mixture by the smell when rubbed or heated.

But if the substance which is to be examined has a sparry texture, is not acted upon by the nitric acid, and is less hard than quartz, we then may first examine the substance, whether it contains a mineral acid, either the fluoric or the sulphuric, which often occurs, and with what basis they are combined.—In this case we examine it according to the manner I have described before, whether it belongs to the *fluors*, *selenites*, or *ponderous spars*; if we find it to belong to the baryts or selenites, its component parts, and their proportion to each other, may be ascertained in the following way: 100 grains of the substance, which has been previously reduced to a fine powder, may be mixed with 200 grains of purified alkali, (if heavy spar 300 grains) and ignited together in a crucible (made of clay) for half an hour; after this the mass is taken and washed out of the crucible, and boiled with 12 times the quantity of distilled water, and put upon a filtre, where the remaining earth is to be edulcorated with distilled water, perfectly dried, and its weight ascertained, it is then marked A.

If the filtered liquid proves to be alkaline, it may be saturated with muriatic acid; and if

after the saturation, a precipitate is observed, it must be collected upon a filtre, and added to the other earth A.

The saline liquor is then diluted with a little more water, and gradually mixed with muriate of baryt, as long as that occasions a precipitate. The precipitate is then collected upon a filtre, and welledulcorated, perfectly dried, and its weight ascertained; 100 parts of such precipitate, will very nearly indicate 13 parts of sulphuric acid.

The earthy residuum marked A. is then to be dissolved in diluted muriatic acid, and diluted with about two pounds of distilled water; diluted sulphuric acid is then added as long as any precipitation takes place. The precipitate is collected upon a filtre, and after beingedulcorated, well heated, and its weight ascertained; 100 parts of this precipitate will indicate 70 parts of baryt earth, which was the quantity of the baryt contained in the mineral.

The solution from which the baryt had thus been separated, is then evaporated to about four ounces; concentrated sulphuric acid is added as long as any precipitation is observed; the whole is then heated and evaporated to about one ounce, and placed to cool;  
after



after which it is put upon a filtre, and edulcorated or washed with a mixture of distilled water, and one fourth of spirits of wine, and afterwards dried, heated, and weighed; 100 parts of it will indicate 32 parts of calcareous earth. The remaining liquid is then saturated with a solution of purified potash, and if a precipitate ensues, it is collected upon a filtre, edulcorated and dried; when mixed with sulphuric acid, if it forms a concrete salt, which is not soluble in a mixture of three parts of water, and one of spirits of wine, it is then selenite, but if otherwise, it is again decomposed by a solution of soda, and the precipitate collected and calcined for half an hour, and digested with distilled vinegar; what is dissolved then by the vinegar, is magnesian earth; and what remains undissolved, is argillaceous earth. This analysis may therefore answer for selenites and heavy spars.

If the earthy substance or stone which is to be analysed, is found not to contain sulphuric, or fluoric, or boracic, or phosphoric acid, or saline parts, or combustible non-metallic substances, we may conduct an analysis in the following way:

First we have to ascertain whether the substance effervesces with acids, and whether this is occasioned by the escape of fixed air—if so, the fixed air may be ascertained in the way before mentioned—if not, 200 grains of the substance are reduced to a fine powder in an agate, or any other very hard mortar, and strongly heated by a certain heat, to separate the moisture; the loss of weight is thus marked; it is then put into a glass matrafs, and digested with nitro muriatic acid, (mixed of equal parts of nitric and muriatic acid) as long as the acid will take up any of the substance. The whole is then put upon a filtre, and edulcorated with water, and collected upon the filtre, afterwards dried in the same heat; it is then weighed; its loss will indicate the quantity of the substance which had thus been dissolved in the acid. The filtered solution is then put aside, and marked A.

The remaining undissolved substance is then to be rubbed again in the agate mortar, and mixed with three parts of deaguated soda, put into a crucible of three times the capacity of the bulk of the mixture, and placed in the furnace, and covered with another larger crucible; heat is then applied until the outer crucible is become perfectly red hot, which is sufficient

sufficient for the purpose, as care must be taken to prevent the mixture from fusing, otherwise the mass may likely act upon the crucible, and thus introduce heterogeneous matter into the mixture.

The mass which is found cohering, is then taken out, and reduced in the mortar to fine powder. The powdered substance is put into a cylindrical glass or matrafs, and first mixed with a little pure water; if the water exhibits a green, or amethyst, or brown colour, then manganese is suspected; fresh nitro muriatic acid is then poured on it, as much as is necessary to saturate the alkali, and to dissolve every part which is soluble in that acid; the digestion is assisted by a moderate heat (the digestion may be repeated with fresh acid.) The whole is then put upon a filtre, and the residuum sufficientlyedulcorated with water, afterwards dried by the same heat as before, and its weight ascertained, it will be the siliceous matter or quartz; if this should still have a colour, it must be mixed again with soda, and treated in the same manner as before.

All the solutions in acid, if they contain too much predominating acid, should be a little evaporated; and if during this a precipitate should take place, a little sugar is added to occasion  
the

the precipitate to re-dissolve if manganese, or a few drops of muriatic acid, if iron. If the acid still abounds too much, the solution is then nearly saturated with soda; liquid prussiate of lime, or soda, is then gradually added, until no more precipitate is occasioned; the whole is put aside for a few days to subside; if in this time the coloured precipitate has not subsided, the liquid may be heated a little, which will then occasion the separation of the metallic precipitate; after this the whole is put upon a small filtre; (made of writing paper, freed from size by boiling distilled water) and the precipitate, after beingedulcorated with water, is carefully collected, dried, and ignited in a small crucible for one hour; its weight is then ascertained; if the precipitate could not be well separated from the paper, the precipitate, together with the paper, is put into the crucible (100 grains of such paper, leave generally one grain of residuum, which must then be deducted from the weight of the precipitate thus calcined.)

The calcined precipitate may now consist of iron, copper, nickel, or manganese. It is then first digested with mild liquid ammonia; this will take up the copper and nickel with a blue colour, if it contains any—if so, a polish-  
ed

ed weighed plate of iron is put into the solution—the copper, if any, will then be found deposited upon the iron in the metallic state ; if no copper is thus found, the liquid is then evaporated to dryness, and its weight ascertained, it will then be the oxyd of nickel.

The residuum left from the extraction by ammonia, is likewise dried, and its weight ascertained, it will be the iron ; but if any manganese is also suspected, the last precipitate, namely, the ferruginous, is to be digested with a strong saturated solution of pure or caustic potash, and exposed to a heat nearly to boil ; after which it is filtered, and the liquid left to cool and to subside ; the precipitate will be the manganese, which is then collected upon a filtre, washed and dried, and weighed ; and the substance, which remained on the filtre before, is the iron.

The liquid collected by the filtration, from which the metallic parts had been separated, is then to be examined and analysed ; for this purpose, a little sulphuric acid is dropped into the solution ; if this occasion a white precipitate, baryt is suspected ; the whole is then mixed with two pounds of distilled water, and as much diluted sulphuric acid is added, until no more precipitate is observed ; the thus  
produced

produced precipitate, which consists of the baryt earth and the sulphuric acid, is collected upon a filtre, washed, perfectly dried, and weighed, 100 parts of the precipitate, will indicate near 70 parts of baryt, or to be more accurate, the precipitate may be decomposed again by fusing it with potash, whereby the potash will unite with the sulphuric acid, and separate the baryt earth, which may be deprived of the saline parts, by lixiviating it with boiling distilled water; the earth is then left behind, which is to be dried, and its weight ascertained.

The liquid from which the baryt had been separated, is then evaporated to about four ounces measure, and mixed gradually with concentrated sulphuric acid, as long as any separation of the solution is observed, the whole is suffered to cool if fresh acid is added, and this occasions no more separation; it is then put upon a filtre, and edulcorated with a mixture of warm water and spirits of wine, in the proportion as has been observed before, the selenite upon the filtre is then dried, heated, and its weight ascertained, from which the quantity of calcareous earth, as was mentioned before, may be ascertained by calculation, or 100 parts of selenite thus formed, contain near

30 parts of calcareous earth, or the selenite may be decomposed by potash, as before mentioned.

The solution from which the selenite had been separated, is then saturated, and decomposed by a solution of soda, which will separate the argillaceous and magnesian earth, if it contains any, which is collected upon a filtre, dried and ignited as usual, and its weight ascertained; after which, it is put into a small crucible, and ignited for half an hour. The whole is then taken out, weighed, and put in digestion with distilled vinegar, which will gradually take up the magnesian earth, if any, and the argillaceous earth is left behind, which is dried and weighed again; by this means, the substance is analysed in so far as we are able to judge from our present knowledge in chemistry.

As it is well known that gold is occasionally found mixed with sand, or earthy substances, often in the state of so minute particles, that it cannot be distinguished by the mere eye, we may for that purpose examine such substances in the following way: First, we may separate the light and dusty parts of the earth or sand, by washing it with water in a vessel, and frequently decant the water immediately, after stirring

stirring it each time; some of the subsided parts must be well dried, and a little calcined, to separate any combustible and volatile parts.

A certain quantity of the sandy substances, or stone, is then reduced to a very subtile powder, and put into a matras; nitro-muriatic acid, or aqua regia is then poured upon it, and left in a warm digestion; when the acid is saturated, it is filtered, and tried whether a purple precipitate is occasioned on adding a little of a solution of tin dissolved in the same acid; if so, the whole solution may be mixed with sulphate of iron, as long as any precipitation takes place; the precipitate will be the gold contained in that substance, which may afterwards be fused and purified by cupellation; the quantity of gold will indicate, whether it be worth while to continue the trouble and expence of the process, for obtaining more.

Sometimes TIN is found mixed with sand, or other stony substances. This may be discovered in the same way, by extracting a certain quantity of the pulverised substances with the nitro-muriatic acid, which takes up the tin, if any; a little of a solution of gold made by the same acid, added to the solution which is supposed to contain tin, will occasion a purple



ple precipitate; if so, the ore may be analysed in the way I have mentioned, in that part of this volume which treats of tin ores.

Sometimes we find zink in the state of calx, mixed with stony substances, composed of siliceous earth, calcareous earth, oxyd of iron, and sometimes also lead. In order to analyse such stones, a certain quantity is reduced to a fine powder, and digested in a glass vessel, with twice its weight of nitric acid, by a little heat, the digestion is twice repeated with fresh acid; the whole is then put upon the filtre, and what remains upon the filtre, is washed with water, dried, and its weight ascertained;—it is the siliceous part of the stone.

The solution is then evaporated to dryness, and a little ignited in a crucible, after which, it is digested again with nitric acid, which takes up the other substances, and leaves the iron behind; after this, the lead may be separated by adding muriatic acid;—the calcareous earth by concentrated sulphuric acid, in the state of selenite.—The remaining liquid is to be decomposed by a solution of soda; the precipitate thus formed, isedulcorated, dried, and weighed.—It is the oxyd of zink which contains generally  $\frac{1}{7}$  part of metal.

#### EXAMPLE

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## E X A M P L E

OF THE

### ANALYSIS OF AN ORE.

**T**HIS, we will suppose, we had found by previous experiments, to contain copper—lead—silver—iron—bismuth and sulphur.—In order to separate these different substances from each other, we may proceed in the following way : The ore is to be reduced to fine particles, and first digested and extracted with nitric acid, as long as it will take up any of the ore ; the whole is then filtered, by which means, the **SULPHUR** remains on the filtre, which may be washed, collected, and dried between paper, in a heat not above that of boiling water, and its weight ascertained. If  
it

it be pure sulphur, it may be volatilised by a continued gentle heat. The filtered solution is first repeatedly diluted with distilled water, as long as any precipitate is occasioned, this precipitate is collected upon a filtre, and dried.—It is BISMUTH.

The filtered liquid is then mixed with muriatic acid, as long as any precipitate is occasioned; the precipitate is also collected upon a filtre; it is the SILVER combined with muriatic acid, from which the silver may be separated, by mixing the precipitate with two parts of dry soda, and fusing it in a crucible; by this means, the acid leaves the silver, and unites with the soda, and thus the silver is found reduced, and its weight may then be easily ascertained.

The remaining solution is evaporated to about four ounces bulk, and sulphuric acid is added as long as any precipitate is occasioned; the precipitate contains the lead which was in the ore, and which may be separated from the sulphuric acid by soda, in the same way as the silver.—Thus the LEAD is separated.

The remaining solution is then further decomposed by saturating it with mild ammonia, which occasions the iron to separate, and keeps the copper in solution; the precipitate is then

calcined, and its weight ascertained.—It is the **IRON**.

Lastly, the solution may be decomposed by mixing it with a solution of potash, and boiling it a little; by this means, the ammonia is separated, the potash combines with the acid, and the copper is precipitated.—Thus the **COPPER** is obtained, and the analysis is finished.

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# EXPLANATION

O F

## TABLE I.

**T**AB. I. Fig. 1. Cube with a striated surface, viz. *ferruginous pyrites*.

Fig. 2. Cube with the angles truncated, viz. *galena*.

Fig. 3. Cube with the angles largely truncated.

Fig. 4. Cube with its angles and edges truncated, viz. *boracit*.

Fig. 5. Rhomb.

Fig. 6. Dodecagon, viz. *ferruginous pyrites*, or *mundik*.

Fig. 7. Dodecagon, viz. *garnets*.

Fig. 8. Polyadron, with 24 facets, viz. *volcanic garnet*.

Fig. 9. Four sided pyramid, viz. *white zink spar*, &c.

Fig. 10. Hexahedral pyramid.

Fig. 11. Double tetrahedral pyramid, viz. *balais* and *spinel ruby*, *pyrites*.

Fig. 12. Double hexahedral pyramid, viz. *calcareous spar*, *East Indian saphyr*, *topaz*, and *ruby*.

Fig. 13. Tetrahedral pyramid, with the angles, and one side edge, truncated.

Fig. 14. Tetrahedral prism without pyramids.

Fig. 15. Hexahedral prism, having the sides longitudinally striated, viz. *aquamarin*, and certain kind of *calcareous spar*.

Fig. 16. Tetrahedral prisms, having some angles truncated, and some side edges and end edges doubly and obliquely truncated, viz. *Saxon topaz*.

Fig. 17. Tetrahedral prism, on both ends bevelled or cuniated.

Fig. 18. Hexahedral prism, acuminated on one end, or terminating gradually in a point, having the surface striated across, or transversally, viz. *quartz crystal*.

Fig. 19. Double hexahedral pyramid, having the two opposite broad sides of each end bevelled, or cuniated.

Fig. 20.

Fig. 20. Tetrahedral prism, bevelled in the same manner.

Fig. 21. Tetrahedral prism, with a tetrahedral pyramid, which is obtusely truncated, &c. *Zircon*.

Fig. 22. Hexadral prism, with a hexahedral pyramid, the basis of which corresponding with the side faces of the prism, and the sides of the prism are transversally striated, viz. *rock crystal, spar*, but without *striae*.

Fig. 23. Tetrahedral rhomboidal prism, variously truncated, *vide, Brasil topaz*.

Fig. 24. Tetrahedral prism, acuminate on both ends, the facets are rhombic, and proceed from the side edges of the prism, viz. *hyacinth*.

Fig. 25. Prism with nine side faces, obtusely truncated by three facets, viz. *turmalin*.

Fig. 26. Hexahedral prism, acuminate by three facets. *Grey antimony, calcareous spar, ruby silver ore*.

Fig. 27. Tetrahedral prism, with tetrahedral pyramids on both ends, the basis of which corresponds with the faces of the prism.

Fig. 28. Tetrahedral prism, with a tetrahedral truncated pyramid, having one side edge of the pyramid, and one of the prisms truncated.

Fig. 29. Tetrahedral prism, terminating on both ends in a tetrahedral pyramid, which proceed from the corresponding sides of the prism, by double obtuse truncation.

Fig. 30. A flat hexahedral prism, bevelled or cuniated on both ends, by two large faces, which proceed from the two opposite acute angular edges of the prism, which are slightly truncated.

Fig. 31. Hexangular plate.

Fig. 32. Rectangular plate from all sides, edges bevelled or cuniated.

Fig. 33. Rhombic plate, bevelled in the same manner, viz. *selenites*.

Fig. 34. Triangular plate, bevelled in the same manner.

Fig. 35. Hexahedral plate, acuminate, &c. viz. *heavy spar*.

Fig. 36. Cross crystal formed from two four sided rectangular plates, crossing each other by a right angle, having both ends bevelled and acuminate, viz. *cross crystal*, from Andreasberg on Harz.

Fig. 37. Two rhombic bevelled plates joined together.

Fig. 38. Cross crystal.

Fig. 39. Cross crystal of the nature of shörl, apparently formed from four tetrahedral  
short



short pyramids, which are joined by their points and side edges.

Fig. 40. Cross crystal from Compostella, *vide* page 75, Vol. I.

Fig. 41. Lenticular crystal, oval on both sides.

Fig. 42. Lenticular crystal, whose edges are truncated, and the two sides exhibit one rectangular face in the middle, and four pentangular faces around it.

Fig. 43. Goniometer for measuring the angles of crystals, exhibiting the indication of the angle of a rhomboidal crystal, which is placed between the instrument, as it is to be applied.

## E X P L A N A T I O N

OF THE

DIFFERENT APPARATUS,

EXHIBITED UPON

*THE DIFFERENT ANNEXED PLATES,*

TAB. II, III, IV,

As may be required for examining and analyzing Mineral Substances.

SECT. I.

FOR

POUNDING or PULVERISING.

**F**IG. 13, Tab. II. An iron mortar of a middling size, for dividing large masses of minerals into smaller pieces, to render such convenient for examination, and more fit for pulverising

pulverising them further in smaller stone mortars, such, *f. e.* as (Fig. 16, Tab. II.) which are made in Mr. Wedgewood's manufactory, and which are very hard, and made of such materials as are not (or at least hardly) acted upon by the acids and alcalies commonly used for chemical decomposition.

These stone mortars are, in most cases, more convenient than glass mortars, which are too brittle.

A small mortar (Fig. 17, Tab. II.) of agate or flint, is very useful to reduce small portions of very hard stony substances to very subtile powder.

Fig. 15. A small sieve to separate the powder from the coarser pounded particles, and to procure the particles of nearly equal size. The smaller the particles, the more easily they are acted upon by solvents.

## SECT. 2.

### FOR DIGESTION, SOLUTION, &c.

Fig. 14, Tab. II. A graduated glass measure, for measuring moderate quantities of liquids

liquids used for solution, divided into cubic inches, ounces, and to indicate a certain number of grains, which may exceed 100 grains, as smaller portions must be weighed.

Fig. 2, Tab. II. A conical glass, the inside terminating in an oval bottom, for putting a small piece of a mineral substance in, to try the action of acids upon it, having a small solid thin bar of glass for stirring.

Fig. 1, Tab. II. A glass matrass of about 8 or more ounces measure capacity, for digestion, and dissolution of solid bodies in liquids.

Fig. 7, Tab. II. The same vessel placed into a copper basin (*b*) containing fine sifted sand, which is to be placed upon the cylinder of the lamp furnace.—Fig. 4, Tab. IV.

### SECT. 3.

#### FOR

#### FILTRATION.

Fig. 5, Tab. II. Filtering apparatus, having a glass funnel (*a*) with four or six small solid pieces of glass bent on one end, like  
(Fig.

(Fig. *c*) hanged round the inside, to prevent the filtering paper sticking close to the inside of the funnel, which is placed in the cylindrical vessel, (*b*).

Fig. 6. A similar filtering apparatus, but the funnel having a wider passage, to prevent any filtered liquid lodging in the tubular part of the funnel.

Fig. 8, Tab. II. APPARATUS for separating deliquescent salts, from such as do not absorb moisture enough to become perfectly liquid when exposed in the atmosphere.

(*a*) signifies a stand for holding the funnel (*b*), which has a very shallow area, and a narrow tube (*c*), terminating in a small bottle (*d*) to collect the deliquesced salt, which has been occasioned by exposing the substance, spread over the area of the funnel, in the atmosphere.

#### SECT. 4.

#### FOR

#### PRECIPITATION.

Fig. 3, Tab. II. A long conical glass to put in a filtered solution for precipitation,  
which

which is to be covered by a thick plate of glass, as (Fig. 4.) to prevent the adventition of dust.

SECT. 5.

FOR

EVAPORATION.

Fig. 9, Tab. II. A shallow glass, or stony vessel, large enough to fit upon the cylinder of the lamp furnace.—Fig. 4, Tab. IV.—Under which, the Argand lamp, Fig. 5, Tab. IV, is placed.

Fig. 10, Tab. IV. Small shallow glass vessels, or watch glasses, for evaporating small quantities, whose absolute weight is marked on the outside by a diamond. This is to be placed either upon the ring A of the apparatus, Fig. 18, Tab. II, at a proper distance over the cylinder of the lamp.

If a very small and equal degree of heat is required for evaporating a small portion of a liquid, I then place the small glass vessel upon the upper and narrower part of the earthen vessel,

vessel, Fig. 2, Tab. IV, which is open at both ends, and having holes through its sides to allow the air a free exit; this apparatus, with the fluid, which is to be evaporated, is then placed upon the stand of the lamp furnace, and the spirit lamp, Fig. 3, Tab. IV, placed under it, and thus by turning the small wheel of the lamp, the wick is raised at pleasure, to regulate the flame, and consequently the heat, according to the degree which is required; the cotton not being consumed by the spirits of wine, like the wick of the oil lamps, or tallow candles, and therefore no snuffing being required for a very long time, until the lamp is fresh kindled, there is nearly an equal degree of heat for a considerable time, which is sometimes required for very nice experiments; and as this lamp is not meant for producing a strong heat, and the flame being very small, it consumes but a small portion of the spirits.

When a liquid has been sufficiently evaporated, which is to be crystallised, I then place it upon a stand under a glass-bell, Fig. 1, Tab. III, to prevent the adventition of dust.

Large quantities of liquids, as in analysing mineral waters, may be evaporated in large stone basons placed over the furnace, Fig. 7, Tab. III.

## SECT. 6.

## FOR

## DISTILLATION.

Fig. 19, Tab. II. A retort (*b*), which fits into the neck of the tubulated receiver, which rest upon the plate of the stand (*d*), the retort (*b*) is suspended by the ring (A) of the stand, (Fig. 18). The ring (A) can be moved on the stick by the collar having a spring, and the receiver (*c*) can be raised by turning the screw of the stand (*d*).

The lamp, Fig. 20, Tab. II, is then placed under the retort, or the lamp furnace with the cylinder, Fig. 4, Tab. IV, may be placed under the retort, by means of which, the heat is directed to circulate better round the bottom of the retort; whereas without this contrivance, much heat is carried off immediately by the surrounding air, and only a certain part of the retort is heated at the time.

For distilling in the dry way, substances which require a stronger heat than what can be produced by the lamps; 1. in open fire: the



the earthen or glass retort coated with a proper clay (of sand and argile) Fig. 7, Tab. IV, is placed in the wind furnace, Fig. 7, Tab. III, suspended by the neck, which rests in the side orifice marked (*b*), on the upper part of one side of the furnace, to which retort a receiver may be adjusted, whereby the retort is sufficiently suspended. The conical dome is then fitted over the furnace, in order to increase the draught of air, and to carry off the bad air and smook through the chimney, which may be directed into a larger chimney of a room, or out of the window, just as is most convenient. The dome having a door marked by (*a*), is very convenient to inspect the fire, and to throw fresh fuel into the furnace.

Distillation on a moderate large scale, may be performed by placing a distilling apparatus in the same bath, as exhibited by Fig. 8, Tab. III, made of strong iron plates, having likewise a chimney with a tube, which is to be placed upon the furnace, when the dome is removed, which serves likewise for digesting large quantities of mixtures.

## SECT. 7.

## FOR

Collecting AERIAL FLUIDS, and for separating FIXED AIR, or CARBONIC ACID, from them.

The apparatus consists of a small tubulated phial, Fig. 5, Tab. III, having a bent tube, the end of which, immersed in the water contained in the tub, Fig. 2, and terminating under the cylindrical graduated receiver, Fig. 3, when the gas is all collected in the receiver, over the acidulous water, with which the cylinder was previously filled; then a bottom piece, Fig. 4, containing a sufficient quantity of flaked lime, is fitted to the lower part of the cylinder, and the whole well shaken together; the lower part of the cylinder is then immersed in water, and the stopper on the side of the bottom piece, is drawn out, to let in as much water as the bulk of the fixed air had previously occupied; the shaking is continued until no more absorption takes place. The loss therefore of the bulk of gas, which was indicated

indicated by the graduated scale on the cylinder, previous to the absorption, will indicate the quantity of fixed air, which that quantity of the decomposed substance had contained.

If a mineral substance is found to contain no metal, and only fixed air, I make use of another method, which I found to answer the purpose, pretty accurately, and which is very easy.

I take a small vessel, (Fig. 6) consisting of a bottle mark'd (*b*), and of a stopper terminating in a long tube which is perforated, and put in a sufficient quantity of nitric acid, as will dissolve 50 grains of carbonate of earth, and dilute the acid with water, so as to fill the half of the bottle, and weigh the whole accurately; I then put in 50 grains, or any small quantity of calcareous earth, spar, or marl, put the stopper on, and give time for the fixed air to escape, the long tube of the stopper prevents the fixed air from carrying off moisture, which will be the case, if the air is not made to rise a sufficient height. When the formation of fixed air has ceased, the whole instrument is then weighed again, and the loss of weight, will indicate the quantity of fixed air which had been contained in that earth. It is

better to put the spar or marl into the acid, in the state of small pieces, which prevents the sudden action of the acid upon the substances, and the fixed air from rushing out too rapidly, and hence carrying off with it, a portion of moisture.

## SECT. 8.

USTULATION, or TORREFACTION, and  
OXYDATION of ORES.

Fig. 11, Tab. II. A flat, shallow, earthen, and unglazed vessel, to which belongs a spatula, Fig. 12, made of glass, or hard stone ware, for stirring the ores, to accelerate the process. The vessel may be placed over the furnace, Fig. 7, Tab. III, and the heat to be applied, regulated by the register marked by (*f*), on the ash-pit of the furnace.

## SECT. 9.

FOR  
FUSION, &c.

Fig. 7, Tab. III. A wind-furnace made of strong iron plates, about twelve inches high from the ash-pit to the top of the furnace, and about six inches wide, having a dome terminating in a tubular chimney, about two inches in diameter. The inside of the furnace is lined with two coatings, the first, or next to the iron plates, is made of clay and pounded charcoals well beaten, and when this is dry, another coat of pipe clay, or a mixture of clay and sand is applied over the first, so that the coats are about half an inch thick, which will resist the action of the fire, and corroding vapours upon the iron, and confine the heat in the furnace, sufficient to answer the purpose for fusions, and other operations as may be performed suitable to its size, or quantity of fuel which it can hold.

The grate which is exhibited in the furnace marked by (*b*, Fig. 6, Tab. IV) has a stand of solid iron, or which may be made of the composition of which crucibles are made, having a flat top, with a slight impresson for the crucible, marked (*g*), to stand upon; the stand (of which two may be kept of different lengths) is fastened in the middle piece of the grate. The crucible is better in many cases, to be covered by another inverted one, to prevent the adventition of heterogeneous matter, and to collect the volatile parts.

When a fusion is to be performed, the inside of the furnace is laid out with long pieces of charcoal, placed in a perpendicular position upon the grate, by which contrivance, a greater draught is allowed for the air to pass, and the heat is consequently greatly increased. If a vehement heat is required, I then apply a pair of double bellows, Fig. 11, Tab. III, placed and fastened by the two legs marked by (*a*), upon a low table, the pipe of which is introduced in the hole indicated by (*f* of Fig. 6, Tab. IV) of the side of the furnace, a little below the top of the stand upon which the crucible is placed. If a moderate heat is only required, this can be regulated by the registers,

registers, or regulators, Fig. *g*, on the side of the ash-pit of the furnace, Fig. 7, Tab. III, consisting of a solid flat piece of metal, having several holes through it, proportioned to each other, so as to admit such quantities of fresh air, as may be necessary; I have found this described in the fourth edition of the Edinburgh New Dispensatory, and it is much improved by Dr. Rotheram, a very eminent chemist of Edinburgh, whom Dr. Black has chosen as his assistant, in his chemical lectures, much to the honour of that University, and greatly to the satisfaction of his auditors.

Fig. 9, 10, and 11, of Tab. IV, represent a variety of crucibles, which may be used for many purposes, some of which must be made of black-lead, a substance known not to be fusible, and particularly useful for fusing metals in it, which at the same time, may assist to recover the metallic calces, by absorbing the calcining principle, with which it enters into combination, on account of its stronger chemical attraction.

If cupellation is to be performed, I then place the other grate, Fig. 8, Tab. IV, in the furnace, so as to rest upon the hooks (marked *d d* on the inside of the fire place) and

and upon the top of the stand of the lower grate, in the direction that the plate of the upper grate longitudinally faces the semicircular opening of the side of the furnace, exhibited by *e*, Fig. 7, Tab. III, which can be shut and opened when necessary, by a door (*d*), having in the middle, a piece of solid metal to fit exactly into the opening.

The muffle, Fig. 9, Tab. III, in which the small tests or cupellæ, Fig. 10, are placed, is then introduced through the opening in the furnace, so as to rest upon the upper grate, and the door shut; after which, the upper part of the furnace is filled with fuel, and ignited, and thus the process may be performed with conveniency. A pair of tongs, Fig. 12, Tab. IV, are convenient for putting in, and taking out the tests and crucibles, occasionally through the apertures.

In the upper part of the side of the furnace, is a hole with a stopper of metal, through which fresh air may be admitted, or introduced by means of the bellows.

*FINIS.*





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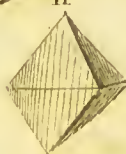
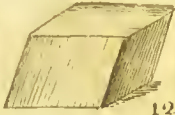
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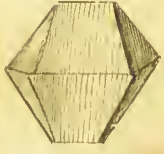
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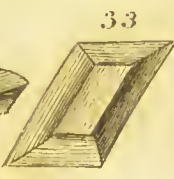
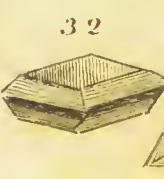
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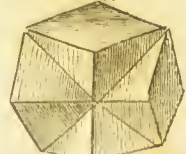
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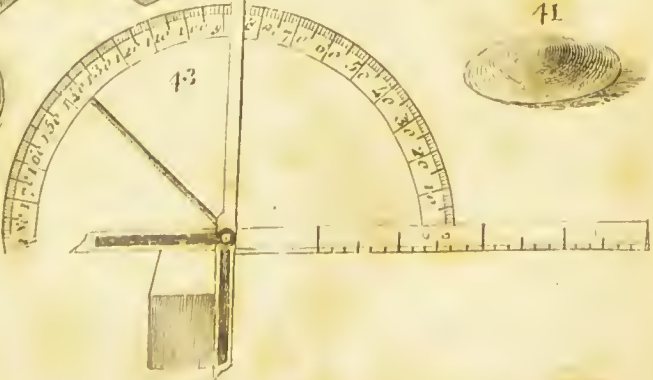


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