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MANUAL

OF

MINERALOGY.

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MANUAL

OF

MINERALOGY:

CONTAINING

AN ACCOUNT OF SIMPLE MINERALS,

AND ALSO A

DESCRIPTION AND ARRANGEMENT

OF

MOUNTAIN ROCKS.

BY

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TO

THOMAS MACKENZIE, Esq.

OF APPLECROSS,

MEMBER OF PARLIAMENT FOR THE COUNTY OF ROSS; FELLOW OF THE ROYAL SOCIETY OF EDINBURGH; OF THE WERNERIAN NATURAL HISTORY SOCIETY, *&c.*

THIS WORK

IS INSCRIBED,

IN TESTIMONY OF THE RESPECT AND ESTEEM

OF

HIS FAITHFUL AND SINCERE FRIEND,

ROBERT JAMESON.

College, Edinburgh,
April 2. 1821.

CORRIGENDA.

Page xxx. line 12. *for* Prismatoidal *read* Prismatic
—— 3. line 3. *for* 1.1, *read* 1.0,
—— 3. — 5. *after* Without smell or taste. *add*, Sp. gr. = 1.0.
—— 3. — 15. *after* Sensible smell and taste. *add*, Sp. g. = 1.0269.
—— 20. — 10. *for* Sp. g. = 2.2,—2.3. *read* Sp. gr. = 2.2,—3.3.
—— 41. — 3. *for* naturally *read* named
—— 71. *for* Prismatoidal Baryte, *read* Prismatic Baryte,
—— 96. *for* Prismatic Olivenite. *read* Prismatic or Acicular Olivenite.
—— 117. *for* Graphite. *read* Graphite or Black Lead.
—— 136. Here add the analysis of Arvedson, which is as follows: Silica, 65.40; Alumina, 25.30; Lithina, 8.85; Oxide of Iron, 1.45.
—— 232. line 7. *delete* is
—— 250. *for* 3. Prismatic Iron-Ore. *read* 3. Prismatic or Brown Iron-Ore.
—— 324. *for* Lievrite, *read* Lievrite or Jenite,
—— 369. The reference to the Island of Skye to be erased.

INTRODUCTION.

THIS Manual of Mineralogy contains an account of Simple Minerals, and of Mountain Rocks. The rocks are arranged according to their geognostical relations, and the descriptions and history are given in such a manner, as will enable the student, by them, to determine the nature of the strata and veins of a country. The views and system of my distinguished friend MOHS are adopted in the arrangement, and in the specific characters, of the simple minerals; while the *descriptions* of the subspecies and kinds are given in the same form as in my larger treatise on Mineralogy.

Those who wish for an explanation of the language used in the *descriptions* of the mineral species, may be referred to my *Treatise on the Characters of Minerals*, 3d edition; and the following details from MOHS * will remove every difficulty in understanding the system of arrangement, and the specific characters.

The SPECIFIC CHARACTER consists principally of three *Characters*, which, if the properties of the species would allow

* MOHS, Die Characteristik des Naturhistorischen Mineral Systemes. Dresden, 1820. See also English translation, published at Edinburgh, 1820; View of MOHS' System in Edinburgh Philosophical Journal; and article Mineralogy in Edinburgh Encyclopædia.

it, are given in all instances. These are the Crystalline forms (including cleavage), the degrees of Hardness, and the Specific Gravity. The Crystalline forms may be reduced in all cases to one of four SYSTEMS OF CRYSTALLIZATION;—the RHOMBOIDAL, or that which is derived from a rhomboid; the PYRAMIDAL, or that which is derived from an isosceles four-sided pyramid; the PRISMATIC, or that which is derived from a scalene four-sided pyramid; and, lastly, the TESSULAR, or that which is derived from the hexahedron.

The forms of the three first are indicated by initial letters, with or without numbers or signs; those of the tessular are expressed at large.

The letter R refers always to the Rhomboidal System, and means, without any exception, a rhomboid. The letter P may refer to either of the three first systems; and though it always means a pyramid, it has different significations. The specific character indicates to which system it refers, and determines its signification. If this system be the Rhomboidal, P will be an isosceles six-sided pyramid; if it be the pyramidal, P will be an isosceles four-sided pyramid; and if it be the prismatic, P will be a scalene four-sided pyramid.

All compositions of these letters with numbers or signs, refer to the same system to which the simple letters refer. Thus $R \pm 1$, or more generally $R \pm n$, design also rhomboids, which bear to R (the angles of which, if known, are given in the specific character) a certain relation, of which the explanation will be given in the Elements of Crystallography, to be published afterwards. $R - \infty$ denotes a plane perpendicular to the axis of a rhomboid, or of any form belonging to the rhomboidal system, and is considered as a rhomboid of an infinitely short axis, the side of its horizontal projection remaining a finite line. $R + \infty$ is a regular six-sided prism, in such a position that it cuts the faces of the rhomboid in horizontal lines or edges, or, which is the same, in edges parallel to the horizontal diagonals of this form; and is considered as a rhomboid of an infinite axis. Those two forms ($R - \infty$ and $R + \infty$), represent the limits of the series of rhomboids, of which Nature (for instance in *Rhomboidal Calcareous-spar*) presents many members. 2 R denotes a combination of two rhomboids equal and similar to each other, in such a position, that they assume the appearance of an isosceles six-sided pyramid; and it is called a DIRHOMBOID.

In the Rhomboidal System $P \pm 1$ or $P \pm n$ are isosceles six-sided pyramids, whose difference from the dirhomboid will be explained in the Crystallography. $P - \infty$ is a plane perpendicular to the axis of a rhomboidal form, which, since it cannot be distinguished from $R - \infty$, is not noticed in the Manual. $P + \infty$ is a regular six-sided prism, distinguished from $R + \infty$ by its position, and is therefore not to be confounded with it. The faces of $P + \infty$ do not cut the faces of the rhomboids in horizontal lines or edges, or, which is the same, in such as are parallel to the horizontal diagonals; but in such a manner, that their faces remain rhombs; or, in other words, the section is parallel to their edges. The same applies to the dirhomboids, when they are resolved into simple forms. $P - \infty$ and $P + \infty$, are the limits of the series of isosceles six-sided pyramids.

In the Pyramidal System, $P \pm 1$, or in general $P \pm n$, are isosceles four-sided pyramids, deduced from P. $P - \infty$ means, in like manner, a plane perpendicular to the axis of an isosceles four-sided pyramid, or of some other form connected with it, and is looked upon as an isosceles four-sided pyramid of an infinitely short axis; whereas $P + \infty$, a rectangular prism, is considered as an isosceles four-sided pyramid, of an infinite axis. These two forms are also the limits of the series of isosceles four-sided pyramids. But there is, in respect to the prisms, a distinction to be made. If the faces of the rectangular prism cut the faces of the pyramid P in such a manner as to produce edges parallel to the edges at the base of this pyramid, the prism is called the PARALLEL PRISM, and keeps the sign given above. But if the faces of the prism intersect the faces of P, so that the lines or edges of intersection are parallel to those edges of the pyramid which end in the apex of its axis, the prism is called the DIAGONAL PRISM (the intersections being in this case parallel to the diagonals of the base of P), and it has $[P + \infty]$ for its sign.

In the Prismatic System, P has different significations, which are determined by numbers and other signs. The single P is a scalene four-sided pyramid, and represents the fundamental form of a species. $P \pm 1$, or $P \pm n$, are also scalene four-sided pyramids, of the same base with P, and only distinguished from it by the proportions or lengths of their axis. $P - \infty$ is again a plane perpendicular to the axis of a prismatic form; and $P + \infty$, an oblique angular prism, of similar base with P: these two last are the limits of that series which is formed by substituting for n in the expression $P \pm n$, whole numbers, in their natural order. But, moreover, there exists still two kinds of scalene four-sided pyramids, also connected with P, but having bases which are not similar to the base of P. The first kind contains those, in the bases of which, one diagonal of P; the other those, in the bases of which, neither of the diagonals of P remains unaltered. Still, however, the diagonals, consequently the angles of the base, depend on those of P. The first are denoted by the general expression $(P \pm n)^m$; the second by $(Pr \pm n)^m$.

This designation, however is not yet sufficient. It is necessary to express also the relation between these two kinds of forms and P, so that by the sign it may be seen which of the diagonals of the base of P remains in the first kind unchanged; and in the second is to be changed, according to a certain determined proportion. This is done in the following manner.

In the first kind $(\overset{\circ}{P} \pm n)^m$ signifies, that in the base of this scalene four-sided pyramid, the longer diagonal remains unchanged, whilst $(\bar{P} \pm n)^m$, signifies that in the base of this scalene four-sided pyramid (different from the former), the shorter diagonal of P remains unchanged. In the second kind $(P\overset{\circ}{r} \pm n)^m$, likewise denotes that the longer diagonal of P must be altered in a determined proportion. On the other hand $(P\bar{r} \pm n)^m$ signifies that the shorter diagonal of P must be altered in the same determined proportion which is found from the value of m; but still so, that neither in the first case the shorter, nor in the second the longer diagonal, remains unchanged. The forms of these two kinds are said to belong to that diagonal of P, which in the first remains unchanged, and in the second is changed in that determined proportion to which the sign refers. The letter m is a number determined by experience, and has an influence in the dimensions or angles of these pyramids.

The Manual contains no example of the forms just now described, but of those oblique angular four-sided prisms which limit the series of the pyramids with which the prisms have consequently the same bases. Thus $(\breve{\mathrm{P}} + \infty)^m$, $(\bar{\mathrm{P}} + \infty)^m$, $(\mathring{\mathrm{P}}\mathrm{r} + \infty)^m$, $(\mathrm{P}\bar{\mathrm{r}} + \infty)^m$, substituting for m the numbers determined by experience, as the examples in the Manual shew, represent oblique angular four-sided prisms, which differ from each other, and from $\mathrm{P} + \infty$, by the dimensions or angles of their bases. If, in a species, the dimensions or angles of P are known, those of the oblique angular four-sided prisms, occurring in that species, are also given.

All the prisms hitherto mentioned, are VERTICAL ones, or in other terms, such, that their axes are vertical, if those forms, in the combination of which they appear, are in an upright position. In the Prismatic system there occur, however, prisms whose axes have a horizontal direction. When the combinations in which these prisms enter are in an upright position, these are named HORIZONTAL prisms. The general expression for a Horizontal prism, is $\mathrm{Pr} \underline{+} n$; where n, as in all former general expressions, may be any whole number, even $= 0$, or $= \infty$. $\mathrm{Pr} \underline{+} 1$ are therefore also such horizontal prisms, and $\mathrm{Pr} - \infty$, $\mathrm{Pr} + \infty$, the limits of the series, obtained by substituting for n, whole numbers in their natural order.

If $\mathrm{P} + \infty$ be a Vertical prism, the faces of $\mathrm{Pr} \underline{+} n$ being a finite number, will appear as Bevelments on its extremities, and the planes of these bevelments will be set upon the edges of $\mathrm{P} + \infty$. But, as these edges may be the acute, as well as the obtuse ones, or what comes to the same, as between them the longer, as well as the shorter diagonal, may be contained, this must be shewn by the signs. In the first case, the sign will be $\mathrm{P}\breve{\mathrm{r}} \underline{+} n$, whereas in the second, $\mathrm{P}\bar{\mathrm{r}} \underline{+} n$. If $n = - \infty$, the faces of the bevelment fall into one plane, perpendicular to the axis of $\mathrm{P} + \infty$, and as this plane is the same with $P - \infty$, no notice is taken of it in the Manual. If $n = + \infty$, the faces of the bevelment become parallel to the axis of $P + \infty$; or they appear as truncations on the respective edges of this oblique angular four-sided prism. $\breve{P}r + \infty$ and $\bar{P}r + \infty$ combined together, produce evidently a rectangular prism, the termination of which, in the direction of its axis, depends upon other forms, which may be contained in the combination.

A full explanation of this matter being intimately connected with the theory of the scalene four-sided pyramid, would require more room than can be here spared. But for the application of the method, what has been said will be found sufficient, and no doubts will remain, if the reader will merely recollect, that, in the prismatic system, P, the fundamental form of a species, and also $P \pm n$, the derivations from P, are scalene four-sided pyramids, and $P + \infty$, a vertical oblique-angular four-sided prism, all having the same base; whereas $(\breve{P} + \infty)^m$, $(\bar{P} + \infty)^m$, $(\breve{P}r + \infty)^m$, and $(\bar{P}r + \infty)^m$ are also vertical oblique-angular four-sided prisms, distinguished from each other, and from $P + \infty$, by their bases; and at the same time that $\breve{P}r \pm n$, $\bar{P}r \pm n$, signify horizontal prisms, or bevelments on the ends at $P + \infty$, the faces of the first set on the acute, the faces of the latter on the obtuse edges of $P + \infty$; and lastly, that $\breve{P}r + \infty$ and $\bar{P}r + \infty$ effect truncations, the first of the acute, the second of the obtuse edges of $P + \infty$, or that they are in general faces which pass through the axis and the diagonals of the basis of P.

By means of these signs, not only the crystalline forms, but also the cleavage, have been expressed; and there remains only to point out the manner in which this has been done.

In the specific character, the first character given is the system of Crystallisation; to this the form and cleavage of the species belong. Then follows, together with its dimensions (if known), the Fundamental form, from which all other simple and compound forms are derived. In rhomboids, that edge which ends in the apex of the axis is given; for instance, in *rhomboidal Calcareous-spar*, $R = 105° 5'$; in isosceles four sided pyramids, both edges, first that which passes through the apex of the axis, and then that on the base, are mentioned; for instance in *pyramidal Zircon*, $P = 123° 19'$; $84° 20'$; and in scalene four-sided pyramids, first, both of those edges which cut the axis, then that at the basis, are given; thus in *prismatic Topaz* $P = 141° 7'$; $101° 52'$; $90° 55'$. In this system, besides the dimensions of the finite forms, those of the infinite ones, or of the limits, are mentioned, as in the last example $P + \infty = 124° 19'$, and so on; which is very convenient, as the cases in which these can be examined, occur more frequently than those in which the edges of pyramids can be measured.

With respect to CLEAVAGE, the expression "Cleavage, "R," for instance, in *rhomboidal Calcareous-spar*, means, that this mineral has its cleavage parallel to the faces of a rhomboid, similar to the fundamental form of this species; "Cleavage, $P - \infty$, $P + \infty$, $[P + \infty]$" in *pyramidal Garnet*, means, that this mineral has its cleavage parallel to the faces of two rectangular prisms, and at the same time perpendicular to their axis; "Cleavage, $\breve{P}r + \infty$" in *prismatic Chrysolite*, indicates, that the cleavage of this mineral passes at the same time through the axis and the short diagonal of the prism $P + \infty$; and "Cleavage, $(Pr + \infty)^{5} = 87^\circ\, 42'$, $P\breve{r} + \infty \,.\, P\bar{r} + \infty$," expresses, for instance, in *pyramido-prismatic Augite-Spar* (Augite), that the individuals of this species can be cleaved, first, parallel to the faces of an oblique angular four-sided prism, of the given dimensions; and secondly, parallel to planes which pass through the axis and both diagonals of the prism $P + \infty$; or, what comes to the same, parallel to the faces of a rectangular prism.

There occurs in the prismatic system, without, however, being peculiar to it, a very remarkable appearance, relating to form and cleavage. It very often happens, that of the faces of one or more forms, contained in a combination, not the whole number, but only half of them, are to be found; for instance, instead of eight faces of a scalene four-sided pyramid, only four; or instead of four faces of an oblique-angular four-sided prism, only two; and that, if such a form be the form of CLEAVAGE, the same takes place. *Pyramido-prismatic Augite-Spar* shews an example of it, where the two faces of the pyramid P, which meet under an angle of 120°, appear often as faces of crystallization, and sometimes as faces of cleavage, while the others are wanting. Combinations or cleavages of this kind, are called HEMIPRISMATIC, and their sign is in the above mentioned instance, $\frac{P}{2}$. From this explanation it is easy to understand what is meant in *prismatoidal Gypsum*, (common gypsum,) by the sign $\frac{P\bar{r}}{2}$. In like manner the expression TETARTO PRISMATIC is applied, in the prismatic system, to combinations, in which, instead of the eight faces of a scalene four-sided pyramid, only two of them appear.

Cleavage is termed PRISMATOIDAL, if its planes pass through the axis of a vertical four-sided prism, and are at the same time parallel, either to one of its faces, or to one of its diagonals. This expression is used in cases where a more accurate determination cannot be obtained. Cleavage is said to be DIPRISMATIC, if its planes have the direction of the faces of a vertical, and at the same time of a horizontal prism; and it is termed AXOTOMOUS, if it appears in a single plane, perpendicular to the axis of any form which does not belong to the tessular system.

The degrees of HARDNESS, or (if not constant) their limits, are expressed by numbers, and these numbers refer to the following scale:

1. denotes the degree of hardness of a variety of PRISMATIC TALC-MICA, known by the name of Common Talc, and Venetian Talc.
2. of a variety of PRISMATOIDAL GYPSUM, of imperfect cleavage, and not perfectly transparent. Varieties perfectly transparent and crystallised, are commonly too soft.
3. of a cleavable variety of RHOMBOIDAL CALCAREOUS-SPAR.
4. of OCTAHEDRAL FLUOR.
5. of APATITE.
6. of PRISMATIC FELSPAR.
7. of RHOMBOIDAL QUARTZ.
8. of PRISMATIC TOPAZ.
9. of RHOMBOIDAL CORUNDUM.
10. of OCTAHEDRAL DIAMOND.

It is necessary for practical purposes, to have in our possession a set of well-selected specimens, of the different members of the scale. If we wish to determine the hardness of a mineral by their assistance, we first try which of the members of the scale can be scratched by one of the angles or corners of a fragment of the given mineral. We begin with the highest, and proceed downwards, until we reach that member of the scale which is scratched by the mineral we are examining. We next compare the hardness of the given mineral with that which it scratches, and that next higher in the scale which it does not scratch, by drawing equally shaped angular pieces across the surface of a hard and fine file. If the specimens used in the experiment agree in shape, the resistance which they offer to the file, and the noise they emit, allow us to estimate their relative hardness. The degree of hardness is expressed, by referring to the numbers on the scale; but if it is not exactly that of any particular degree, it must be between two subsequent degrees; and the space between each degree being supposed to be divided into *ten* equal parts, we are thus enabled to mark minute shades of hardness. Thus the hardness of a variety of Prismatoïdal Antimony-glance, being found equal to that of Prismatoidal Gypsum; the hardness of a variety of Rhomboidal Tourmaline, lying between that of Rhomboidal Quartz and Prismatic Topaz; the former, if we designate hardness in general by the letter H, will be represented by $H=2$; the latter by $H=7.5$. In the character of the species, the limits of the degrees of hardness are given in the mode shewn by the characters given in the body of the Work.

Specific gravity is determined by the hydrostatic balance, the hydrometer, or more easily and conveniently by Mr Aidie's instrument described in the 3d volume of the *Memoirs of the Wernerian Society*, just published.

COLOUR and LUSTRE are sometimes used in the characters of the species, genera, and orders, but most frequently in the descriptions of the species and subspecies. The expression METALLIC, refers to a perfect metallic appearance, and includes PERFECT METALLIC LUSTRE: Examples, *Galena* or *Lead-glance*, and *Copper-pyrites*. NOT-METALLIC, means every appearance except the perfect metallic, and includes therefore also the imperfect metallic lustre, or semi-metallic; Examples, *Tantalum-ore*, and *Uranium-ore*.

The faces of crystals, and the surface of the cleavage belonging to different forms of crystallization or cleavage, can sometimes be distinguished by the kind of their lustre. The consideration of the lustre can also assist in determining to which system of crystallization belongs a rectangular four-sided prism. In simple minerals, the pearly lustre occurs only on the faces of crystals, or in the planes of cleavage. When, therefore, in the Manual, this kind of lustre is mentioned, it implies the existence of such faces and planes.

If a mineral is to be determined, first its FORM must be made out, at least so far as to know the system to which it belongs; then HARDNESS and SPECIFIC GRAVITY must be tried with proper accuracy, and expressed in numbers. It is sufficient, however, to know the latter to one or two decimals. The specific character *requires* these data; and they are also of use in the characters of the genera, orders, and classes. This being done, the method may be applied, and it will at the same time point out what other characters are wanting; so that a mere inspection of the mineral, or a very easy experiment, for instance, to try the streak upon a file, or still better, upon a plate of porcelain biscuit, will be sufficient. Having advanced in this manner to the character of the species, it will in some instances be necessary, and in all cases advisable, for the sake of certainty, to have recourse to the dimensions of the forms. This is particularly necessary, if the Genus to which the mineral belongs contains several Species, having forms of the same system, as is the case in the genus *Augite-Spar*. This determination of the dimensions of the forms may be effected by the common Goniometer, the differences in the angles being in general so great, that they cannot easily be missed, even by the application of this instrument.

It will seldom be necessary to read over the whole of any character of a class, order, genus, or species, excepting those which comprise the individual; one part that does not agree, sufficing for its exclusion. Thus even the characters of the orders, though the longest, will not be found troublesome.

The application of the method will become very easy and expeditious, by taking particular notice of some characters, which may be termed PROMINENT. Such are a metallic appearance; a high degree of specific gravity, particularly if the appearance is not metallic; and a high degree of hardness. The observation of these will immediately decide whether an individual can belong to any particular class, order, genus, or species. It is understood, that if it be not thereby excluded, the other characters must next be examined, till either an excluding one be found, or if not, the individual may be considered as belonging to that class, order, &c. with which it has been compared, and found to agree.

In illustration of this, let us take the following example: Let the form of an unknown mineral be a combination of a scalene eight-sided pyramid, of an isosceles four-sided pyramid, and of a rectangular four-sided prism; the cleavage parallel to the faces of two rectangular four-sided prisms, in a diagonal position to each other; form and cleavage therefore PYRAMIDAL, or belonging to the pyramidal system. Let HARDNESS be $= 6.5$; SPECIFIC GRAVITY $= 6.9$.

In this case, both hardness and specific gravity are prominent characters, and exclude the individual at once from the first and third, but not from the second class; with the character of which, its other properties also perfectly agree. Hence the individual belongs to the second class.

Comparing the properties of the individual with the characters of the orders in the second class; hardness and specific gravity will be found too great for the order Haloïde; hardness too great for the orders Baryte and Kerate; both of them too great for the orders Malachite and Mica; and specific gravity too great for the orders Spar and Gem. But in the character of the order Ore, both hardness and specific gravity fall between the fixed limits, and cannot exclude the individual from this order. The other parts of this character are now to be taken in consideration. If the appearance of the individual be metallic, its colour must be black, otherwise it cannot belong to the order Ore. But the appearance is not metallic; therefore the colour of the individual is quite indifferent: that is, this conditional part of the character does not affect the individual, and consequently cannot decide. Since the appearance is not metallic, the individual must exhibit adamantine or imperfect metallic lustre. The first will be found, particularly in the fracture. The next part of the character refers to minerals of a red, yellow, brown, or black streak; and as the individual gives neither of these, its streak being grey or white, this part of the character does not come into consideration. Hardness keeps between the limits. Should it be $=4.5$ and less, the streak must be yellow, red, or black; but hardness is $=6.5$, therefore the colour of the streak is indifferent. If hardness be $=6.5$ and more, and streak grey or white, then specific gravity must be $=6.5$ and more. Now this condition takes place; hardness is $=6.5$; streak is grey or white. But also the conditioned character takes place, specific gravity being $=6.9$, which is greater than 6.5. Lastly, specific gravity keeps within the limits.

As respects the individual which is to be determined, all the characters in the Character of the order Ore may be divided into two parts. The first part contains those which refer to the individual; the second those which do not; the last are not decisive. But with the first all the properties of the individual concur. These properties agree consequently with the whole character of the order, as far as it is applicable to the individual, and determine it to belong to the order Ore; or, in shorter terms, to be an Ore.

Beginners may also compare the characters of the remaining orders. Sometimes they find, as I have occasionally observed, one individual belonging to two orders, in which case there must evidently be a mistake in the comparison, which would perhaps not have been discovered had they stopt at the first not excluding order. In the present case, the not-metallic appearance excludes the individual from the orders Metal, Pyrites, and Glance; hardness from the order Blende; and hardness and specific gravity from the order Sulphur. The individual can therefore be nothing else than an Ore; and the characters of the genera of the order Ore may now be examined.

Considering again hardness and specific gravity as prominent, the individual will be immediately excluded from the genera Titanium-Ore, Zinc-Ore, and Copper-Ore, but not from the genus Tin-Ore; and the form being pyramidal, and the streak grey or white, also agrees with this genus. From the genus Schelium-Ore, it is excluded by its too great hardness, and too little specific gravity; from the genera Tantalum, Uranium, Cerium, Chrome, Iron, and Manganese Ore, by hardness and specific gravity, both of them being too great; as also by its grey or white streak, which only agrees with that genus from which the individual differs most, by its hardness and specific gravity. The form also does not agree with any in these genera; consequently the individual can belong to no other than to the genus Tin-Ore.

This genus contains but one species. The conclusion that the individual must belong to this species, might, nevertheless, be erroneous. There could exist a second species of this genus. The dimensions of the form must now be accurately considered. If these coincide with the angles given in the character, the highest degree of certainty that the individual belongs to, or is *Pyramidal Tin-Ore*, will be obtained.

The perfect determination of an individual depends, as the above example has shewn, upon the possibility of making out correctly those three properties, viz. Form, including cleavage; Hardness, and Specific Gravity. In Botany it is the same. The characters must be observable, otherwise the species cannot be determined. In Mineralogy, the method affords sometimes more: it leads to a correct determination, even if the knowledge of the form remains imperfect. But such a determination is not perfectly satisfactory; and for this reason it will be an useful rule for beginners to occupy themselves at first with the determination of such individuals as present properties which can be easily and fully investigated. The rest will come of itself, when their knowledge of the mineral kingdom, and particularly of the properties of minerals, increases, and when they have, by experience, acquired the skill to judge properly of form and cleavage, at least so far as is necessary for the determination of the system of Crystallization, even in those cases where form and cleavage are somewhat difficult to be observed.

Optical Characters of Minerals.

To Dr Brewster Mineralogists are indebted for an important discovery, namely, the number and position of the axes of double refraction of minerals. By means of this character, we are enabled to determine mineral species; and even in those cases where neither form nor cleavage are present, to refer the mineral to its system of crystallization. We have no hesitation in considering it as a far more certain and useful aid to mineralogists than chemical analysis. It ought to be introduced into all systems of mineralogy; but we have delayed using it until some more simple and easy mode than the present of employing it shall be laid before the public; and Dr Brewster, we trust will, ere long, by the contrivance of an appropriate instrument, and the publication, for the use of the student, of a few rules for observation, render the application of the Optical Character as easy and satisfactory as that of specific gravity or form.

With the view of facilitating the use of the System to the the student, we lay before him the following characters ot the Classes and Orders *.

CHARACTERS OF THE CLASSES.

CLASS I.

If solid, is sapid. No bituminous smell. Specific gravity under 3.8.

CLASS II.

Insipid. Specific gravity above 1.8.

CLASS III.

If liquid, the smell is bituminous. If solid, is tasteless. Specific gravity under 1.8.

CHARACTERS OF THE ORDERS.

CLASS I.

Order I.—Gas.

Elastic. Not acid. Sp. gr. = 0.0001 — 0.0014.

Order II.—Water.

Liquid. Tasteless, or with sensible smell and taste. Sp. gr. = 1.1, — 1.0269.

Order III.—Acid.

Acid. Sp. gr. = 0 0015 — 3.7.

Order IV.—Salt.

Solid. Not acid. Sp. gr. = 1.2 — 2.9.

* *Vid.* Mohs' Characteristic.

CLASS II.

Order I.—Haloide.

No metallic lustre. Streak white or grey. If pyramidal, or prismatic, the hardness = 4.0, and less. If tessular, the hardness = 4.0. If single highly perfect faces of cleavage, the Sp. gr. = 2.4, and less.

Hardness = 1.5 — 5.0. If under 2.5, the Sp. gr. = 2.4, and less.

Sp. gr. = 2.2 — 3.3. If 2.4 and less, the hardness is under 2.5; and no resinous lustre.

Order II.—Baryte.

No true metallic lustre. If adamantine, or imperfect metallic lustre, the Sp. gr. = 6.0 and more. Streak white and grey, or orange-yellow. If orange-yellow, the Sp. gr. = 6.0 and more; and the hardness = 3.0 and less.

Hardness = 2.5 — 5.0. If 5.0, the Sp. gr. is under 4.5.

Sp. gr. = 3.3 — 7.2. If under 4.0, and the hardness = 5.0, the cleavage is diprismatic.

Order III.—Kerate.

No true metallic lustre. Streak white or grey. No single distinct cleavage.

Hardness = 1.0 — 2.0.

Sp. gr. = 5.5. *

Order IV.—Malachite.

No true metallic lustre. Colour blue, green, brown. If brown in colour or in streak, the hardness = 3.0 and less; and the Specific gravity above 2.5. If white in the streak, the Sp. gr. = 2.2 and less; and hardness under 3.0.

No single distinct cleavage faces.

Hardness = 2.0 — 5.0.

Sp. gr. = 2.0 — 4.6.

* The other limit of the range of specific gravity unknown.

Order V.—Mica.

If metallic lustre, the Specific gravity is under 2.2. If no metallic lustre, the specific gravity is above 2.2. If the streak is yellow, it is pyramidal. Single, perfect cleavage.

Hardness = 1.0 — 4.5. If above 2.5, it is rhomboidal.

Sp. gr. = 1.8 — 5.6. If under 2.5, it is metallic. If above 4.4 the streak is white or grey.

Order VI.—Spar.

No perfect metallic lustre. Streak white or grey,...... and brown.

If rhomboidal, the Sp. gr. = 2.2, and less, or the hardness = 6.0.

Hardness = 3.5 — 7.0. If 4.0 and less, there is a single highly perfect cleavage. If above 6.0, the Sp. gr. is under 2.5, or above 2.8; and the lustre is pearly.

Sp. gr. = 2.0 — 3.7. If above 3.3, it is hemi-prismatic; or the hardness = 6.0; and no adamantine lustre. If 2.4 and less, there are traces of form and cleavage.

Order VII.—Gem.

No metallic lustre. Streak white or grey.

Hardness = 5.5 — 10.0. If 6.0 and less, the Sp. gr. = 2.4 and less; and no traces of form or cleavage.

Sp. gr. = 1.9 — 4.7. If under 3.8, there is no pearly lustre.

Order VIII.—Ore.

If the lustre is pure metallic, the colour is black. If the lustre is not pure metallic, it is adamantine, or imperfect or semimetallic.

If the streak is yellow or red, the hardness = 3.5 and more; and the Sp. gr. = 4.8 and more. If the streak is brown or black, the hardness = 5.0 and more, or perfectly prismatoidal.

Hardness = 2.5 — 7.0. If 4.5 and less, the streak is red, yellow or black. If 6.5 and more, the streak is white or grey, and the Sp. gr. = 6.5 and more.

Sp. gr. = 3.4 — 7.4.

Order IX.—Native Metal.

Lustre metallic. Not black. If grey, it is malleable, and the Sp. gr. = 7.4 and more.

Hardness = 0.0 — 4.0, or malleable.

Sp. gr. = 5.7 — 20.0.

Order X.—Pyrites.

Metallic lustre.

Hardness = 3.5 — 6.5. If 4.5 and less, the specific gravity is less than 5.0.

Sp. gr. = 4.1 — 7.7. If 5.3 and less, the colour is yellow or red.

Order XI.—Glance.

Lustre metallic. Grey, black.

Hardness = 1.0 — 4.0.

Sp. gr. = 4.0 — 7.6. If under 5.0, and single perfect cleavage, the colour is lead-grey. If above 7.4, the colour is lead-grey.

Order XII.—Blende.

If the lustre is metallic, the colour is black. If the lustre is not metallic, it is adamantine. If the streak is brown, white, or grey, the Specific gravity is between 4.0 — 4.2; and the form tessular. If the streak is red, the Sp. gr. = 4.5 and more; and the hardness = 2.5 and less.

Hardness = 1.0 — 4.0.

Sp. gr. = 3.9 — 8.2. If 4.3 and more, the streak is red.

Order XIII.—Sulphur.

No metallic lustre. Coloured red, yellow, or brown.

Prismatic.

Hardness = 1.0 — 2.5.

Sp. gr. = 1.9 — 3.6. If above 2.1, the streak is yellow or red.

CLASS III.

Order I.—Resin.

Liquid. Solid. Streak white, grey, yellow, brown, and black.

Hardness = 0.0 — 2.5.

Sp. gr. = 0.7 — 1.6. If 1.2 and more, the streak is white or grey.

Order II.—Coal.

Solid. Streak brown and black.

Hardness = 0.1 — 2.5.

Sp. gr. = 1.2 — 1.5.

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II.

Descriptions of Minerals, whose Specific Characters have not been completely determined.

Description and Arrangement of Mountain Rocks.

Systematic View of Petrifactions.

DIVISION I.—ANIMALS.

Descriptions Omitted.

SYSTEM

OF

MINERALOGY.

SYSTEM

OF

MINERALOGY.

CLASS I.

If solid, is sapid. No bituminous smell. Specific gravity under 3.8.

Order I. GAS.

Elastic. Not acid. Sp. gr. = 0.0001,—0.00014.

Genus I. Hydrogen Gas.

Evident smell. Sp. gr. = 0.0001,—0.00014.

1. Pure Hydrogen Gas.

Specific Character.—Hydrogenous smell. Sp. gr. = 0.00012.

Constituent Parts.—Nearly pure hydrogen gas.

Geognostic and Geographic Situations.—Rises from rocks of various kinds, as from limestone, coal-formations, &c. in Europe, Asia, Africa and America. The *perpetual fires* met with in Italy, north of Asia, and other countries, are nearly pure hydrogen gas, in a state of inflammation.

2. Empyreumatic or Carburetted Hydrogen Gas.

Specific Character.—Empyreumatic smell. Sp. gr. = 0.0008.

Constituent Parts.—Is a binary compound of Carbon and Hydrogen.—*Thomson.*

Geognostic and Geographic Situations.—Rises from marshes and volcanoes; is also met with in great quantities in coal-mines, forming the *fire-damp* of miners. Frequent in many places in Great Britain.

3. Sulphuretted Hydrogen Gas.

Specific Character.—Smell of putrid eggs. Taste nauseous and bitter. Sp. gr. = 0.00135.

Constituent Parts.—

Hydrogen,	- -	6.244
Sulphur,	- -	93.756
		100 *Berzelius.*

Geognostic and Geographic Situations.—Rises from sulphureous springs; also from marshy places; and is met with in mines. Frequent in many places in Great Britain, and also on the Continent.

4. Phosphuretted Hydrogen Gas.

Specific Character.—Smell of putrid fish. Sp. gr. unknown.

Constituent Parts.—

Phosphorus,	- -	92.3
Hydrogen,	- -	7.7
		100.0

Geognostic Situation.—Rises from marshy and other places where organic substances are in a state of decomposition.

Genus II. Atmospheric Air.

Without smell or taste. Sp. gr. = 0.001,—0.0013.

1. Pure Atmospheric Air.

Specific Character.—Respirable, and without smell or taste.

Constituent Parts.—

Azotic Gas,	- -	75.55
Oxygen Gas,	- -	23.32
Aqueous Vapour,	- -	1.03
Carbonic Acid Gas,	-	0.10
		100.00

Forms the atmosphere which surrounds the earth.

ORDER II. WATER.

Liquid. Tasteless, or with sensible taste and smell. Sp. gr. = 1.1,—1.0269.

GENUS I. ATMOSPHERIC WATER.

Without smell or taste.

1. Pure Atmospheric Water.

Specific Character.—Without smell or taste.

Constituent Parts.—

Oxygen, - - -	88.3
Hydrogen, - -	11.7
	100.0

This is common rain, river and spring water. Mineral waters may be considered accidental varieties of pure atmospheric water.

GENUS II. SEA WATER.

Sensible smell and taste.

1. Common Sea Water.

Specific Character.—Bitter nauseous taste, and disagreeable smell.

Constituent Parts.—

Muriate of Soda,	170.2	grains.
Magnesia, -	30.6	
Lime, - -	5.8	
Sulphate of Soda,	21.9	
	228.5	in a Pint of Water, *Murray*.

Is the water of the ocean.

ORDER III. ACID.

Acid. Sp. gr. = 0.0015,—3.7.

GENUS I. CARBONIC ACID.

Spiritus Lethalis, *Pliny*.—Gas Sylvestre; Spiritus Sylvestre, *Paracelsus* and *Van Helmont*.—Fixed Air, *Black*.

Taste slightly acid. Sp. gr. = 0.0018.

1. Aëriform Carbonic Acid.

Specific Character.—Elastic. Taste acidulous and pungent.

Constituent Parts.—

Carbon,	27.4	
Oxygen,	72.6	
	100.0	*Gay Lussac.*

Geognostic and Geographic Situations.—Occurs in considerable abundance in marshy places; rises from acidulous waters, and abounds in many caves, as in that of Dell' Cane, near Naples, and of Aubenas in Ardeche.

is emitted from the Trap Rocks near [illegible]

Genus II. Muriatic Acid.

Smell of saffron, and strong acid taste. Sp. gr. = 0.0023.

1. Aëriform Muriatic Acid.

Muriatic Acid Gas of Chemists.

Specific Character.-Elastic. Smell pungent and suffocating.

Geognostic Situation.—Emanates from volcanoes.

Genus III. Sulphuric Acid.

If gaseous, the smell is sulphureous. If liquid, the taste is strongly acid. Sp. gr. 0.0025,—1.5.

1. Aëriform Sulphuric Acid.

Sulphurous Acid of Chemists.

Specific Character.—Elastic. Sp. gr. = 0.0028.

Geognostic Situation.—Emanates from volcanoes, and sometimes in considerable quantity.

2. Liquid Sulphuric Acid.

Specific Character.—Liquid. Sp. gr. = 1.4,—1.5.

Geognostic and Geographic Situations.—Occurs near Aix in Savoy; trickles from the roofs of caves in Ætna, and in other places in Italy. Also in similar situations in America, and in the island of Java.

Genus IV. Boracic Acid.

Solid. Sp. gr. under 3.0.

1. Scaly Boracic Acid.

Sassoline, or Native Boracic Acid.

Specific Character.—Occurs in scaly crusts. Taste first sourish, or subacid, then bitter and cooling, and lastly sweetish.

Geognostic and Geographic Situations.—Found on the edges of hot-springs near Sasso, in the territory of Florence; and also in Volcano, one of the Lipari islands.

Genus V. Arsenic Acid.

Solid. Sp. gr. above 3.

1. Octahedral Arsenic Acid.

Arsenic oxydé, *Haüy.*

Specific Character.—Tessular. Cleavage, octahedral. Taste sweetish-astringent. Hardness unknown. Sp. gr. = 3.6,—3.7.

External Characters.—Colour white. Occurs massive, in thin crusts, stalactitic, small reniform, and botryoidal; and frequently in delicate capillary shining crystals, which are scopiformly or stellularly aggregated. Lustre shining and pearly. Translucent or opaque. Soft.

Chemical Characters.—Soluble in water.

Geognostic and Geographic Situations.—Occurs as a secondary formation in veins, at Andreasberg in the Hartz, associated with native arsenic, red silver, galena, and red orpiment.

Order IV. *Salt.*

Solid. Not acid. Sp. gr. = 1.2,—2.9.

Genus I. Natron.

Prismatic. Taste pungent and alkaline. Hardness = 1.0, —1.5. Sp. gr. = 1.5,—1.6.

1. Prismatic Natron.

Prismatisches Natron-Salz, *Mohs.*—Natürliches Mineral-Alkali, *Werner.*—Soudé carbonatée, *Haüy.*

Specific Character.—Prism = 129° 60′? Pyramid unknown. Cleavage prismatic.

This species is divided into two subspecies, viz. Common Natron and Radiated Natron.

FIRST SUBSPECIES.

Common Natron.

Gemeines Natron, *Werner*.

Description.—External Characters.—Colours white, grey and yellow. When fresh, compact granular, or radiated; lustre glistening and vitreous, and more or less translucent: when weathered, is loose, dull and opaque.

Chemical Characters.—Effervesces with acids. It is easily soluble in acids, and its solution colours blue vegetable tinctures green. Easily fusible before the blowpipe.

Constituent Parts,—

	Egyptian Natron.
Dry Sub-carbonate of Soda,	32.6
Dry Sulphate of Soda, -	20.8
Dry Muriate of Soda, -	15.6
Water, - - - - -	31.6
	100.00
	Klaproth.

Is found in the oldest primitive rocks

Geognostic Situation.—Occurs as an efflorescence on the surface of soil,—on decomposing rocks of particular kinds,—on the sides and bottoms of lakes that become dry during the summer season,—also on the walls and bottoms of caves,—and dissolved in the water of lakes and springs.

Geographic Situation.—It abounds in Hungary; occurs in Bohemia, Italy, and other countries in Europe: in great quantity in the famous natron lakes in Northern Africa; in many lakes in Asia, and also in those of Mexico, and of other regions in the new world.

SECOND SUBSPECIES.

Radiated Natron.

Strahliches Natron, *Klaproth*.

External Characters.—Colours greyish and yellowish white. Occurs in crusts, in radiated distinct concretions, and crystallized in capillary or acicular crystals. Lustre glistening and vitreous; and translucent.

Chemical Characters.—Same as those of common natron.

Constituent Parts.—

	Radiated Natron.
Water of Crystallization,	22.50
Carbonic Acid, -	38.00
Pure Soda, - -	37.00
Sulphate of Soda, -	2.50
	100.00 *Klaproth.*

Geognostic and Geographic Situations.—Mr Bagge, Swedish Consul at Tripoli, gives the following information respecting this interesting subspecies of natron. "The native country of this natron, which is there called *Trona*, is the province Sukena, two days' journey from Fezzan. It is found at the bottom of a rocky mountain, forming crusts usually the thickness of a knife, and sometimes, although rarely, of an inch, on the surface of the earth. It is always crystalline: in the fracture it consists of cohering, longish, parallel, frequently radiated crystals, having the aspect of unburnt gypsum. Besides the great quantity of trona which is carried to the country of the negroes and to Egypt, fifty tons are annually carried to Tripoli. It is not adulterated with salt. The salt-mines are situated on the sea-shore; but the trona occurs twenty-eight days journey up the country." According to Mr Barrow, it would appear also to occur in the district of Tarka, in Boshieman's Land, in Southern Africa.

Uses.—It is principally employed in the manufacture of glass and soap, in dyeing, and for the washing of linen. It is sometimes purified before it is used, but more frequently (particularly that from Egypt) it is used in its natural state.

Genus II. Glauber Salt.

Prismatic. Taste first cooling, and then saline and bitter. Hardness = 1.5,—2.0. Sp. gr. 2.2,—2.3.

1. Prismatic Glauber Salt.

Prismatisches Glauber Salz, *Mohs.*—Natürliches Glauber Salz, *Werner.*—Soude sulphatée, *Haüy.*

Specific Character.—Prismatic. Pyramid unknown. Cleavage P + ∞ = 105° (nearly).

External Characters.—Colours white. Occurs in the form of mealy efflorescences; in crusts; seldom stalactitic, small botryoidal, reniform; in small and fine granular distinct concretions; and crystallized in prisms, which are often acicular. Internally shining, and lustre vitreous. Fracture conchoidal, or uneven. Brittle, and easily frangible. More or less transparent and translucent.

Chemical Characters.—Before the blowpipe, it is affected in the same manner as Epsom salt, but its solution does not, like that of Epsom salt, afford a precipitate with an alkali.

Geognostic and Geographic Situations.—It occurs in different parts of Europe and Asia, along with rock-salt and Epsom salt, on the borders of salt-lakes, and dissolved in the waters of lakes; in efflorescences on moorish ground; also on sandstone, marl-slate, and on old and newly built walls.

Uses.—It is used as a purgative medicine; and in some countries as a substitute for soda, in the manufacture of white glass.

Genus III. Nitre.

Prismatic. Taste, cooling and saline. Hardness = 2.0. Sp. gr. 1.9, 2.0.

1. Prismatic Nitre.

Prismatiches Nitrum-Salz, *Mohs.*—Natürlicher Salpeter, *Werner.* —Potasse nitratée, *Haüy.*

Specific Character.—Prismatic. Pyramid $= 132° 22'; 91° 15'; 107° 43'$. Cleavage, $P + \infty = 120°$. More distinct $Pr + \infty$.

External Characters.—Colour white. Occurs in flakes, crusts, and in capillary prismatic crystals. Dull, glimmering, or shining, and lustre vitreous. Alternates from translucent to transparent. Brittle, and easily frangible.

Chemical Characters.—Deflagrates when thrown on hot coal.

Constituent Parts.—The natural nitre of Molfetta, according to Klaproth:

Nitrate of Potash,	42.55	
Sulphate of Lime,	25.45	
Carbonate of Lime,	30.40	
Muriate of Potash ?	0.20	
Loss,	1.40	
	100.00	*Klaproth.*

Geognostic Situation.—It is usually found in thin crusts on the surface of soil, and sometimes also covering the surface of compact limestone, chalk, and calc-tuff. In many countries it germinates in certain seasons out of the earth, and when this earth is accumulated in heaps, so as to expose a large surface to the atmosphere, it is found to produce it annually.

Geographic Situation.—It is found in great quantities in many places in Spain; in Hungary; and uncommonly abundant in India; and plentiful in limestone caves in the United American States.

Uses.—In Hungary, Spain, and the East Indies, considerable quantities of natural nitre are collected; but most of that used in commerce, is obtained by working artificial nitre beds. These consist of the refuse of animal and vegetable bodies, undergoing putrefaction, mixed with calcareous and other earths. Its principal use is in the fabrication of gunpowder: it is also used in medicine, and in many of the arts.

Genus IV. Rock-Salt.

Steinsalz, *Werner* and *Mohs.*

Tessular. Cleavage, hexahedral. Taste saline. Hardness $= 2.0$. Sp. gr. $= 2.2, 2.3$.

1. Hexahedral Rock-Salt.

Hexaedrisches Steinsalz, *Mohs.*—Natürlich Kochsalz, *Werner.*—Soude muriatée, *Haüy.*

Specific Character.—Tessular. Cleavage, hexahedral.

This species is divided into two subspecies, viz. Rock-Salt and Lake-Salt.

FIRST SUBSPECIES.

Rock-Salt.

Steinsalz, *Werner.*

This subspecies is divided into two kinds, viz. Foliated Rock-Salt and Fibrous Rock-Salt.

First Kind.

Foliated Rock-Salt.

Blättriches Steinsalz, *Werner.*

External Characters.—Colours white, grey, yellow, red, blue, and green. Occurs massive, disseminated, in minute veins, in crusts, plates, and stalactitic; also in distinct concretions, which are fine angulo-granular, and these sometimes incline to prismatic, and also crystallized. On the fresh fracture shining or splendent, lustre resinous. Fracture conchoidal. Fragments cubic. In general strongly translucent, sometimes semitransparent and transparent. Feels rather greasy. Rather brittle, and easily frangible.

		Cheshire Rock-Salt.
Constituent Parts.—	Muriate of Soda, - -	$983\frac{1}{4}$
	Sulphate of Lime, - -	$6\frac{1}{2}$
	Muriate of Magnesia, - -	$0\frac{3}{10}$
	Muriate of Lime, - -	$0\frac{1}{10}$
	Insoluble Matter, - -	10
		1000.0
		Henry.

Second Kind.

Fibrous Rock-Salt.

Fasriges Steinsalz, *Werner.*

External Characters.—Colours white and grey; more rarely it is marked with stripes of red and blue. Occurs massive and dentiform; also in distinct concretions, which are straight and curved fibrous. Internally shining and glistening, and lustre resinous. Fragments splintery. Strongly translucent, verging on semi-transparent. In other characters it resembles the preceding kind.

Chemical Characters.—It decrepitates briskly when exposed to the action of the blowpipe, or when laid on burning coals.

Geognostic Situation.—Occurs in transition rocks in Switzerland, and in secondary rocks in Germany, England, and South America.

Geographic Situation.—The principal deposite of salt in this island is that in Cheshire, where there are several beds that vary in thickness from four feet to upwards of one hundred and thirty fect, and alternate with clay and marl, which contain compact, foliated, granular, and radiated gypsum. Rock-salt also occurs at Droitwich in Worcestershire.

Uses.—Its uses are very various and important. We employ it daily as a seasoning for our food: vast quantities are employed for the preservation of animal flesh, butter, &c.; it is also used in the manufacture of earthen-ware, soap-making, and in many metallurgic operations. It affords muriatic acid and soda by certain chemical processes. It is sometimes employed in its crude state, but is more commonly purified.

Rock salt has never been found in Scotland

SECOND SUBSPECIES.

Lake-Salt.

Seesalz, *Werner.*

External Characters.—Colour greyish-white. Occurs in coarse and roundish grains. Internally shining or glistening, and lustre resinous. Fracture imperfect foliated. In other characters it agrees with the preceding subspecies.

Geognostic and Geographic Situations.—It is found on the bottoms and sides of salt-lakes. In Egypt, Asia, and also in Africa and America.

GENUS V. SAL AMMONIAC.

Tessular. Taste pungent and urinous. Hardness = 1.5,—2.0. Sp. gr. 1.5,—1.6.

1. Octahedral Sal Ammoniac.

Octaedrisches Salmiac, *Mohs.*—Natürlicher Salmiac, *Werner.*—Ammoniaque muriatée, *Haüy.*

Specific Character.—Tessular. Cleavage, octahedral.

This species is divided into two subspecies, viz. Volcanic Sal Ammoniac and Conchoidal Sal Ammoniac.

FIRST SUBSPECIES.

Volcanic Sal Ammoniac.

Vulcanischer Salmiac, *Karsten.*

External Characters.—Colours white, grey, yellow, and sometimes apple-green and brownish-black. Occurs in efflorescences, crusts, stalactitic, small botryoidal, tuberose, corroded, also in granular concretions, and crystallized in octahedron and in leucite forms. Externally dull or glistening; internally shining and vitreous. Alternates from transparent to opaque. Slightly ductile and elastic.

Chemical Characters.—When moistened, and rubbed with quicklime, it gives out a pungent ammoniacal odour.

		Sal Ammoniac of Vesuvius.
Constituent Parts.—Muriate of Ammonia,	-	99.5
Muriate of Soda,	-	0.5
		100.0 *Klaproth.*

Geognostic Situation.—As its name implies, it is a volcanic production, occurring in the fissures, or on the surface of volcanic or pseudo-volcanic rocks.

Geographic Situation.—It occurs in the vicinity of burning beds of coal, both in Scotland and England; and in many volcanic districts in different parts of the world.

SECOND SUBSPECIES.

Conchoidal Sal Ammoniac.

Muschlicher Salmiak, *Karsten.*

External Characters.—Colour white. Occurs in angular pieces. Surface uneven. Externally glimmering; internally shining and vitreous. Fracture conchoidal. Semi-transparent or transparent. Malleable. Soft.

Constituent Parts.—Muriate of Ammonia,		97.50
Sulphate of Ammonia,	-	2.50
		100.0 *Klaproth.*

Geognostic and Geographic Situations.—Is said to occur, along with sulphur, in rocks of indurated clay, or indurated clay-slate, in the country of Bucharia.

Uses.—Sal ammoniac is employed by coppersmiths, to prevent the oxidation of the surface of the metals they are covering with tin. It renders many metallic oxides volatile, and is frequently used to separate metals from each other.

* Mascagnine, or Sulphate of Ammonia.

Mascagnin, *Karsten.*

External Characters.—Colours grey and yellow. Occurs in mealy crusts, or stalactitic. Internally dull or glistening. Fracture uneven or earthy. Semi-transparent or opaque. Taste pungent and bitter.

Chemical Characters.—It is easily soluble in water; partly volatilised by heat; and becomes moist on exposure to the air.

Geognostic and Geographic Situations.—It occurs among the lavas of Ætna and Vesuvius.

Genus VI. Vitriol.

Pyramidal, prismatic. Taste astringent. Hardness = 2.0,—2.5. Sp. gr. = 1.9,—2.3.

1. Hemi-prismatic Vitriol, or Green Vitriol.

Hemiprismatisches Vitriol Salz, *Mohs.*—Eisen Vitriol, *Werner.* —Fer sulfatée, *Haüy.*

Specific Character.—Hemi-prismatic. Pyramid unknown. Cleavage in the direction of a prism. Green. Hardness = 2.0. Sp. gr. = 1.9,—2.0.

External Characters.—Colour green, but on exposure to the air becomes yellow, and yellowish-brown. Occurs pulverulent, massive, disseminated, stalactitic, tuberose, botryoidal, reniform, in fibrous distinct concretions, and crystallized. Shining, both externally and internally, and the lustre vitreous, with exception of the fibrous varieties, which are pearly. Fracture flat conchoidal. Alternates from semi-transparent to opaque. Refracts double.

Chemical Character.—Before the blowpipe, on charcoal, it becomes magnetic, and colours glass of borax green.

Constituent Parts.—Oxide of Iron,	-	25.7
Sulphuric Acid,	-	28.9
Water,	- -	45.4
		100.0 *Berzelius.*

Geognostic and Geographic Situations.—It is always associated with iron-pyrites, from which it is formed by decomposition. Occurs in several coal-mines in this country, and in many iron and coal mines on the Continent of Europe, and also in America and Asia.

Uses.—It is employed to dye linen yellow, and wool and silk black; in the preparation of ink; of Berlin-blue; for the precipitation of gold from its solution; and sulphuric acid can be obtained from it by distillation. The residue of the latter process (colcothar of iron) is used as a red paint, and, when washed, for polishing steel.

2. Prismatic Vitriol, or Blue Vitriol.

Prismatisches Vitriol-Salz, *Mohs.*—Kupfervitriol, *Werner.*—Cuivre sulfatée, *Haüy.*

Specific Character.–Tetarto-prismatic. Pyramid unknown. Cleavage, two faces, one more distinct than the other; incidence 124° 2′. Hardness = 2.5. Sp. gr. = 2.2,—2.3.

External Characters.—Common colour dark sky-blue, which sometimes approaches to verdigris-green. On exposure to the air it becomes yellow. Occurs massive, disseminated, stalactitic; and dentiform, and crystallized. Externally and internally shining and vitreous. Fracture conchoidal. Translucent.

Chemical Characters.—When a portion of it is dissolved in water, and spread on the surface of iron, it immediately covers it with a film of copper.

Constituent Parts.—Oxide of Copper,	-	32.13
Sulphuric Acid,	- -	31.57
Water,	- -	36.30
		100.00 *Berzelius.*

Geognostic and Geographic Situations.—It occurs along with copper-pyrites, in Pary's mine in Anglesea; and also in the copper-mines in the county of Wicklow in Ireland.

Uses.—It is used in cotton and linen-printing; and the oxide separated from it is used by painters.

3. Pyramidal Vitriol, or White Vitriol.

Pyramidales Vitriol-Salz, *Mohs.*—Zink-vitriol, *Werner.*—Zinc sulfatée, *Haüy.*

Specific Character.—Pyramidal. Pyramid = 120°; 90°. Cleavage unknown, and imperfect. White. Hardness unknown. Sp. gr. = 2.0.

External Characters.—Colour white. Occurs massive, stalactitic, reniform, botryoidal, in crusts; also in radiated, fibrous and granular distinct concretions; and crystallized. It is shining, translucent, brittle, and easily frangible.

Chemical Characters.—It intumesces before the blowpipe, but does not phosphoresce; it dissolves in 2.285 parts of boiling water.

		From Rammelsberg.
Constituent Parts.—	Oxide of Zinc, - -	27.5
	Oxide of Manganese, -	0.5
	Sulphuric Acid, - -	22.0
	Water, - - -	56.0
		100.0 *Klaproth.*

Geognostic and Geographic Situations.—Occurs in repositories that contain blende, and appears to be formed by the decomposition of that mineral. Occurs at Holywell in Flintshire; and it is said also in Cornwall.

Uses.—It is used as a medicine; is employed in great quantities by varnishers to make oil drying; and a fine white colour named *Zinc-white*, which is more durable than white-lead, is prepared from it. To prepare this colour, the salt is dissolved in water, and the white oxide, which is the zinc-white, is precipitated from it by means of potash or chalk.

* Red Vitriol or Sulphate of Cobalt.

Kobaltvitriol, *Werner.*

External Characters.—Colour red. Occurs coralloidal, stalactitic, in crusts; also in granular distinct concretions. Surface rough, and longitudinally furrowed. Dull, and seldom shining on the surfaces of the distinct concretions, and lustre pearly. Fracture earthy. Opaque. Affords a yellowish-white streak. Easily friable, and brittle. Taste styptic.

Chemical Characters.—Its solution affords, with carbonate of potash, a pale-bluish precipitate, which tinges borax of a pure blue colour.

Constituent Parts.—

Oxide of Cobalt,	38.71	
Sulphuric Acid,	19.74	
Water,	41.55	
	100.00	*Koppe.*

Geognostic and Geographic Situations.—Occurs in mining-heaps in Biber, along with lamellar heavy-spar, earthy cobalt, and grey cobalt; and has been also found in the Leogang at Salzburg.

Genus VII. Epsom Salt.

Prismatic. Taste bitter and saline. Hardness unknown. Sp. gr. unknown.

1. Prismatic Epsom Salt.

Bittersalz, *Mohs.*—Natürlicher Bittersalz, *Werner.*—Magnésie sulfatée, *Haüy.*

Specific Character.—Prismatic. Pyramid unknown. Cleavage very perfect prismatoidal.

External Characters.—Colours white and grey. Occurs in farinaceous crusts, flakes, small botryoidal, reniform, and crystallized. Prisms acicular and capillary. The farinaceous variety is dull, the others shining, glistening, and pearly. Varies from transparent to opaque. Brittle, and easily frangible.

Chemical Characters.—Before the blowpipe, it dissolves very easily by the assistance of its water of crystallization, but it is difficultly fusible. Its solution gives a precipitate with lime-water.

Constituent Parts.—The constituent parts of purified Epsom salt, the sulphate of magnesia of chemists, are, according to Kirwan,

Sulphuric Acid,	29.46
Magnesia,	17.00
Water of Crystallization,	53.54
	100.00

Geognostic and Geographic Situations.—It occurs as an efflorescence at Hurlet, near Paisley, along with natural alum; and sometimes on old walls.

Uses.—When purified, it is used as a purgative medicine; and it is valued by chemists on account of the magnesia which can be obtained from it.

Gen. VIII. Alum.

Tessular. Taste sweetish astringent and acidulous. Hardness = 2.0,—2.5. Sp. gr. = 1.7,—1.8.

1. Octahedral Alum.

Octaedrisches Alaun, *Mohs.*—Natürlicher Alaun, *Werner.*

Specific Character.—Tessular. Cleavage octahedral.

External Characters.—Colour white. Occurs as a farinaceous efflorescence, stalactitic, in delicate curved and parallel fibrous concretions. The varieties with fibrous concretions have a pearly lustre; others are glistening and vitreous. When the fracture can be observed, it is conchoidal.

Chemical Characters.—It is soluble in from sixteen to twenty times its weight of water. It melts easily by means of its water of crystallization; and by continuance of the heat, it is converted into a white spongy mass.

Constituent Parts.—

	Natural Alum of Freinwald.
Alumina,	15.25
Potash,	0.25
Oxide of Iron,	7.50
Sulphuric Acid, and Water,	77.00
	100.00 *Klaproth.*

Geognostic Situation.—It generally occurs as an efflorescence on aluminous minerals, as alum-slate, alum-earth, alum-stone, aluminous coal, aluminous slate-clay, and bituminous-shale, and also encrusting lavas.

Geographic Situation.—It occurs as an efflorescence on the surface of bituminous-shale and slate-clay at Hurlet near Paisley; also encrusting alum-slate near Moffat, in Dumfriesshire; Ferrytown of Cree, in Galloway; and at Whitby in Yorkshire.

Uses.—It is employed as a mordant in dyeing; also in the manufacture of leather and paper; as a medicine; for preserving animal substances from putrefaction; and it is sometimes mixed with bread, in order to give it a whiter colour.

* Rock-Butter (*a*).

Bergbutter, *Werner.*

External Characters.—Colours white, grey, and yellow. Occurs massive, and tuberose. Internally strongly glimmering, and resinous. Fracture straight foliated. Translucent on the edges. Feels rather greasy. Easily frangible.

Constituent Parts.—It is Alum, mixed with Alumina and Oxide of Iron.

Geognostic Situation.—Oozes out of rocks that contain alum, or its constituents, as alum-slate, bituminous-shale impregnated with iron-pyrites, or alum-earth.

Geographic Situation.—Occurs at the Hurlet alum-work, near Paisley; oozing out of rocks of alum-slate in the island of Bornholm, in the Baltic; and in other places.

Genus IX. Borax.

Borax-Salz, *Mohs.*

Prismatic. Taste sweetish, and feebly alkaline. Hardness $= 2.0, - 2.5$. Sp. gr. $= 1.5, - 1.7$.

1. Prismatic Borax.

Prismatisches Borax-Salz, *Mohs.*—Soude boratée, *Haüy.*

Specific Character.—Hemi-prismatic. $P = 152° \, 9'$; $120° \, 23'$; $67° \, 3'$. $\frac{P}{2} = 120° \, 23'$. $P + \infty = 52° \, 53'$. Cleavage $(P\breve{r} + \infty)^3 = 88° \, 9'$. More distinct $P\breve{r} + \infty$.

External Characters.—Colours white, grey, and green. Occurs crystallized; and the following are some of its secondary forms:

1. Irregular six-sided prism, with alternate broad and narrow lateral faces, and oblique terminal faces. 2. Irregular six-sided prism; sometimes bevelled on the extremities, the bevelling planes set on the smaller lateral planes. 3. Irregu-

lar eight-sided prism. Internally shining and resinous. Fracture flat conchoidal. Semi-transparent. Refracts double.

Chemical Characters.—Intumesces before the blowpipe, and melts into a transparent glass.

Constituent Parts.—Boracic Acid,	37.00	
Soda,	14.50	
Water,	47.00	
	98.50	*Klaproth.*

Geognostic and Geographic Situations.—Occurs dissolved in the water of springs, and in the soil, of different districts in Persia; and in Thibet, it is found in similar situations.

Uses.—It is employed as a flux for metals, and as an ingredient in artificial gems; but its principal use is in facilitating the soldering of the more precious metals.

Genus X. Glauberite.

Brithyn Salz, *Mohs.*

Prismatic. Taste saline and feebly astringent. Hardness = 2.5,—3.0. Sp. gr. = 2.7,—2.9.

1. Prismatic Glauberite.

Prismatisches Brithyn Salz, *Mohs.*—Glauberite, *Haüy.*

Specific Characters.—Hemi-prismatic. Pyramid unknown. Cleavage $\frac{P\bar{r}}{2}$, perfect. Indistinct $P + \infty = 104^\circ\ 28'$.

External Characters.—Colours white and yellow. Occurs crystallized in oblique four-sided prisms. Shining. Fracture conchoidal. Transparent. Brittle.

Chemical Characters.—Decrepitates before the blowpipe, and melts into a white enamel. Becomes opaque in water, and is partly soluble in it.

Constituent Parts.—Dry Sulphate of Lime,	49.0	
Dry Sulphate of Soda,	51.0	
	100.0	*Brongniart.*

Geognostic and Geographic Situations.—Occurs imbedded in rock-salt at Villaruba, near Ocana in New Castile in Spain.

CLASS II.

Insipid. Specific gravity above 1.8.

ORDER I. HALOIDE *.

No metallic lustre. Streak white or grey.

If pyramidal, or prismatic, the hardness = 4.0, and less. If tessular, the hardness = 4.0. If single highly perfect faces of cleavage, the sp. gr. = 2.4, and less.

Hardness = 1.5,—5.0. If under 2.5, the sp. gr. = 2.4, and less.

Sp. gr. = 2.2,—2.3. If 2.4 and less, the hardness is under 2.5; and no resinous lustre.

GENUS I. GYPSUM. 90405

Mentioned

Prismatic. Hardness = 1.5,—3.5. Sp. gr. = 2.2,—3.0. If above 2.5, there are cleavages in three directions, perpendicular to each other, and one less distinct than the others.

1. Prismatoidal.

Prismatoidisches Gyps-Haloid, *Mohs.*—Chaux sulfatée, *Haüy.*

Specific Character.—Hemi-prismatic. Pyramid = 149° 33′; 135° 32′; 54° 52. $\frac{P}{2} = 149° 33'$. $P + \infty = 110° 30'$. Cleavage, $\frac{P\bar{r}}{2}$. $P\bar{r} + \infty$ (inclination of $\frac{P\bar{r}}{2}$ to $P\bar{r} + \infty = 113° 6'$). More distinct and perfect, $P\breve{r} + \infty$. Hardness = 1.5, —2.0. Sp. gr. = 2.2,—2.4.

This species contains six subspecies, viz. Sparry or Selenite, Foliated, Compact, Fibrous, Scaly Foliated, and Earthy, * Montmartrite.

* From ἅλς, *salt*; and εἶδος, *the appearance*, (habitus.)

FIRST SUBSPECIES.

Sparry Gypsum or Selenite.

Fraueneis, *Werner*.

External Characters.—Colours grey, white, yellow, and brown. Some varieties display iridescent colours. Occurs massive, coarsely disseminated, also in distinct concretions, which are large and coarse granular, and sometimes inclining to thick lamellar; and crystallized. The following are some of the secondary figures:

1. Six-sided prism, in which the terminal faces are sometimes conical, or spherical-convex, or are bevelled or acuminated with four planes. 2. Lens. 3. Twin-crystals. These twin-crystals are formed, either by two lenses, attached by their faces, or by two six-sided prisms pushed into each other in the direction of their breadth, in such a manner, that the united summits at one extremity form a re-entering angle, but at the other a salient angle, or four-planed acumination. When two such twin-crystals are pushed into each other in the direction of their length, a Quadruple crystal is formed.

Lateral planes of the prism sometimes smooth, sometimes longitudinally streaked, and shining; the convex terminal faces, and faces of the lens, rough and dull. Internally, lustre splendent and pearly. Alternates from semi-transparent to transparent. Refracts double. Sectile. Very easily frangible. In thin pieces flexible, but not elastic.

Chemical Characters.—Exfoliates before the blowpipe, and, if the flame is directed towards the edge of the folia, it melts into a white enamel, which, after a time, falls into a white powder.

Constituent Parts.—	Lime,	33.9	
	Sulphuric Acid,	43.9	
	Water,	21.0	
	Loss,	2.1	
		100.00	*Bucholz.*

Geognostic Situation.—Occurs principally in secondary gypsum: less frequently in rock-salt; more rarely as a constituent part of metalliferous veins; but in considerable quantity in the Blue or London Clay.

Geographic Situation.—It is not unfrequent in the blue clay in the south of England, as at Shotover Hill, near Oxford, and occurs in the secondary gypsum around Paris.

Uses.—At a very early period, before the discovery of glass, selenite was used for windows; and at present it is employed for the finest kind of stucco, and the most delicate pastil colours. When burnt, and perfectly dry, it is used for cleansing and polishing precious stones, work in gold and silver, and also pearls.

SECOND SUBSPECIES.

Foliated Granular Gypsum.

Blættriger Gyps, *Werner.*

External Characters.—Most common colours white, grey, and red; seldomer yellow, brown, and black. Occurs massive, also in granular and prismatic distinct concretions. Sometimes crystallized in small conical lenses, in which the surface is rough. Lustre passes from shining through glistening to glimmering, and is pearly. Fragments very blunt-edged. Translucent. Sectile, and very easily frangible.

Geognostic Situation.—Occurs in beds in primitive rocks: in a similar repository in transition limestone and clay-slate; but most abundantly in beds in rocks of the secondary or flœtz class.

Geographic Situation.—Occurs in Cheshire and Derbyshire; at the Segeberg, near Kiel, and at Lüneburg, and in both places it contains crystals of boracite, and sometimes of quartz.

Uses.—The foliated and compact subspecies of gypsum, when pure, and capable of receiving a good polish, are by artists named simply *Alabaster*, or, to distinguish them from calc-sinter, or what is called Calcareous Alabaster, *Gypseous Alabaster*. The finest white varieties of granular gypsum are selected by artists for statues and busts: the variegated kinds are cut into pillars, and various ornaments, for the interior of halls and houses; and the most beautiful variegated sorts are cut into vases, columns, plates, and other kinds of table furniture. Those varieties that contain imbedded portions of selenite, when cut across, exhibit a beautiful iridescent appearance, and are named *Gypseous Opal.* The pure white varieties are used as ingredients in the composition of earthenware and porcelain; and the glaze or enamel with which porcelain is covered, has the purest gypsum, or even selenite, as one of its ingredients. Its most important use is in the preparation of *stucco.*

Easily distinguished from marble by yielding to the nail

THIRD SUBSPECIES.

Compact Gypsum.

Dichter Gypsum, *Werner.*

External Characters.—Colours white, grey, blue, red, and sometimes yellow. Occurs massive. Generally dull, seldom feebly glimmering. Fracture fine splintery, passing on the one side into even, on the other into fine-grained uneven. Fragments indeterminate angular, and blunt-edged. Translucent on the edges.

Chemical Characters.—All the different varieties of gypsum, when exposed to heat, are deprived of their water of crystallization, become opaque, fall into a powder, which, when mixed with water, speedily hardens on exposure to the air. They are difficultly fusible before the blowpipe, without addition, and melt into a white enamel: when heated with charcoal, they are converted into sulphuret of lime.

Geognostic Situation.—Occurs in beds, along with granular gypsum, selenite, and stinkstone, in the secondary class of rocks.

Geographic Situation.—Occurs in the Campsie Hills; Derbyshire; Ferrybridge in Yorkshire; and in Nottinghamshire, and other districts in England.

FOURTH SUBSPECIES.

Fibrous Gypsum.

Fasriger Gyps, *Werner.*

External Characters.—Principal colours white and grey; also occurs red and yellow. Occurs massive, and dentiform; also in fibrous distinct concretions, which are parallel, generally straight, and sometimes curved. Lustre passes from glistening, through shining to splendent, and is pearly. Fragments are long splintery. Translucent.

Constituent Parts.—

Lime,	33.00	
Sulphuric Acid,	44.13	
Water,	21.00	
	98.13	*Bucholz.*

Geognostic Situation.—Occurs along with the other subspecies of this species.

Geographic Situation.—Occurs in red sandstone near Moffat; in red clay, on the banks of the Whitadder in Berwickshire; in Dunbartonshire; also in Cumberland, Yorkshire, Cheshire, Worcestershire, Derbyshire, Somersetshire, and Devonshire.

Uses.—When cut *en cabochon*, and polished, it reflects a light not unlike that of the cat's-eye. It is also cut into necklaces, ear-pendents, and crosses.

FIFTH SUBSPECIES.

Scaly Foliated Gypsum.

Schaumgyps, *Werner.*

External Characters.—Colour white. Occurs massive and disseminated; also in distinct concretions, which are small and scaly granular. Internally glistening and pearly. Fracture small scaly foliated. Fragments blunt-edged. Opaque, or translucent on the edges. Sectile, and easily frangible.

Geognostic and Geographic Situations.—Occurs with selenite and compact gypsum at Montmartre, near Paris.

SIXTH SUBSPECIES.

Earthy Gypsum.

Gyps-erde, *Werner.*

External Characters.—Colours white and grey. Composed of fine scaly or dusty particles, which are more or less cohering. Feebly glimmering. Feels meagre, and rather fine. Soils slightly. Light.

Geognostic Situation.—It is found immediately under the soil, in beds several feet thick, resting on gypsum, and also in nests or cotemporaneous masses imbedded in it.

Geographic Situation.—Occurs in Saxony, Switzerland, Salzburg, and Norway.

* Montmartrite.

Chaux sulfatée calcarifère, *Lucas & Haüy*.—Gypsum of Montmartre.

External Characters.—Colour yellowish. Occurs massive, but never crystallized. Soft. Effervesces with nitric acid.

The Montmartrite is composed of gypsum and carbonate of lime. This carbonate is converted into quicklime in the furnace, and thus a kind of mortar is formed: it is on this account, that the *plaster* made of this mineral may be used in work exposed to the weather; while that of pure gypsum, on exposure, soon yields to the action of rain. The montmartrite contains, about

Sulphate of Lime,	- -	83
Carbonate of Lime,	- -	17
		100

Geognostic and Geographic Situations.—Occurs along with gypsum at Montmartre near Paris.

2. Prismatic Gypsum, or Anhydrite.

Prismatisches Gyps-Haloide, *Mohs*.—Muriacit, *Werner*.—Chaux anhydro-sulfatée, *Haüy*.

Prismatic. Pyramid $= 121° 32'$; $108° 35'$; $99° 7'$. Cleavage, $P - \infty$. More perfect $P\breve{r} + \infty$. $P\bar{r} + \infty$. Traces of $P + \infty = 100° 8'$. Hardness $= 3.0, - 3.5$. Sp. gr. $= 2.7, - 3.0$.

It is divided into five subspecies, viz. Sparry, Scaly, Fibrous, Conchoidal, and Compact. * Vulpinite.

FIRST SUBSPECIES.

Sparry Anhydrite, or Cube-Spar.

Wurfelspath, *Werner*.

External Characters.—Chief colour white, which passes on the one side into blue, and on the other into red. Occurs massive; also in distinct concretions, which are thin and straight lamellar, collected into others which are large granular. Sometimes crystallized in the following figures:

1. Rectangular four-sided prism, which is sometimes so low as to appear as a four-sided table. 2. Broad six-sided prism.

3. Eight-sided prism. 4. Broad rectangular four-sided prism, acuminated on the extremities with four planes, which are set on the lateral edges, and the apex of the acumination deeply truncated.

Externally shining or splendent, and pearly: internally splendent and pearly. Fracture conchoidal. Fragments cubical. Alternates from transparent to strongly translucent, and refracts double. Brittle, and very easily frangible.

Chemical Characters.—When exposed to the blowpipe, it does not exfoliate, and melt like gypsum, but becomes glazed over with a white friable enamel.

Constituent Parts.—

	From Tyrol.
Lime, - - -	41.75
Sulphuric Acid, - -	55.00
Muriate of Soda, - -	1.00
	97.55 *Klaproth.*

Geognostic and Geographic Situations.—Occurs in the gypsum of Nottinghamshire, in the salt-mines of Hall in the Tyrol, and in other countries.

SECOND SUBSPECIES.

Scaly Anhydrite.

Anhydrite, *Werner.*

External Characters.—Colours white, smalt-blue, and rarely grey. Occurs massive, and in small granular concretions. Lustre splendent and pearly. Translucent on the edges. Easily frangible.

Geognostic and Geographic Situations.—It is found in the salt-mines of Hall in the Tyrol, 5088 feet above the level of the sea.

THIRD SUBSPECIES.

Fibrous Anhydrite.

Fasriger Muriacit, *Werner.*

External Characters.—Colour red; also blue and grey. Occurs massive, and in coarse fibrous concretions, which are straight or curved, and sometimes stellular. Internally glimmering and glistening, and pearly. Fragments long splintery. Translucent on the edges, or feebly translucent. Rather easily frangible.

Geographic Situation.—Occurs in the salt-mines of Upper Austria, at Hall in the Tyrol, and in Carinthia.

Uses.—The blue varieties are sometimes cut and polished for ornamental purposes.

FOURTH SUBSPECIES.

Convoluted Anhydrite.

Gekröstein, *Werner.*

External Characters.—Colour dark milk-white. Occurs massive; intestinally convoluted or contorted; also in distinct concretions, which are thick lamellar, and thin prismatic. Internally glistening or glimmering, and lustre pearly. Fracture splintery. Translucent on the edges, or translucent.

Geognostic and Geographic Situations.—Occurs in the salt-mines of Bochnia, and at Wieliczka in Poland.

FIFTH SUBSPECIES.

Compact Anhydrite.

Dichter Muriacit, *Werner.*

External Characters.—Colours bluish-white, and tile-red. Sometimes with spotted delineations. Occurs massive; also in granular distinct concretions. Feebly glimmering, or dull. Fracture small splintery, passing into even and flat conchoidal. Alternates from translucent to translucent on the edges.

Geognostic and Geographic Situations.—Occurs in beds in the salt-mines of Austria and Salzburg; and also in secondary gypsum, on the eastern foot of the Hartz mountains.

* Vulpinite.

External Characters.—Colour greyish-white, and veined with bluish-grey. Occurs massive, and in granular concretions. Internally splendent. Translucent on the edges. Brittle. Easily frangible.

Chemical Characters.—It melts easily before the blowpipe into a white opaque enamel; and becomes feebly phosphorescent when thrown on glowing coals.

Constituent Parts.—	Sulphate of Lime, -	92.0
	Silica, - - -	8.0
		100.0 *Vauquelin.*

Geognostic and Geographic Situations.—Occurs along with granular foliated limestone and quartz, and occasionally with sulphur. It is found at Vulpino in Italy.

Uses.—It takes a very fine polish, and is employed by the statuaries of Bergamo and Milan for making slabs, chimney-pieces, &c.

GENUS II. CRYOLITE.

Before the Blowpipe

Kryon-Haloide, *Mohs.*

Prismatic. Cleavage in three directions, perpendicular to each other, of which one is more perfect than the others. Hardness = 2.5,—3.0. Sp. gr. = 2.9,—3.0.

1. Prismatic Cryolite.

Kryolite, *Werner.*—Prismatisches Kryon-Haloid, *Mohs.*—Alumine fluatée alcaline, *Haüy.*

Specific Character.—Prismatic. Pyramid unknown. Cleavage, $P - \infty$. Less distinct, $P\breve{r} + \infty$. $P\bar{r} + \infty$. Traces of P.

External Characters.—Colours white, brown, and red. Occurs massive, disseminated, and in straight lamellar concretions. It is shining, inclining to glistening, and lustre vitreous, inclining to pearly. Fracture uneven. Fragments cubical or tabular. Translucent. Brittle, and easily frangible.

Chemical Characters.—It becomes more translucent in water, but does not dissolve in it. It melts before it reaches a red heat, and when simply exposed to the flame of a candle. Before the blowpipe, it at first runs into a very liquid fusion, then hardens, and at length assumes the appearance of a slag.

Constituent Parts.—	Alumina, - - -	24.0
	Soda, - - - -	36.0
	Fluoric Acid and Water,	40.0
		100.0 *Klaproth.*

Geognostic and Geographic Situations.—This curious and rare mineral has been hitherto found only in West Greenland, where it occurs in thin layers in gneiss.

Genus III. Alumstone.

Alaun Haloide, *Mohs.*—Alaunstein, *Werner.*

Rhomboidal. Hardness = 5.0. Sp. gr. = 2.4,—2.6.

1. Rhomboidal Alaunstein.

Rhomboedrisches Alaun Haloide, *Mohs.*

Specific Character.—Rhomboidal. Rhomboid unknown. Cleavage. R — ∞. R.

External Characters.—Colours white, red, and more rarely grey. Sometimes several of these colours occur together in spotted, striped, and veined delineations. Occurs massive, sometimes porous, or in vesicular cavities, of which the walls are lined with small crystals. Internally dull, or feebly glimmering. Fracture uneven, which passes into splintery, earthy, and flat conchoidal. Feebly translucent on the edges. Brittle and easily frangible.

Constituent Parts.—	Alumstone from Tolfa.
Alumina,	43.92
Silica,	24.00
Sulphuric Acid,	25.00
Potash,	3.08
Water,	4.00
	100.00 *Vauquelin.*

Geognostic and Geographic Situations.—Occurs at Tolfa, near Civita Vecchia, in nests, kidneys, and small veins in a secondary rock. The Hungarian varieties are found in beds in the country of Beregher in Upper Hungary.

Uses.—Alum is obtained from this mineral, by repeatedly roasting it, then lixiviating it, and crystallizing the solution thus obtained. Always associated with Volcanic

Genus IV. Fluor.

Tessular. Hardness = 4.0. Sp. gr. = 3.0, 3.1.

1. Octahedral Fluor.

Flus, *Werner.*—Octaedrisches Flus Haloide, *Mohs.*—Chaux fluatée, *Haüy.*

Specific Character.—Tessular. Cleavage octahedral.

It is divided into three subspecies, Compact, Foliated and Earthy.

FIRST SUBSPECIES.

Compact Fluor.

Dichter Fluss, *Werner*.

External Characters.—Colours grey, white, red, green, and greenish-black. Occurs massive. Externally and internally dull, or feebly glimmering. Fracture even, passes on one side into splintery, on the other into conchoidal. More or less translucent. Brittle, and easily frangible.

Chemical Characters.—The chemical characters same as in the following subspecies.

Geognostic and Geographic Situations.—Found in veins, associated with foliated fluor, at Stolberg in the Hartz.

SECOND SUBSPECIES.

Foliated Fluor.

Flus-Spath, *Werner*.

External Characters.—Most common colours white, yellow, green, and blue, seldomer red, grey, brown, and rarely black. Colours of all degrees of intensity, and sometimes pieces occur spotted or striped. Green cubes occur with blue angles, &c. Some colours, as sky-blue, fade by keeping, particularly in warm places. Occurs massive, disseminated, also in distinct concretions, which are granular, sometimes prismatic, which latter are traversed by others that are curved lamellar. Occurs crystallized in the following figures:

1. Cube. 2. Cube, truncated on all the edges. 3. Rhomboidal dodecahedron. 4. Cube, with truncated angles. 5. Octahedron. 6. Cube, with bevelled edges. 7. Cube, in which all the angles are acuminated with three planes, which are set on the lateral planes. 8. Cube, in which all the angles are acuminated with six planes, which are set on the lateral planes.

Surface smooth and splendent, or drusy and rough, as in the rhomboidal dodecahedron, and some octahedrons. Internally lustre specular-splendent, or shining and vitreous. Fragments octahedral or tetrahedral. Alternates from translucent to transparent, and refracts single. Brittle, and easily frangible.

Chemical Characters.—Before the blowpipe it generally decrepitates, gradually loses its colour and transparency, and melts without addition into a greyish-white glass. When two fragments are rubbed against each other, they become luminous in the dark. When gently heated, or laid on glowing coal, it phosphoresces, (particularly the sky-blue, violet-blue, and green varieties,) partly with a blue, partly with a green light. When brought to a red-heat, it is deprived of its phosphorescent properties.

		Northumberland.	
Constituent Parts.—	Lime, - - -	67.34	
	Fluoric Acid, -	32.66	
		100.00	*Thomson.*

Geognostic Situation.—Occurs principally in veins that traverse primitive, transition, and sometimes secondary rocks; also in beds, associated with other minerals; in kidneys in secondary limestone; and in drusy cavities in trap-rocks.

Geographic Situation.—It is a very rare mineral in Scotland, but is abundant, and in great variety, in England.

Uses.—On account of the variety and beauty of its colours, its transparency, the ease with which it can be worked, and the high polish it receives, it is cut into vases, pyramids, and other ornamental articles.

THIRD SUBSPECIES.

Earthy Fluor.

External Characters.—Colours greyish-white, and violet-blue. Occurs generally in crusts, investing some other mineral. Dull. Earthy. Friable, passing into very soft.

Geognostic and Geographic Situations.—Occurs in veins, along with foliated fluor, at Beeralston in Devonshire; in limestone, along with foliated fluor and arragonite, in Cumberland.

Genus V. Apatite. Phosphate of

Rhomboidal. Hardness = 5.0. Sp. gr. = 3.1, 3.2.

1. Rhomboidal Apatite.

Rhomboedrisches Flus-Haloide, *Mohs.*—Apatit, *Werner.*—Chaux phosphatée, *Haüy.*

Specific Character.—Di-rhomboidal. 2. R = 131° 14′; 111° 20′. Cleavage R — ∞. P + ∞.

This species is divided into three subspecies, viz. Foliated, Conchoidal, and Lamellar.

FIRST SUBSPECIES.

Foliated Apatite.

Gemeiner Apatite, *Werner.*

External Characters.—Colours white, green, blue, red, yellow, and brown. Occurs massive and disseminated, also in distinct concretions, which are angulo-granular, and sometimes lamellar. Its secondary figures are the six-sided prism, and six-sided table, variously modified by truncations, bevelments, and acuminations. The lateral planes of the prism are seldom smooth, generally longitudinally streaked; the truncating and acuminating planes are smooth. Externally splendent or shining; internally glistening, and lustre resinous. Fracture intermediate between uneven and imperfect conchoidal. Generally translucent; seldom nearly transparent, when it refracts single. Brittle, and easily frangible.

Physical Characters.—It becomes electric by heating, and also by being rubbed with woollen cloth.

Chemical Character.—When thrown on glowing coals, it emits a pale grass-green phosphoric light. It dissolves very slowly in the nitric acid, and without effervescence. It is infusible without addition.

Constituent Parts.—Lime,	55	
Phosphoric Acid, and trace of Manganese,	45	
	100	*Klaproth.*

Geognostic Situation.—Occurs in tinstone veins, and also imbedded in talc.

Geographic Situation.—Occurs in yellow foliated talc, and, along with fluor-spar, in the mine called Stena-Gwyn, in St Stephen's, in Cornwall, also at Michael's Mount, Godolphinbal in Breage, also in Cornwall; and in various districts on the Continent of Europe.

SECOND SUBSPECIES.

Conchoidal Apatite or Asparagus Stone.

Spargelstein, *Werner.*

External Characters.—Colours green and yellow; also blue, grey, and brown. Sometimes massive and disseminated, also in distinct concretions, which are granular; but most frequently crystallized, and in the following figures:

1. Equilateral, longish, six-sided prism, acuminated with six planes, which are set on the lateral planes. 2. The same figure, truncated on the lateral edges of the prism.

Externally crystals splendent and vitreous; internally shining, and resinous. Fracture conchoidal. Alternates from transparent to translucent. In other characters agrees with foliated apatite.

Chemical Characters.—Some varieties of this subspecies do not phosphoresce when exposed to heat.

		From Zillerthal.	
Constituent Parts.—	Lime, - - -	53.75	
	Phosphoric Acid, -	46.25	
		100.00	*Klaproth.*

Geognostic and Geographic Situations.—Occurs imbedded in gneiss, near Kincardine in Ross-shire; in the same rock in the Shetland islands; and in veins in greenstone, along with hypersthene, in the island of Rume.

THIRD SUBSPECIES.

Lamellar Apatite, or Phosphorite.

Phosphorit, *Werner.*

This Subspecies is divided into two Kinds, viz. Common and Earthy.

First Kind.

Common Lamellar Apatite.

External Characters.—Colour yellowish-white. Occurs massive, and in distinct concretions, which are thin and curved lamellar. Surface uneven and drusy. Internally dull or glistening. Cleavage imperfect curved, and generally floriform. Fracture uneven. Opaque, or feebly translucent on the edges.

Geognostic and Geographic Situations.—Occurs near Leigrosan, in the province of Estremadura in Spain, where it forms whole beds, that alternate with limestone and quartz.

Second Kind.

Earthy Phosphorite.

External Characters.—Colours greyish-white, greenish-white, and pale greenish-grey. Consists of dull dusty particles, which are partly loose, partly cohering, and which soil slightly, and feel meagre and rough.

Chemical Characters.—Phosphoresces when laid on glowing coals.

Geognostic and Geographic Situations.—Occurs in a vein, in the district of Marmarosch in Hungary.

Genus VI. Limestone.

Kalk-Haloide, *Mohs.*

Rhomboidal, prismatic. Cleavage, rhomboidal, prismatoidal. Hardness = 3.0,—4.5. If above 4.0, sp. gr. = 2.8 and more. Sp. gr. = 2.5,—3.2.

1. Prismatic Limestone or Arragonite.

Prismatisches Kalk-Haloide, *Mohs.*—Arragon, *Werner.*—Arragonite, *Haüy.*

Specific Character.—Prismatic. Pyramid = 113° 44′; 93° 43′; 122° 10′. $P + \infty$ = 105° 23′. Cleavage, $P\bar{r} - 1$ = 109° 28′. $(P\breve{r} + \infty)^3$ = 64° 4′. More distinct $P\bar{r} + \infty$. Hardness = 3.5,—4.0. Sp. gr. = 2.6,—3.0.

This species is divided into two subspecies, viz. Common and Coralloidal.

FIRST SUBSPECIES.

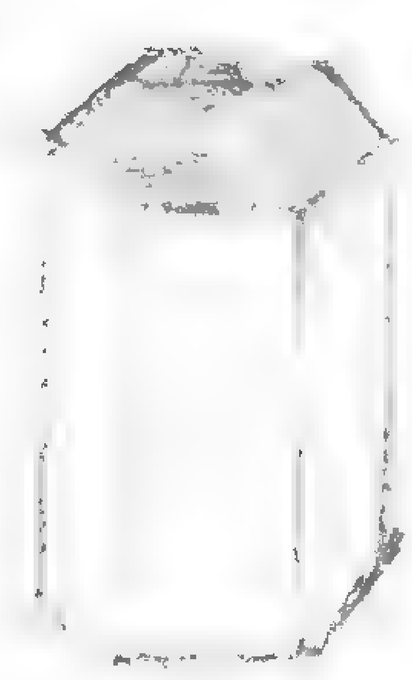
Common Arragonite.

Gemeiner Arragon, *Werner.*

External Characters.—Colours white, grey, green, and violet-blue. In some crystals, green and blue colours occur together, and sometimes also grey. Occurs massive, and in distinct concretions, which are prismatic, and sometimes scopiformly diverging. Frequently crystallized.

The following are some of its secondary figures:

1. Irregular six-sided prism, frequently with four lateral edges of about 116°, and two of 128°; or with three lateral edges of 128°, two of 116°, and one of 104°. These are formed by the grouping of several oblique four-sided prisms, bevelled on the extremities. Sometimes this prism is so flat, that it appears like a table. 2. Six-sided table. When, on the contrary, the long six-sided prism becomes acicular, there is formed, 3. Long, and generally acicular double six-sided pyramids.



Lateral planes of the crystals sometimes smooth, more frequently more or less deeply streaked or grooved. Terminal planes seldom smooth, generally uneven and rough, and sometimes also deeply notched. External lustre varies from dull to shining, and is vitreous; internally shining and glistening, and vitreous, inclining to resinous. Fracture conchoidal, passing into uneven. Translucent, passing into semi-transparent, and refracts double. Brittle, and easily frangible.

Chemical Characters.—If we expose a small fragment to the flame of a candle, it almost immediately splits into white particles, which are dispersed around the flame. This change takes place principally with fragments of transparent crystals, fragments of the other varieties becoming merely white and friable. Fragments of calcareous-spar, when placed in a similar situation, undergo no alteration. Completely soluble, with effervescence, in the nitric and muriatic acids.

[illegible] arragonite will scratch ca[illegible]

		From Molina in Arragon.
Constituent Parts.—	Carbonate of Lime,	94.5757
	Carbonate of Strontian,	3.9662
	Hydrate of Iron, -	0.7062
	Water of Crystallization,	0.3000
		99.5489 *Stromeyer.*

Geognostic and Geographic Situations.—Occurs along with galena in the lead-mines of Lead-hills, and in secondary trap-rocks in different parts of Scotland.

SECOND SUBSPECIES.

Coralloidal Arragonite.

External Characters.—Colour white. Occurs massive, reniform, tuberose, coralloidal, imperfect globular; in distinct concretions, which are fibrous, generally straight, seldom curved, and stellular, and scopiform, sometimes also in reniform curved lamellar, and angulo-granular concretions. Lustre glimmering, or glistening and pearly. Fracture fine splintery. Translucent, or translucent on the edges. In other characters, agrees with the preceding subspecies.

Geognostic and Geographic Situations.—It is found in Dufton Fell in Cumberland, also in the iron-mines of Stiria and Carinthia, and at St Marié aux Mines.

2. Rhomboidal Limestone.

Rhomboedrischer Kalk-Haloide, *Mohs.*

Specific Character.—Rhomboidal. Rhomboid = 105° 5′. Cleavage, R. Hardness = 3.0. Sp. gr. = 2.5,—2.8.

This species is divided into twelve subspecies, viz. 1. Foliated Limestone; 2. Compact Limestone; 3. Chalk; 4. Agaric Mineral; 5. Fibrous Limestone; 6. Tufaceous Limestone or Calc-Tuff; 7. Pea-stone; 8. Slate-Spar; 9. Aphrite; 10. Lucullite; 11. Marl; 12. Bituminous Marl-Slate.

FIRST SUBSPECIES.

Foliated Limestone.

Blättriger Kalkstein, *Werner.*

This subspecies is divided into two kinds, viz. Calcareous-spar, and Foliated Granular Limestone.

First Kind.

Calcareous-Spar or Calc-Spar.

Kalkspath, *Werner*.

External Characters.—Colours white, grey, red, blue, green, yellow, yellowish-brown, and greyish-black. White and grey varieties occur more frequently in the massive; yellow, green, and red, in those which are crystallized. Occurs massive, disseminated, globular, botryoidal, reniform, tuberose, stalactitic, tubular, cellular, and curtain-shaped; also in distinct concretions, which are angulo-granular; sometimes prismatic, and these are always straight, sometimes parallel, and occasionally scopiform; and these are intersected by lamellar concretions.

Is very frequently crystallized. Besides the primitive rhomboid of 105° 5′, there are some other rhomboids which are obtuser and acuter. Depending on these rhomboids, there are series of isosceles six-sided pyramids. Lastly, these rhomboids and isosceles six-sided pyramids have depending on them equiangular six-sided prisms, which differ from each other solely by their position. In calcareous-spar, therefore, the chief forms are *rhomboids*, or what are sometimes termed double three-sided pyramids; *isosceles six-sided pyramids;* and *regular six-sided prisms.* Frequently *twin-crystals* occur.

The lateral planes of the prisms and pyramids are generally shining, splendent and smooth; the acuminating planes frequently streaked or drusy, seldom granulated. Sometimes it occurs in extraneous external forms of shells, &c. Internally generally specular splendent, or shining, sometimes glistening, and lustre vitreous, inclining sometimes to resinous, and more rarely to pearly. Fracture perfect conchoidal. Fragments indeterminate angular, and rather sharp-edged, or rhomboidal. Occurs transparent, semi-transparent, and occasionally only translucent. Refracts double*. Brittle, and very easily frangible.

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* The double refracting power of calcareous-spar was first observed by Erasmus Bartholin.

Chemical Characters.—Infusible before the blowpipe, but becomes caustic, losing by complete calcination about 43 *per cent.*; effervesces violently with acids.

Constituent Parts.—

	Iceland-Spar.	Iceland-Spar.
Lime, - -	56.15	55.50
Carbonic Acid,	43.70	44.00
Water, - -		0.50
Oxide of Manganese, with trace of Iron,	0.15	
	100.00	100.00
	Stromeyer.	*Phillips.*

Geognostic Situation.—Never occurs in mountain-masses, but venigenous in almost every rock, from granite to the newest secondary formations.

Geographic Situation.—Calcareous-spar is so common in every country, as to render any account of its geographic distribution unnecessary.

Second Kind.

Granular Foliated Limestone.

Blättriger Körniger Kalkstein, ***Werner.***

External Characters.—Colours white, grey, red, yellow, and green. Has generally but one colour; sometimes, however, it is spotted, dotted, clouded, striped, and veined. Occurs massive, and in angulo-granular distinct concretions. Internally alternates from shining to glistening, and glimmering; lustre intermediate between pearly and vitreous. Fracture foliated, but sometimes inclines to splintery. More or less translucent. Brittle, and easily frangible. Sp. gr. 2.71.

Chemical Characters.—Generally phosphoresces when pounded, or when thrown on glowing coals.

Constituent Parts.—

Lime, - - -	56.50	
Carbonic Acid, -	43.00	
Water, - - -	0.50	
	100.00	*Bucholz.*

Geognostic Situation.—Occurs in beds, in granite, gneiss, mica-slate, clay-slate, syenite, greenstone, grey-wacke, and rarely in some of the secondary rocks.

Geographic Situations.—Occurs in all the great ranges of primitive rocks that occur in Europe, and in such as have been examined in Asia, Africa, and America.

Uses.—All the varieties of this subspecies may be burnt into quicklime; but it is found, that in many of them, the concretions exfoliate and separate during the volatilization of their carbonic acid, so that by the time when they are rendered perfectly caustic, their cohesion is destroyed, and they fall into a kind of sand,—a circumstance which will always render it improper to use such varieties in a common kiln. But the most important use of this mineral is as marble. These marbles have been known from a very early period; and ancient statuaries have immortalised their names, by the masterpieces of art which they have executed in them. Of the ancient marbles, the most celebrated are those of Paros, Pentelicus, and Carrara. Marbles of different descriptions occur in Scotland, England, and Ireland.

SECOND SUBSPECIES.

Compact Limestone.

Dichter Kalkstein, *Werner.*

This Subspecies is divided into three kinds, viz. Common Compact Limestone, Blue Vesuvian Limestone, and Roestone.

First Kind.

Common Compact Limestone.

Gemeiner Dichter Kalkstein, *Werner.*

External Characters.—Most frequent colour is grey; it also occurs greyish-black, yellow, and red. Frequently exhibits veined, zoned, striped, clouded, and spotted coloured delineations; and sometimes also black and brown coloured arborisations. It very rarely exhibits a beautiful play of colours, caused by intermixed portions of pearly shells. Occurs massive, corroded, in large plates, and in various extraneous external shapes, of univalve, bivalve, and multivalve shells, of corals, fishes, and more rarely of vegetables, as of ferns and reeds. Internally dull, seldom glimmering, which is owing to intermixed calcareous-spar. Fracture small and fine splintery, which sometimes passes into large and flat conchoidal, sometimes into uneven, inclining to earthy, and it occasionally inclines to straight and thick slaty. Fragments indeterminate angular, more or less sharp-edged, but in the slaty variety they are tabular. Generally translucent on the edges, sometimes opaque. In general rather softer than granular foliated limestone. Brittle, and easily frangible. Streak generally greyish-white. Sp. gr. 2.67.

Chemical Characters.—It effervesces with acids, and the greater part is dissolved; and burns to quicklime, without falling to pieces.

Constituent Parts.—

	Rudersdorf.	
Lime,	53.00	
Carbonic Acid,	42.50	
Silica,	1.12	
Alumina,	1.00	
Iron,	0.75	
Water,	1.03	
	100	*Simon.*

Geognostic Situation.—Occurs in vast abundance in nature, principally in secondary formations, along with sandstone, gypsum, and coal; also, but in small quantity, in primitive mountains.

Geographic Situation.—It abounds in the sandstone and coal formations, both in Scotland and England; and in Ireland, it is a very abundant mineral in all the districts where clay-slate and red sandstone rocks occur. On the Continent of Europe, it is a very widely and abundantly distributed mineral; and forms a striking feature in many extensive tracts of country in Asia, Africa, and America.

Uses.—When compact limestone joins to pure and agreeable colours, so considerable a degree of hardness that it takes a good polish, it is by artists considered as a Marble; and if it contains petrifactions mineralized, it is named *shell* or *lumachella*, and *coral* or *zoophytic marble*, according as the organic remains are testaceous or coralline *. In some compact marbles, the surface presents a beautiful arborescent appearance, and these are naturally *arborescent* or *dendritic marbles.*

The *Florentine Marble*, *Ruin Marble*, or *Landscape Marble*, as it is sometimes called, is a compact limestone. To the same compact limestone may be referred the variety called *Cottam Marble*, from being found at Cottam, near Bristol.

It is sometimes used as a building stone, and, in want of better materials, for paving streets, and making highways. When, by exposure to a high temperature, it is deprived of its carbonic acid, and converted into quicklime, it is used for mortar; also by the soap-maker, for rendering his alkalies caustic; by the tanner, for cleansing hides, or freeing them from hair, muscular substance, and fat; by the farmer, in the improvement of particular kinds of soil; and by the metallurgist, in the smelting of such ores as are difficultly fusible, owing to an intermixture of silica and alumina.

Second Kind.

Blue Vesuvian Limestone.

Blauer Vesuvischer Kalkstein, *Klaproth.*

External Characters.—Colour dark bluish-grey, partly veined with white. Externally it appears as if it had been rolled; and the surface is uneven. Fracture fine earthy, passing into splintery. Opaque. Affords a white streak.

Constituent Parts.—

Lime,	58.00	
Carbonic Acid,	28.50	
Water, which is somewhat ammoniacal,	11.00	
Magnesia,	0.50	
Oxide of Iron,	0.25	
Carbon,	0.25	
Silica,	1.25	
	99.75	*Klaproth.*

* The name *marmor*, is derived from the Greek μαρμαιρειν, *to shine*, or *glitter*, and was by the ancients applied, not only to limestone, but also to stones

From this analysis, it appears, that the Vesuvian limestone differs remarkably in composition from common compact limestone. In common compact limestone, 100 parts of lime are combined with at least 80 parts of carbonic acid; whereas in the Vesuvian limestone, 100 parts of limestone are not combined with more than 50 parts of carbonic acid. Secondly, In common limestone, independent of the water which adheres to it accidentally, as far as we know, there is little or no water of composition; but in the Vesuvian limestone, there are 11 parts of water of composition.

Geographic Situation.—This remarkable limestone is found in loose masses amongst unaltered ejected minerals in the neighbourhood of Vesuvius.

Observations.—It is known to collectors under the name *Compact Blue Lava* of Vesuvius; and is sometimes employed by artists in their mosaic work, in representing the sky.

Third Kind.

Roestone or Oolite *.

Roogenstein, *Werner*.

External Characters.—Colours brown and grey. Occurs massive, and in distinct concretions, which are round granular; the larger concretions are composed of fine spherical granular, and sometimes of very thin concentric lamellar concretions. Internally dull. Fracture of the concretions fine splintery; but of the mass round granular in the small, and slaty in the large. Fragments in the large blunt-edged. Opaque. Rather brittle, and very easily frangible. Sp. gr. 2.68, 2.61, *Kopp.*—2.58, *Breithaupt.*

Chemical Characters.—Dissolves with effervescence in acids.

Geognostic Situation.—Occurs along with red sandstone, and *lias* limestone.

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possessing agreeable colours, and receiving a good polish, such as gypsum, jasper, serpentine, and even granite and porphyry.

* *Roestone*, so named on account of its resemblance in form to the roe of fishes.

Geographic Situation.—This rock, which, in England, is known under the names Bath-stone, Ketton-stone, Portland-stone, and Oolite, extends, with but little interruption, from Somersetshire to the banks of the Humber in Lincolnshire.

Uses.—The Oolite, or Roestone, particularly that of Bath and Portland, is very extensively employed in architecture; it can be worked with great ease, and has a light and beautiful appearance; but it is porous, and possesses no great durability, and should not be employed where there is much carved or ornamental work, for the fine chiselling is soon effaced by the action of the atmosphere. On account of the ease and sharpness with which it can be carved, it is much used by the English architects, who appear to have little regard for futurity. St Paul's is built of this stone, also Somerset-House. Roestone is also used as a manure, but when burnt into quicklime, the marly varieties afford rather an indifferent mortar; but those mixed with sand a better mortar.

THIRD SUBSPECIES.

Chalk.

Kreide, *Werner*.

External Characters.—Colour white. Sometimes marked with yellowish-grey. Occurs massive, disseminated, in crusts, and in extraneous external shapes. Dull. Fracture coarse and fine earthy. Fragments blunt-edged. Opaque. Writes and soils very much. Soft, and sometimes very soft. Rather sectile, and easily frangible. Adheres slightly to the tongue. Feels very meagre, and rather rough. Sp. gr. 2.31, *Kirwan.*—2.22, *Breithaupt.*

Chemical Characters.—Effervesces strongly with acids.

Constituent Parts.

		Chalk from Gallicia.			
Lime, -	56.5	Lime, -	47.00	Lime, -	53
Carbonic Acid,	43.0	Carbonic Acid,	33.00	Carbonic Acid,	42
Water, -	0.5	Silica, -	7.00	Alumina,	2
	——	Alumina, -	2.00	Water, -	3
	Bucholz.	Magnesia, -	8.00		——
		Iron, -	0.05		100
			——		
			Hacquet.		*Kirwan.*

Geognostic Situation.—It constitutes one of the newer secondary or flœtz formations; is usually found in low situations, and frequently on sea-coasts. It is stratified, and the strata in general are horizontal. It often contains flint, which is disposed either in interrupted beds in the chalk, or in globular, tuberose, or tabular masses imbedded in it. It abounds in organic remains, and these are principally of animals of the lower orders, such as echinites, belemnites, terebratulites, pinnites, &c.

Geographic Situation.—It abounds in England, but has not been met with in Scotland.

Uses.—The uses of this mineral are various. The more compact kinds are employed as building-stones: it is burnt into quicklime, and used for mortar in different countries *: it is also employed in great quantities in the polishing of glass and metals, and whitening the roofs of rooms, in the state of *whiting* †; in constructing of moulds to cast metal in; by carpenters and others as a material to mark with.

FOURTH SUBSPECIES.

Agaric Mineral, or Rock Milk.

Berg-Milch, *Werner.*

External Characters.—Colour white. Occurs frequently in crusts, also in loosely cohering tuberose pieces. Dull. Composed of fine dusty particles. Soils strongly. Feels meagre. Adheres slightly to the tongue. Very light, almost supernatant.

Chemical Characters.—It effervesces with acids, and is completely dissolved in them.

Constituent Parts.—It is pure Carbonate of Lime.

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* According to Smeaton, it makes as good lime as the best limestone or marble.

† In the preparation of whiting, chalk is pounded, and diffused through water, and the finer part of the sediment is then dried; by this means, the siliceous particles are separated, which, by their hardness, would scratch the surface of metallic and other surfaces, in the polishing of which whiting is used.—Aikin's *Chem. Dictionary*.

Geognostic and Geographic Situations.—It is found on the north side of Oxford, between the Isis and the Cherwell, and near Chipping-Norton, also in Oxfordshire, and near Edinburgh.

FIFTH SUBSPECIES.

Fibrous Limestone.

Fasriger Kalkstein, *Werner.*

This subspecies is divided into two kinds, viz. Common Fibrous Limestone, or Satin-Spar, and Fibrous Calc-Sinter.

First Kind.

Common Fibrous Limestone, or Satin-Spar.

Gemeiner fasriger Kalkstein, *Werner.*

External Characters.—Colour white. Occurs massive, also in distinct concretions, which are coarse and fine fibrous, and either straight or curved. Lustre glistening or shining, and pearly. Fragments splintery. Feebly translucent. As hard as calcareous-spar. Easily frangible. Sp. gr. 2.70, *Pepys.*

Constituent Parts.—	Carbonate of Lime,	95.75	
	Carbonate of Manganese,	4.25	
		100.00	*Holme.*

Stromeyer says that fibrous limestone contains some *per cents.* of gypsum.

Geognostic and Geographic Situations.—It occurs in thin layers in clay-slate at Aldstone Moore in Cumberland; in layers and veins in the middle district of Scotland, as in Fifeshire.

Uses.—It is sometimes cut into necklaces, crosses, and other ornamental articles.

Second Kind.

Fibrous Calc-Sinter *.

Fasriger Kalksinter, *Werner.*

External Characters.—Colours white, yellow, brown,

* This is the Alabaster of the ancients, and is by the moderns named *Calcareous Alabaster*, to distinguish it from another mineral, gypsum, which they name *Gypseous Alabaster.*

grey, red, green, and blue. Sometimes concentrically and reniformly striped, or it is spotted or clouded. Occurs massive, stalactitic, globular, tubular, claviform, fruticose, curtain-shaped, cock's-comb-shaped, coralloidal, reniform, and tuberose; also in distinct concretions, which are fibrous, and these are straight, seldom curved, and sometimes scopiform or stellular; also in reniform curved lamellar concretions. Surface generally rough, and seldom fine drusy. Internally glimmering, which passes on the one side into dull, on the other into glistening; and lustre pearly. Fracture fine splintery. Translucent, or only translucent on the edges.

Constituent Parts.—

Lime,	56.0	
Carbonic Acid,	43.0	
Water,	1.0	
	100.0	*Bucholz.*

Geognostic and Geographic Situations.—It is found encrusting the roofs, walls, and floors of caves, particularly those situated in limestone rocks. It is formed from water holding carbonate of lime in solution. Caves lined with this mineral occur in almost every country. Maccallister's Cave, in the island of Skye, and those in the limestone hills of Derbyshire, are the most striking appearances of this kind hitherto observed in Scotland and England. But the most celebrated stalactitic cave is that of Antiparos in the Archipelago, which has been particularly described by Tournefort.

Uses.—Calc-sinter or calcareous alabaster, is used for the same purposes as marble, and is cut into tables, columns, vases, drapery for marble figures, and sometimes also into statues. It was also used by the ancients in the manufacture of their unguentary vases.

SIXTH SUBSPECIES.

Tufaceous Limestone or Calc-Tuff *.

Kalk-Tuff, *Werner.*

External Characters.—Colours grey, yellow, and brown.

* The term *tufa* appears to be derived from the verb τύφω, which, in its original signification, is appropriate to volcanic productions, especially to such as are of a spongy or porous texture.—*Kid.*

Occurs massive, perforated, ramose, spongy, tabular, claviform, botryoidal, globular, cellular, and in crusts; inclosing vegetable stems and leaves; also enveloping bones of animals, as of elephants and rhinoceroses, and land shells; and frequently contains impressions of leaves, mosses, and roots. The globular variety is sometimes composed of curved lamellar concretions. Internally dull, or very faintly glimmering. Fracture fine-grained uneven, inclining to earthy; and sometimes splintery. Opaque, or translucent on the edges. Sometimes semi-hard, sometimes soft, and is frequently soft, inclining to friable. Rough. Brittle, and easily frangible.

Constituent Parts.—It is nearly pure Carbonate of Lime.

Geognostic Situation.—It occurs in beds, generally in the neighbourhood of lakes and rivers: also encrusting rocks, and enveloping animal and vegetable remains in the vicinity of calcareous springs.

Geographic Situation.—It is a frequent mineral in the neighbourhood of all the calcareous springs in this country, as in those at Starly Burn in Fifeshire, and other places; and on the Continent of Europe it is also a frequent mineral.

Uses.—The hardest kinds are used for building-stones, and are also burnt into quicklime. It is sometimes used as a filtering-stone.

SEVENTH SUBSPECIES.

Pisiform Limestone, or Peastone.

Erbsenstein, *Werner*.

External Characters.—Colours white, pea-yellow, and pale yellowish-brown. Occurs massive; also in distinct concretions, which are small spherical round granular, composed of others which are very thin and concentric lamellar. In the centre there is either a bubble of air, or a grain of sand, or of some mineral matter. Internally dull, or very feebly glimmering. Fracture even. Opaque, or feebly translucent on the edges. Soft, approaching to semi-hard. Brittle, and very easily frangible. Sp. gr. 2.53.

Constituent Parts.—It is Carbonate of Lime, slightly coloured with Iron.

Geognostic and Geographic Situations.—Occurs in great masses in the vicinity of the Hot Springs at Carlsbad in Bohemia.

Uses.—It is sometimes cut into plates for ornamental purposes.

EIGHTH SUBSPECIES.

Slate-Spar.

Schieferspath, *Werner.*

External Characters.—Colour white. Occurs massive, also in distinct concretions, which are generally curved lamellar, and sometimes coarse and large granular. Lustre intermediate between shining and glistening, and is pearly. Feebly translucent, or only translucent on the edges. Soft. Intermediate between sectile and brittle. Easily frangible. Feels rather greasy. Sp. gr. 2.61, *Breithaupt.*

Chemical Characters.—It effervesces very violently with acids: but is infusible before the blowpipe.

		Bremsgrün.
Constituent Parts.—	Lime, - - -	55.00
	Carbonic Acid, - -	41.66
	Oxide of Manganese, -	3.00
		99.66 *Bucholz.*

Geognostic Situation.—Occurs in metalliferous beds and veins in primitive limestone.

Geographic Situation.—Occurs imbedded in marble in Glen Tilt, Perthshire; in Assynt in Sutherland: in Cornwall; and near Granard in Ireland.

NINTH SUBSPECIES.

Aphrite.

Schaumerde, *Werner.*

External Characters.—Colour white. Occurs either friable or compact. Friable varieties composed of glistening or glimmering particles, in which the lustre is pearly. Particles are fine scaly, feel fine, but not greasy. Either loose, or loosely cohering. Compact varieties are massive, disseminated, or in lamellar concretions, with a shining lustre, which is pearly, sometimes inclining to semi-metallic. Fracture foliated or slaty. Fragments indeterminate angular, and blunt-edged in the great, but tabular in the small. Opaque. Soils slightly. Very soft, passing into friable. Sectile, and uncommonly easily frangible. Feels very fine, but not greasy. Soils slightly.

Chemical Character.—Effervesces most violently with acids.

Constituent Parts.—

Lime,	51.5
Carbonic Acid,	39.0
Silica,	5.715
Oxide of Iron,	3.285
Water,	1.0
	100.5 *Bucholz.*

Geognostic Situation.—Occurs in nests, disseminated, or in small veins, in flœtz or secondary limestone, and gypsum.

Geographic Situation.—Found in Thuringia and Hessia.

TENTH SUBSPECIES.

Lucullite.

This subspecies is divided into three kinds, viz. Compact, Prismatic, and Foliated.

First Kind.

Compact Lucullite.

Dichter Lucullan, *John.*

This kind is divided into Common Compact Lucullite or Black Marble, and Stinkstone.

a. Common Compact Lucullite or Black Marble.

External Characters.—Colour greyish-black. Occurs massive. Internally glimmering, inclining to glistening. Fracture fine-grained uneven, and large conchoidal. Opaque. Semi-hard. Yields a dark ash-grey coloured streak. Brittle, and easily frangible.

When two pieces are rubbed against each other, a fetid urinous odour is exhaled, the intensity of which is increased when we at the same time breathe on them.

Chemical Characters.—Dissolves with effervescence in acids, and during the solution and escape of the carbonic acid, a smell resembling that of sulphuretted hydrogen is evolved.

Constituent Parts.—Is Carbonate of Lime, with a slight intermixture of Carbon, and Sulphureous Matter.

Geognostic Situation.—Occurs in beds in transition and secondary rocks.

Geographic Situation.—Hills of this mineral occur in the district of Assynt in Sutherland. Varieties of it are met with at Ashford, Matlock, and Monsaldale, in Derbyshire: at Kilkenny; at Crayleath, in the county of Down; at Kilcrump, in the county of Waterford; at Churchtown, in the county of Cork; and in the county of Galway, in Ireland.

Uses.—The finer varieties of this mineral have been highly prized and used as marble from a very remote period. It was so much admired and esteemed by the Consul Lucullus, that he gave it his own name.

The finest varieties of lucullite met with in trade in this island, are the black marbles of Kilkenny and Galway.

b. Stinkstone, or Swinestone.

Stinkstein, *Werner*.

External Characters.—Colours white, grey, black, yellow, and brown. Sometimes dendritic on the surface, or clouded with greyish-black. Occurs massive, disseminated, also in distinct concretions, which are granular, and concentric lamellar. Internally dull or glimmering. Fracture sometimes small splintery, sometimes imperfect conchoidal, and fine-grained uneven, which passes into earthy, or straight slaty. Fragments indeterminate angular, or slaty. Opaque, but the cream-yellow varieties are translucent on the edges. Affords a greyish-white coloured streak, and when rubbed emits a fetid urinous odour. Brittle, and easily frangible.

Chemical Characters.—Nearly the same as in the preceding kind.

Geognostic Situation.—Occurs in beds, in secondary limestone, and occasionally alternates with secondary gypsum, and beds of clay. In some places, the strata are quite straight, in others have a zig-zag direction, or are more or less deeply waved, and they are occasionally disposed in a concentric manner like the concentric lamellar concretions of greenstone. Some strata contain angular pieces of stinkstone, which at first sight might be taken for fragments; and even whole beds occur, which are composed throughout of angular portions, either connected together by means of clay, or immediately joined without any basis.

Geographic Situation.—Occurs in the vicinity of North Berwick in East Lothian, resting on red sandstone; and in the parish of Kirkbean in Galloway.

Uses.—It is principally employed as a limestone, and when burnt affords an excellent lime both for mortar and manure.

Second Kind.

Prismatic Lucullite.

Stänglicher Lucullan, *John.*

External Characters.—Colours black, grey, and brown. Occurs massive, in balls, also in distinct concretions, which are stellular and scopiform prismatic. Internally shining and splendent, and the lustre intermediate between vitreous and resinous. Fragments indeterminate angular, sometimes inclining to rhomboidal. Translucent on the edges, or opaque. Affords a grey-coloured streak. Brittle, and easily frangible. When rubbed, it emits a strongly fetid urinous smell. Sp. gr. 2.653, 2.688, 2.703, *John.*

Chemical Characters.—Nearly same as preceding kind.

Constituent Parts.—Same as the preceding kind.

Geognostic and Geographic Situations.—Occurs in balls, varying from the size of a pea to two feet in diameter, in brown dolomite, at Building-Hill near Sunderland. At Stavern in Norway, it appears to occur in transition-rocks; in alum-slate at Garphytta in Nericke in Sweden; and in Greenland.

Third Kind.

Foliated or Sparry Lucullite.

Späthiger Lucullan, *John*.

External Characters.—Colour white; also grey and black. Occurs massive, disseminated, and in small granular concretions. Internally alternates from glimmering to shining. Fragments generally rhomboidal. Translucent, or translucent on the edges. Semi-hard, approaching to soft. Brittle, and easily frangible. When rubbed, it emits an urinous smell. Sp. gr. 2.650, *John*.

Chemical Characters.—Same as the preceding.

Constituent Parts.—Nearly as in preceding kind.

Geognostic and Geographic Situations.—Occurs in veins, and also in small cotemporaneous masses, in a bed of limestone in clay-slate, at Andreasberg in the Hartz: in veins of silver-ore in hornblende-slate at Kongsberg in Norway: also in transition alum-slate in larger and smaller elliptical masses, the centre of which is of iron-pyrites, and the periphery sparry lucullite, at Andrarum in Schonen, Garphytta in Nericke, and Christiania in Norway.

ELEVENTH SUBSPECIES.

Marl.

Mergel, *Werner*.

This subspecies is divided into two kinds, viz. Earthy and Compact.

First Kind.

Earthy Marl.

Mergel Erde, *Werner*.

External Characters.—Colour grey. Consists of fine dusty particles, either loose or feebly cohering. Dull. Particles feel fine, or rather rough and meagre. Soils slightly. Is light.

Chemical Characters.—Effervesces strongly with acids; emits a strong urinous smell when first dug up; but after exposure to the air, it loses this quality.

Constituent Parts.—It is said to be composed of Lime, Alumina, Silica, and Bitumen.—*Friesleben.*

Geognostic and Geographic Situations.—Occurs in beds in secondary limestone and gypsum formations, along with stinkstone, in Thuringia and Mansfeld.

Second Kind.

Compact or Indurated Marl.

Verhärteter Mergel, *Werner.*

External Characters.—Colour grey. Occurs massive, in blunt angular pieces, vesicular, in flattened balls; and frequently contains petrifactions of fishes and crabs, also of gryphites, belemnites, chamites, pectinites, ammonites, terebratulites, ostracites, musculites, and mytulites. Dull both externally and internally, and only glimmering when intermixed with foreign parts. Fracture generally earthy, which approaches sometimes to splintery, sometimes to conchoidal; in the great inclines to thick and straight slaty. Fragments indeterminate angular and blunt-edged, and sometimes tabular. Yields to the nail. Is opaque. Affords a greyish-white streak. Rather brittle, and easily frangible. Feels meagre. Sp. gr. 2.365, 2.550, *Breithaupt.*

Chemical Characters.—Before the blowpipe it intumesces, and melts into a greenish-black slag. Effervesces briskly with acids.

Constituent Parts.—Carbonate of Lime, -	50	
Silica, - - -	12	
Alumina, - - -	32	
Iron, and Oxide of Manganese,	2	
	96	*Kirwan.*

Geognostic Situation.—Occurs in beds in secondary limestone and coal formations; also in the new secondary formations that rest upon chalk.

Geographic Situation.—Frequently occurs in the coal formation in Scotland and England, and in the secondary formations which rest upon chalk in the south of England.

Uses.—Several different kinds of compact marl occur in nature: these are Calcareous Marl, in which the calcareous earth predominates: Clay Marl, in which the aluminous earth is in considerable quantity; and Ferruginous Marl, in which the mass contains a considerable intermixture of oxide of iron. The latter kind occurs in spheroidal concretions, called *septaria* or *ludi Helmontii*, that vary from a few inches to a foot and a half in diameter. When broken in a longitudinal direction, we observe the interior of the mass intersected by a number of fissures, by which it is divided into more or less regular prisms, of from three to six or more sides, the fissures being sometimes empty, but oftener filled up with another substance, which is generally calcareous-spar. From these septaria are manufactured that excellent material for building under water known by the name of ***Parker's Cement****. The calcareous and aluminous marls are used for improving particular kinds of land; also for mortar; in some kinds of pottery; and in the smelting of particular ores of iron.

TWELFTH SUBSPECIES.

Bituminous Marl-Slate.

Bituminöser Mergelschiefer, *Werner*.

External Characters.—Colour intermediate between greyish-black and brownish-black. Occurs massive, and frequently contains impressions of fishes and plants. Lustre glimmering, glistening, or shining, and resinous. Fracture straight, or curved slaty. Fragments slaty in the large, but indeterminate and rather sharp angular in the small. Opaque. Shining and resinous in the streak. Soft, and feels meagre. Rather sectile, and easily frangible. Sp. gr. 2.631, 2.690, *Breithaupt*.

Constituent Parts.—It is said to be a Carbonate of Lime, united with Alumina, Iron, and Bitumen.

Geognostic Situation.—Occurs in secondary limestone. Frequently contains cupreous minerals, particularly copper-pyrites, copper-glance, variegated copper-ore, and more rarely, native copper, copper-green, and blue copper. It contains

* These marly septaria abound in the Isle of Shepey, in the Medway, and often contain in their interior globular portions of heavy-spar, having diverging fibrous concretions. Similar septaria occur in Derbyshire, and in the county of Durnam, in wl ich latter district the internal fissures are filled with quartz.

abundance of petrified fishes, and these are said to be most numerous in those situations where the strata are basin-shaped.

Geographic Situation.—Occurs in abundance in Hessia, and other countries in Germany.

3. Macrotypous * Limestone.

Macrotypes Kalk-Haloid, *Mohs.*

Specific Character.—Rhomboidal. Rhomboid = 106° 15′. Cleavage, rhomboidal. Hardness = 3.5,—4.0. Sp. gr. = 2.8,—2.95.

This species contains three subspecies, viz. 1. Dolomite; 2. Miemite; 3. Brown-Spar.

FIRST SUBSPECIES.

Dolomite. Called so a celebrated

Dolomit, *Werner.*

This subspecies is divided into three kinds, viz. Granular, Columnar, Compact.

First Kind.

Granular Dolomite.

This is again divided into White and Brown Granular Dolomite.

a. White Dolomite.

External Characters.—Colours white, and rarely pale ash-grey. Occurs massive; also in small and fine granular distinct concretions, frequently so loosely aggregated that they can be separated by the mere pressure of the finger. Internally glimmering, approaching to glistening, and lustre pearly. Fracture in the large imperfect slaty, in compact varieties small splintery, which passes into uneven. Faintly translucent, or only translucent on the edges. Brittle, and easily frangible.

Chemical and Physical Characters.—Effervesces very feebly with acids,—a character which distinguishes it from granular limestone.

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* From μακρὸς, *long*, and τύπος, *the type*, (fundamental form).

		Iona.
Constituent Parts.—	Carbonic Acid,	48.00
	Lime,	31.12
	Magnesia,	17.06
	Insoluble Matter,	4.00
		Tennant.

Geognostic Situation.—Occurs principally in primitive mountains.

Geographic Situation.—Beds of dolomite, containing tremolite, occur in the island of Iona; and it is found in many countries on the Continent of Europe.

Uses.—It appear to to have been used by ancient sculptors in their finest works.

Observations.—It is named Dolomite, in honour of the celebrated French geologist Dolomieu.

b. Brown Dolomite, or Magnesian Limestone of *Tennant.*

Only occurs in secondary Rocks

External Characters.—Colour brown. Occurs massive, and in minute granular concretions. Internally glistening or glimmering, and lustre between pearly and vitreous. Fracture splintery, and sometimes flat conchoidal. Translucent, or translucent on the edges. Semi-hard; is harder than calcareous spar. Is brittle. Sp. gr. of the crystals, 2.823, *Tennant.*—2.777, 2.820, *Berger.*—2.791, *Thomson.*

Chemical Characters.—Dissolves slowly, and with but feeble effervescence, in nitrous acid.

		Building Hill, near Sunderland.
Constituent Parts.—	Carbonate of Lime,	56.80
	Carbonate of Magnesia,	40.84
	Carbonate of Iron,	0.36
	Insoluble Matter,	2.00
		100.00 *Thomson.*

Geognostic and Geographic Situations.—In the north of England it occurs in beds of considerable thickness, and of great extent, and appears to rest on the Newcastle coal-formation: but in the Isle of Man, it occurs in a limestone which rests on grey-wacke, and contains imbedded portions of quartz, rhomb-spar, and sparry-iron.

Uses.—Like common limestone, it is burnt and made into mortar, but it remains much longer caustic than quicklime from common limestone; and this is the cause of a very important difference between magnesian and common limestone, with regard to their employment in agriculture: Lime, from magnesian limestone, is termed *hot*, and when spread upon land in the same proportion as is generally practised with common quicklime, greatly impairs the fertility of the soil; and when used in a greater quantity, is said by Mr Tennant to prevent all vegetation.

Observations.—A flexible variety occurs about three miles from Tinmouth Castle, in the north of England.

Second Kind.

Columnar Dolomite.

Stänglicher Dolomit, *Klaproth.*

External Characters.—Colour pale greyish-white. Occurs massive, in thin, long, and straight prismatic concretions. Fracture uneven. Lustre vitreous, inclining to pearly. Breaks into acicular-shaped fragments. Feebly translucent. Brittle.

Constituent Parts.—

	From the Mine Tschistagowskoy.
Carbonate of Lime,	51
Carbonate of Magnesia,	47
Carbonated Hydrate of Iron,	1
	99 *Klaproth.*

Geognostic and Geographic Situations.—Occurs in serpentine in the mine Tschistagowskoy, on the river Mjafs, in the Government of Orenburg in Russia.

Third Kind.

Compact Dolomite or Gurhofite.

Gurhofian, *Karsten.*

External Characters.—Colour snow-white. Occurs massive. Dull. Fracture flat conchoidal, passing to even. Fragments indeterminate angular, and sharp-edged. Slightly translucent on the edges. Hard, bordering on semi-hard. Brittle, and rather difficultly frangible.

Chemical Characters.—When pounded, and thrown into diluted and heated nitrous acid, it is completely dissolved, with effervescence.

Constituent Parts.—

Carbonate of Lime,	-	70.50
Carbonate of Magnesia,		29.50
		100.00 *Klaproth.*

Geognostic and Geographic Situations.—Occurs in veins in serpentine rocks, between Gurhof and Aggsbach, in Lower Austria.

SECOND SUBSPECIES.

Miemite, *Klaproth.*

This subspecies is divided into two kinds, viz. Granular Miemite, and Prismatic Miemite.

First Kind.

Granular Miemite.

External Characters.—Colour pale asparagus-green which passes into greenish-white. Occurs massive, in angulo-granular distinct concretions; crystallized in flat double three-sided pyramids, in which the lateral planes of the one are set on the lateral edges of the other. Internally splendent and pearly. Translucent. Semihard. Brittle.

Constituent Parts.—

Carbonate of Lime,	-	53.00
Carbonate of Magnesia,		42.50
Carbonate of Iron, with a little Manganese,	- -	3.00
		98.50 *Klaproth.*

Geognostic and Geographic Situations.—Is found at Miemo in Tuscany, imbedded in gypsum.

Second Kind.

Prismatic Miemite.

Stänglicher Bitterspath, *Klaproth.*

External Characters.—Colour green. Occurs in prismatic concretions, and crystallized in flat rhomboids, which are deeply truncated on all the edges. Internally shining and vitreous. Fracture splintery. Strongly translucent.

Chemical Characters.—It dissolves slowly, and with but feeble effervescence, in nitrous acid.

Geognostic and Geographic Situations.—Occurs in cobalt veins that traverse sandstone at Glücksbrunn in Gotha, and at Beska in Servia, on the frontier of Turkey.

THIRD SUBSPECIES.

Brown-Spar, or Pearl-Spar.

Braunspath, *Werner.*

This species is divided into two kinds, viz. Foliated and Columnar.

First Kind.

Foliated Brown-Spar.

Blättriger Braunspath, *Werner.*

External Characters.—Colours flesh-red and brownish-red. Often occurs massive, also disseminated, seldom globular, stalactitic, reniform, with tabular and pyramidal impressions; also in distinct concretions, which are granular, and rarely lamellar; and frequently crystallized in rhomboids. Internally alternates from shining to glistening, very rarely splendent, and lustre pearly. Generally translucent on the edges, rarely translucent. Brittle, and easily frangible. Specific gravity, 3.0,—3.2, *Mohs.*

Chemical Characters.—Hardens, and becomes dark brownish-black before the blowpipe; and effervesces feebly with acids.

Constituent Parts.—Lime,	- -	43.0
	Magnesia, -	10.0
	Oxide of Iron, -	8.0
	Manganese, -	3.0
	Water and Carbonic Acid,	26.5

Berthier.

Geographic Situation.—Occurs, along with galena, and other ores of lead, in the lead mines of Lead-Hills and Wanlockhead in Lanarkshire; in the mines of Cumberland, Northumberland, and Derbyshire.

Second Kind.

Columnar Brown-Spar.

Stänglicher Braunspath, *Klaproth.*

External Characters.—Colours reddish-white, rose-red, and pearl-grey. Occurs in distinct concretions, which are prismatic, and have glimmering and longitudinally streaked surfaces. Internally splendent, and appears pearly on the fracture-surface. Has an imperfect cleavage. Translucent. Brittle. Easily frangible.

Constituent Parts.—

Carbonate of Lime,	51.50	
Carbonate of Magnesia,	32.00	
Carbonate of Iron,	7.50	
Carbonate of Manganese,	2.00	
Water,	5.00	
	98.00	*Klaproth.*

Geographic Situation.—Is found in the mine named Segen Gottes at Gersdorf in Saxony; and in that of Valenciana at Guanauxuato in Mexico.

4. Brachytypous* Limestone or Rhomb-Spar.

Brachytyper Kalk-Haloid, *Mohs.*—Rautenspath, *Werner.*—Chaux Carbonateé Magnesifère, *Haüy.*

Specific Character.—Rhomboidal. Rhomboid = 107° 22′. Cleavage Rhomboidal. Hardness = 4.0,—4.5. Sp. gr. = 3.0, —3.2.

External Characters.—Colours white, grey, and yellow. Occurs massive, disseminated, and crystallized in rhomboids. These rhomboids are sometimes rounded or truncated on the edges. The surfaces are sometimes smooth, sometimes rough, and either shining or glimmering. Internally lustre splendent, between vitreous and pearly. Fracture imperfect conchoidal. Fragments rhomboidal. Easily frangible and brittle.

Chemical Character.—Before the blowpipe it is infusible, without addition; even when pounded it effervesces but feebly; and dissolves slowly in muriatic acid.

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* From βραχὺς, *short*, and τύπος, *the type*, or fundamental form.

Constituent Parts.—	Carbonate of Lime,	-	56.60
	Carbonate of Magnesia,	-	42.00
			98.60
Or by another result ;	Carbonate of Lime,	-	56.2
	Carbonate of Magnesia,	-	43.5
			98.9

With a trace of Manganese and Iron, *Murray.*

Geognostic Situation.—Occurs imbedded in chlorite-slate, talc-slate, limestone, and serpentine; in the salt formation, where it is imbedded in anhydrite and gypsum; in drusy cavities in compact dolomite, and in metalliferous veins.

Geographic Situation.—Occurs imbedded in chlorite-slate on the banks of Loch Lomond; in a vein in transition rocks, along with galena, blende, copper-pyrites, and calcareous-spar, near Newton-Stewart in Galloway; in compact dolomite in the Isle of Man and in the north of England.

Order *II. BARYTE.*

No true metallic lustre. If adamantine or imperfect metallic lustre, the Sp. gr. = 6.0 and more. Streak white and grey or orange-yellow. If orange-yellow, the Sp. gr. = 6.0 and more; and the hardness = 3.0 and less.

Hardness = 2.5 — 5.0. If 5.0, the Sp. gr. is under 4.5.

Sp. gr. = 3.3, — 7.2. If under 4.0; and the hardness = 5.0, the cleavage is diprismatic.

Genus I. Sparry Iron.

Rhomboidal. Hardness = 3.5,—4.5. Sp. gr. = 3.6,—3.9.

1. Rhomboidal Sparry Iron.

Brachytyper Parachros Baryte, *Mohs.*—Spath Eisenstein, *Werner.*—Fer Oxydé Carbonaté, *Haüy.*

Specific Character.—Rhomboidal. Rhomboid = 107. Cleavage rhomboidal.

External Characters.—Colours yellow, white, brown, and black. Occurs massive, disseminated, with pyramidal impressions; also in granular distinct concretions; and crystallized. The following are some of the principal crystallizations:

1. Primitive rhomboid. *a.* Perfect, with straight or spherical convex lateral faces. *b.* Truncated on the apices. *c.* Truncated on the terminal edges. *d.* Rounded off on the apices and edges. When the truncating planes in the variety 1. *c.* become so large that the original planes disappear, there is formed 2. A still flatter rhomboid. From the variety 1. *d.* there arises 3. which is a spherical lenticular form. From the rhomboid with curved faces there is formed 4. The saddle-shaped lens. We sometimes observe the primitive form arranged in rows, so as to form an 5. Equiangular six-sided prism, flatly acuminated with three planes, which are set on the alternate lateral planes. The faces of the lens are delicate drusy, but of all the other forms generally smooth; and the lustre varies from splendent, through shining to glistening. Internally lustre pearly, generally glistening, sometimes inclining to shining, and even to splendent; but the black variety is only glimmering. Fracture in compact varieties splintery. Fragments rhomboidal in the foliated varieties, but rather sharp-edged in the compact. Generally translucent on the edges, also translucent; but the black varieties are opaque. The pale varieties afford a white, the darker varieties, which are those in a state of alteration, a yellowish-brown streak. Rather brittle, and easily frangible.

Chemical Characters.—It blackens, and becomes magnetic before the blowpipe, but does not melt: it effervesces with muriatic acid. It dissolves with ebullition in glass of borax, and communicates to it an olive-green colour.

Constituent Parts.—

		Steinheim.
	Oxide of Iron, -	63.75
	Carbonic Acid, -	34.00
	Oxide of Manganese,	0.75
	Magnesia, - -	0.25
	Loss, - - -	1.25
		100.00 *Klaproth.*

Geognostic Situation.—Occurs in veins in granite, gneiss,

2

mica-slate, clay-slate, and grey-wacke, and in these it is associated with ores of lead, cobalt, silver, and seldomer with nickel and bismuth; more frequently with galena, grey copper, iron-pyrites, and grey antimony. In other veins it is accompanied with brown, red, and black iron ore, calcareous-spar, and quartz. But the most extensive formations of this mineral are in limestone, by some referred to primitive, by others to secondary rocks, in which it is arranged in thick beds. It also occurs filling up amygdaloidal cavities in trap-rocks.

Geographic Situation.—Europe.—Occurs in small quantities in different places in England, Scotland, and Ireland; but very abundant in Hessia, Carinthia, and other countries on the continent of Europe.

Uses.—It affords an iron which is excellently suited for steel making. The black variety is said to afford the best kind of iron.

Genus II. Red Manganese.

Rhomboidal. Hardness = 3.5, Sp. gr. = 3.3, — 3.6.

1. Rhomboidal Red Manganese.

Macrotyper Parachros Baryte, *Mohs.*—Rother Braunstein, *Werner.*—Manganese Oxidé Carbonaté, *Haüy.*

Specific Character.—Rhomboidal. Rhomboid = 106° 51′. Cleavage Rhomboidal.

This species is divided into three subspecies, viz. 1. Foliated, 2. Fibrous, and 3. Compact.

FIRST SUBSPECIES.

Foliated Rhomboidal Red Manganese.

External Characters.—Colour bright rose-red, slightly inclining to flesh-red. Occurs massive, disseminated, small reniform, globular, with tabular and rhomboidal impressions, and in granular distinct concretions. Internally shining, inclining sometimes to glistening, sometimes to splendent, and lustre pearly. Fragments indeterminate angular, and rather sharp-edged, or rhomboidal. Generally translucent on the edges; in some rare varieties translucent. Brittle, and rather easily frangible.

Chemical Character.—Before the blowpipe, without addition, it first becomes dark-brown, and then melts into a dark reddish-brown bead.

Constituent Parts.—

Oxide of Manganese,	-	52.60
Silica,	- - -	39.60
Oxide of Iron,	- -	4.60
Lime,	- - -	1.50
Volatile ingredients,	-	2.75
		101.5 *Berzelius,*

Geognostic and Geographic Situations.—Occurs in beds of specular iron-ore and magnetic iron-ore, along with compact garnet and calcareous-spar, in the gneiss hills at Langbanshytta, in Wermeland in Sweden; also at Catharinenburg in Siberia, and in Saxony.

Uses.—The Siberian varieties are cut and polished, and worn as ornamental stones.

SECOND SUBSPECIES.

Fibrous Rhomboidal Red Manganese.

External Characters.—Colours rose-red and flesh-red, inclining to grey and brown. Occurs massive, and in prismatic fibrous concretions, which are straight, scopiform and stellular. Internally glistening and pearly. Fragments splintery and wedge-shaped. Feebly translucent.

Geognostic and Geographic Situations.—Occurs in veins in primitive and transition rocks. It is a rare mineral, and is principally found at Kapnik in Transylvania, and at Schemnitz in Hungary.

THIRD SUBSPECIES.

Compact Rhomboidal Red Manganese.

External Characters.—Principal colour pale rose-red, which sometimes passes into dark reddish-white. Occurs massive, disseminated, and sometimes imperfectly reniform. Internally dull or glimmering. Fracture even sometimes inclining to splintery. Fragments indeterminate angular, and rather sharp-edged. Brittle and easily frangible.

Chemical Character.—It is infusible before the blowpipe, but becomes black by ignition.

Constituent Parts.—Oxide of Manganese,	61	
Silica, - - -	30	
Oxide of Iron, -	5	
Alumina, - -	2	
	98	*Lampadius.*

Geognostic and Geographic Situations.—Occurs at Kapnik in Transylvania; at Langbanshytta, in Wermeland in Sweden; and Catharinenburg in Siberia.

GENUS III. CALAMINE *.

Zink-Baryt, *Mohs.*

Rhomboidal. Prismatic. If rhomboidal, the Sp. gr. = 4.0. Hardness = 5.0, Sp. gr. = 3.3,—4.5.

1. Prismatic Calamine, or Electric Calamine.

Prismatischer Zink-Baryt, *Mohs.*—Zink Oxidé, *Haüy.*

Specific Character.—Prismatic. Pyramid = 134° 50′; 99° 56′; 96° 56′. $P + \infty$ 118° 29′. Cleavage, $P\breve{r}$ = 120°. More distinct $(P\breve{r} + \infty)^3$ = 80° 4′ Hardness = 5.0. Sp. gr. = 3.3,—3.6.

External Characters.—Most common colours white and yellow; it also occurs green, grey, yellow, and brown; and sometimes with curved striped colour delineations. Occurs massive, disseminated, in crusts, stalactitic, reniform, botryoidal, cellular, corroded; also in distinct concretions, which are scopiform radiated and fibrous, granular, and curved lamellar. Sometimes crystallized. The following are some of its secondary forms:

1. Six-sided prism. 2. Flat six-sided prism, bevelled on the terminal planes; the bevelling planes set on the broader lateral planes. This prism is sometimes so flat, that it appears like a longish rectangular four-sided table bevelled on the

* Agricola says, that because the cadmia (calamine) in the furnace, attaches itself to the iron bars in forms like a reed (calamus), it was named *Calamine.*

terminal planes. 3. Acute double four-sided pyramid, sometimes perfect, sometimes truncated on the summits. 4. Acute double four-sided pyramid, acuminated on both extremities, with four planes, which are set on the lateral planes, and sometimes the summits are truncated.

Internally it alternates from glistening to dull, and lustre pearly, inclining to adamantine. Fracture small and fine-grained uneven. Alternates from transparent to translucent on the edges, and opaque. Crystallized varieties as hard as apatite; the massive and opaque softer. Dark-coloured varieties afford a yellowish-grey streak.

Physical Characters.—When gently heated it becomes strongly electric.

Chemical Characters.—It loses, according to Pelletier, about 12 *per cent.* by ignition; it is soluble in muriatic acid without effervescence; and the solution gelatinises on cooling.

		Rezbanya.	
Constituent Parts.—	Oxide of zinc, - -	68.30	
	Silica, - - -	25.00	
	Water, - - -	4.40	
		97.70	*Smithson.*

Geognostic Situation.—Occurs in small quantities in metalliferous veins, principally along with ores of lead, in grey-wacke, grey-wacke-slate, and clay-slate; but most frequently in secondary or flœtz limestone, in imbedded masses, and irregular beds.

Geographic Situation.—Occurs in the lead-mines at Wanlockhead; also in Leicestershire and Flintshire, and in several countries on the Continents of Europe and Asia.

2. Rhomboidal Calamine.

Rhomboedrischer Zink-Baryt, *Mohs.*—Galmei, *Werner.*—Zink Carbonaté, *Haüy.*

Specific Character.—Rhomboidal. Rhomboid = 110° (nearly). Cleavage, Rhomboidal. Hardness = 5.0. Sp. gr. = 4.2,—4.6.

This species is divided into three subspecies, viz. Sparry, Compact, and Earthy.

FIRST SUBSPECIES.

Sparry Rhomboidal Calamine.

Spathiger Galmei, *Karsten.*

External Characters.—Colours white, grey, green, and brown. Occurs massive, botryoidal, reniform, stalactitic, tabular, cellular; also in distinct concretions, which are prismatic, granular, and curved lamellar; and sometimes crystallized. Internally shining and pearly. Fragments rhomboidal. Alternates from semitransparent to opaque.

Chemical Characters.—Dissolves with effervescence in muriatic acid; it is infusible; loses about 34 *per cent.* by ignition.

		Derbyshire.	
Constituent Parts.—	Oxide of Zinc, - -	65.2	
	Carbonic Acid, - -	34.8	
		100	*Smithson.*

SECOND SUBSPECIES.

Compact Rhomboidal Calamine.

Gemeiner Galmei, *Karsten.*

External Characters.—Colours grey, yellow, and yellowish-brown. Ocours massive, disseminated, corroded, reniform, stalactitic, and cellular; also in concentric curved lamellar coneretions. Rarely in supposititious crystals, or incrusting other crystals. Internally dull, or very feebly glimmering and resinous. Fracture coarse-grained uneven, fine splintery, even, and flat conchoidal. Opaque, or feebly translucent on the edges.

Chemical Characters.—Same as in the preceding subspecies.

THIRD SUBSPECIES.

Earthy Rhomboidal Calamine.

Zink-blüthe, *Karsten.*

External Characters.—Colour white, sometimes with a yellowish-brown exterior. Occurs massive, disseminated, botryoidal, flat, reniform, and with impressions. Internally dull. Fracture fine earthy. Opaque. Yields to the nail. Adheres to the tongue.

Chemical Characters.—Same as in the first subspecies.

Geognostic Situation of the Species.—Occurs in beds, veins, nests, filling up or lining hollows, in transition limestone, and in secondary or flœtz limestone, and conglomerate rock.

Geographic Situation of the Species.—Occurs in the Mendip Hills, at Shipham, near Cross, Somersetshire; at Allonhead in Durham; at Holywell, and elsewhere in Flintshire; and in Derbyshire.

Uses.—Both prismatic and rhomboidal calamine, when purified and roasted, are used for the fabrication of brass, which is a compound of zinc and copper; and the pure metal is also employed for a variety of other purposes.

Genus IV. Tungsten *, or Scheelium †.

Pyramidal. Hardness = 4.0,—4.5. Sp. gr. = 6.0,—6.1.

1. Pyramidal Tungsten.

Pyramidaler Scheel-Baryt, *Mohs.*—Schwerstein, *Werner.*—Scheelin Calcaire,—*Haüy.*

Specific Character.—Pyramidal. Pyramid = 107° 26′; 113° 36′. Cleavage, P. P + ∞ = 100° 8′; 130° 20′ P — ∞.

External Characters.—White is the principal colour of this mineral. The following varieties of colour also sometimes occur, viz. brown, which sometimes inclines to orange-yellow and hyacinth-red. Occurs massive, disseminated, also in distinct concretions, which are granular, seldomer wedge-shaped prismatic, and these latter traversed by others, which

* The name *Tungsten* was given to this mineral on account of its great weight.

† Werner gave the name *Scheele* to this genus, in honour of the illustrious chemist Scheele, who discovered the peculiar metal which characterises it.

are curved lamellar. Sometimes crystallised. The following are the secondary forms:

1. The primitive figure, in which the angles of the common base are flatly bevelled, and the bevelling planes set on the edges. 2. Flat double four-sided pyramid.

Externally shining and splendent, and lustre inclines to adamantine. Internally shining, lustre resinous, sometimes inclining to adamantine. Fracture coarse, or small-grained uneven, passing into imperfect conchoidal. More or less translucent, seldom semitransparent. Rather brittle, and easily frangible.

Chemical Characters.—Crackles before the blowpipe and becomes opaque, but does not melt; with borax it forms a transparent or opaque white glass, according to the proportions of each.

		Cornwall.
Constituent Parts.—	Oxide of Tungsten,	75.25
	Lime,	18.70
	Silica,	1.56
	Oxide of Iron,	1.25
	Oxide of Manganese,	0.75
		97.45 *Klaproth.*

Geognostic Situation.—Occurs along with tinstone, wolfram, magnetic iron-ore, and brown iron-ore, in primitive rocks.

Geographic Situation.—Occurs along with wolfram and tin-ore at Pengilly in Breage in Cornwall: at Bispberg in Sweden, in a bed of magnetic iron-ore.

Genus V. Baryte.

Prismatic. Hardness = 3.0,—3.5. Sp. gr. 3.6,—4.6.

Pyramido-Prismatic Baryte, or Strontianite.

Pyramido-prismatischer Hal-Baryt, *Mohs.*—Strontian, *Werner.*—Strontiane Carbonaté, *Haüy.*

Specific Character.—Prismatic. Pyramid unknown. Cleavage, $P\mathring{r} . P + \infty = 117° 19'$. $P\mathring{r} + \infty$. Hardness = 3.5. Sp. gr. 3.6,—3.8.

External Characters.—Colour pale asparagus-green, which sometimes inclines to apple-green, sometimes to yellowish-white and greenish-grey. The greenish-grey varieties sometimes pass into milk and yellowish white, and pale straw-yellow. Occurs massive, in distinct concretions, which are scopiform radiated and fibrous, and crystallised. Its secondary figures are the following: 1. Acicular six-sided prism, acutely acuminated with six planes, which are set on the lateral planes. 2. Acicular acute double six-sided pyramid. Crystals are sometimes scopiformly and manipularly aggregated. Lustre of the distinct concretions shining or glistening; fracture glistening and pearly. Fracture fine-grained uneven. Fragments wedge-shaped or splintery. More or less translucent, and sometimes semi-transparent. Brittle and easily frangible.

Chemical Characters.—Infusible before the blowpipe, but becomes white and opaque, and tinges the flame of a dark purple colour. Soluble, with effervescence, in muriatic or nitric acid; and paper dipped in the solutions thus produced, burns with a purple flame.

Constituent Parts.—	Strontian,	61.21	
	Carbonic Acid,	30.20	
	Water,	8.50	
		100.00	*Hope.*

Geognostic and Geographic Situations.—Occurs at Strontian in Argyleshire, in veins that traverse gneiss, along with galena or lead-glance, heavy-spar, and calcareous-spar.

2. Diprismatic Baryte, or Witherite.

Di-prismatischer Hal-Baryt, *Mohs.*—Witherit, *Werner*.—Baryte Carbonaté, *Haüy*.

Specific Character.—Prismatic. Pyramid unknown. Cleavage, $P\mathring{r} . P + \infty = 120°$ (nearly). $P\mathring{r} + \infty$. Hardness $= 3.0, — 3.5$. Sp. gr. $= 4.2, — 4.4$.

External Characters.—Colours white, grey, and yellow. Occurs, massive, disseminated, in crusts, cellular, corroded, large globular, reniform, botryoidal, stalactitic; also in distinct concretions, which are wedge-shaped, sometimes scopiform radiated, and occasionally pass into coarse granular. More rarely crystallized. The following are the secondary forms:

1. Six-sided prism. *a.* Truncated on the terminal edges. *b.* Acutely acuminated on the extremities with six planes, which are set on the lateral planes. 2. Acute double six-sided pyramid, in which the lateral planes of the one are set on the lateral planes of the other.

Externally glistening; internally shining on the cleavage, and glistening on the fracture, and the lustre resinous. Principal fracture uneven, inclining to splintery. Fragments wedge-shaped, or indeterminate angular. Translucent, rarely semi-transparent. Brittle, and easily frangible.

Chemical Characters.—Before the blowpipe it decrepitates slightly, and melts readily into a white enamel; it is soluble, with effervescence, in diluted muriatic or nitric acid.

Constituent Parts.—	Carbonate of Barytes, -	96.3	
	Carbonate of Strontian, -	1.1	
	Sulphate of Barytes, -	0.9	
	Silica, - - - -	0.5	
	Alumina, and Oxide of Iron,	6.25	
		99.05	*Aikin.*

Geognostic and Geographic Situations.—Occurs in Cumberland and Durham, in lead veins that traverse secondary limestone, which rests on red sandstone, and in these it is associated with coralloidal arragonite, brown-spar, earthy fluor, heavy-spar, and galena or lead-glance, white lead-spar, green lead-spar, copper-pyrites, blue copper, malachite, iron-pyrites, sparry-iron, calamine, and blende. 2. also in Shropshire

Uses.—It is a very active poison, and in some districts, as in Cumberland, it is employed for the purpose of destroying rats. When dissolved by muriatic acid, the solution thus obtained, is said to prove serviceable in scrofula.

3. Prismatoidal Baryte, or Heavy-Spar.

Prismatoidischer Hal-Baryt, *Mohs.*—Schwerspath, *Werner.*—
Baryte Sulphaté, *Haüy.*

Specific Character.—Prismatic. Pyramid = 128° 54′;

91° 20′; 110° 25′. $P + \infty = 101° 59'$. Cleavage, $P\bar{r} = 78° 28'$. $P\breve{r} + \infty$. Less distinct, $P - \infty$. $P\bar{r} + \infty$. Hardness $= 3.0, — 3.5$. Sp. gr. $= 4.1, — 4.6$.

This species is divided into nine subspecies, viz. 1. Earthy, 2. Compact; 3. Granular; 4. Curved Lamellar; 5. Straight Lamellar; 6. Fibrous; 7. Radiated; 8. Columnar; and, 9. Prismatic.

FIRST SUBSPECIES.

Earthy Heavy-spar.

Schwerspath Erde, *Werner*.

External Characters.—Colours yellowish and reddish white. Of friable consistence, and consists of feebly glimmering, nearly dull, particles, which are intermediate between scaly and dusty, soil feebly, and are generally loose, or but feebly cohering. Feels meagre, and rather rough. Specific gravity, 4.0.

Constituent Parts.—Is sulphate of barytes.

Geognostic and Geographic Situations.—Occurs in drusy cavities in veins of heavy-spar, in Staffordshire and Derbyshire.

SECOND SUBSPECIES.

Compact Heavy-spar.

Dichter Schwerspath, *Werner*.

External Characters.—Colours white and grey. Occurs massive, disseminated, reniform, ssmi-globular, tuberose, with cubic impressions; and in curved lamellar concretions. Internally glimmering. Fracture intermediate between coarse earthy, and fine-grained uneven, which sometimes passes into imperfect foliated, and more rarely into splintery. Fragments indeterminate angular, and blunt-edged. Opaque, or translucent on the edges. Rather sectile, and easily frangible.

Geognostic and Geographic Situations.—Is found in the mines of Staffordshire and Derbyshire, where it is named *Cawk*.

THIRD SUBSPECIES.

Granular Heavy-Spar.

Körniger Schwerspath, *Werner*.

External Characters.—Colours white, and sometimes ash-grey. Occurs massive, and in fine granular concretions, which are sometimes so minute as scarcely to be discernible. Internally glistening, approaching to shining, and pearly. Fragments indeterminate angular, and blunt-edged. Feebly translucent. Soft. Rather brittle, and easily frangible.

Geognostic Situation.—Occurs principally in beds along with galena, blende, copper-pyrites, and iron-pyrites.

Geographic Situation.—Occurs in beds, along with galena, blende, copper-pyrites, and iron-pyrites, at Peggau in Stiria; also in the Hartz, in beds, along with copper and iron pyrites, galena, and blende.

FOURTH SUBSPECIES.

Curved Lamellar Heavy-Spar.

Krummschaaliger Schwerspath, *Werner*.

External Characters.—Principal colours white, grey, and red. Sometimes several colours occur together, and arranged in broad stripes. Generally occurs massive, more frequently reniform, and long globular, with a drusy surface; the drusy surface is formed of very small, thin, and longish four-sided tables; also in reniform curved lamellar concretions, which are frequently floriform, and these are again composed of prismatic concretions. Is rarely marked with cubical impressions. Internally intermediate between shining and glistening, and lustre pearly, inclining to resinous. Fracture curved foliated, which sometimes inclines to splintery, and thus approaches to the compact subspecies. Fragments indeterminate angular, and rather blunt-edged. Translucent on the edges. Brittle and easily frangible.

Geognostic and Geographic Situations.—Is one of the most common subspecies of heay-spar. In Scotland, it occurs in trap and sandstone rocks: in Derbyshire, it occurs in secondary limestone: it characterises a particular venigenous formation at Freyberg in Saxony, where it is associated with radiated pyrites, argentiferous galena, brown blende, calcareous-spar, and fluor-spar.

FIFTH SUBSPECIES.

Straight Lamellar Heavy-Spar.

It is divided into three kinds, viz. Fresh, Disintegrated, and Fetid.

First Kind.

Fresh Straight Lamellar Heavy-Spar.

Geradschaaliger Schwerspath, *Werner*.

External Characters.—Colours white, grey, black, blue, green, yellow, red, and brown. Occurs generally massive; also in distinct concretions, which are straight and thin lamellar; and again collected into others which are coarse granular; and also crystallized. The following are the secondary figures it exhibits:

1. Rectangular four-sided table. 2. Oblique four-sided table. 3. Longish six-sided table. 4. Eight-sided table.

Externally smooth and splendent; internally shining and splendent, and lustre intermediate between resinous and pearly. Fragments tabular and rhomboidal. Translucent, or transparent, and refracts double. Brittle, and easily frangible.

Chemical Characters.—Decrepitates briskly before the blowpipe, and, by continuance of the heat, melts into a hard white enamel.

Constituent Parts.—	Sulphate of Barytes, -	97.60
	Sulphate of Strontian, -	0.85
	Water, - - -	0.10
	Oxide of Iron, - -	0.80
	Alumina, - - -	0.05
		Klaproth.

Geognostic Situation.—Is found almost always in veins, which occur in granite, gneiss, mica-slate, clay-slate, grey-wacke, limestone, and sandstone. It is often accompanied with ores, particularly the flesh-red variety, and these are, native silver, silver-glance or sulphuretted silver, copper-pyrites, lead-glance, white cobalt, light red silver, native arsenic, earthy cobalt, cobalt-bloom or red cobalt, antimony, and manganese. It occurs sometimes in beds, and encrusting the walls of drusy cavities.

Geographic Situation.—In this island, it occurs in veins in different primitive and transition rocks, and also in secondary limestone, sandstone, and trap. Beautiful crystallized varieties are found in the lead-mines of Cumberland, Durham, and Westmoreland.

Second Kind.

Disintegrated Straight Lamellar Heavy-Spar.

Mulmicher oder mürber geradschaaliger Schwerspath, *Werner.*

External Characters.—Colour white. Occurs massive. Glistening and pearly. Opaque, or faintly translucent on the edges. Very easily frangible. Other characters same as the preceding.

Geognostic and Geographic Situations.—Was formerly met with in considerable quantity at Freyberg in Saxony, in a mixture of galena, blende, and iron-pyrites.

Third Kind.

Fetid Straight Lamellar Heavy-spar or Hepatite.

External Characters.—Colours white, grey, and black. Occurs massive, disseminated, and in globular or elliptical pieces, from an inch to a foot and upwards in diameter; also in lamellar concretions, which are generally straight, sometimes curved and floriform; sometimes there is a tendency to wedge-shaped and radiated concretions. Externally feebly glimmering; internally shining, and intermediate between pearly and resinous. Fragments indeterminate angular, and blunt-edged. Opaque, or translucent on the edges. Nearly as hard as straight lamellar heavy-spar. Affords a greyish-white coloured streak.

Chemical Characters.—Burns white before the blowpipe; and when rubbed or heated, gives out a fetid sulphureous odour.

Constituent Parts.—

Sulphate of Barytes, -	85.25
Carbon, - - -	0.50
Sulphate of Lime, - -	6.00
Oxide of Iron, - -	5.00
Alumina, - - -	1.00
Loss, including Moisture and Sulphur, - - -	2.25
	100.00 *Klaproth.*

Geognostic and Geographic Situations.—Occurs at Buxton in Derbyshire; at Kongsberg, and Andrarum in Norway.

SIXTH SUBSPECIES.

Fibrous Heavy-Spar.

Fasriger Schwerspath, *Werner.*

External Characters.—Colour pale yellowish and wood brown, which sometimes passes into yellowish-grey. Occurs massive and reniform; also in distinct concretions, which are scopiform prismatic or fibrous, sometimes collected into others which are curved lamellar, and sometimes coarse angulo-granular. Internally shining, and lustre resinous. Fragments splintery, and wedge-shaped. Translucent on the edges.

Geognostic and Geographic Situations.—Found at Neu-Leiningen in the Palatinate; also in an ironstone mine in clay-slate, at Chaud-Fontaine, near Luttich, in the Ourthe department; and at Miess in Bohemia.

SEVENTH SUBSPECIES.

Radiated Heavy-Spar, or Bolognese Spar.

Bologneser Spath, *Werner.*

External Characters.—Colour grey. Occurs in roundish pieces, which have a lenticular aspect and uneven surface; also in distinct concretions, which are parallel and scopiform radiated, and also granular. Internally shining or glistening, and lustre pearly, inclining to resinous. Fragments splintery, or wedge-shaped. Translucent. In other characters it agrees with the preceding.

Geognostic and Geographic Situations.—Occurs imbedded in marl at Monte Paterno, near Bologna; also at Rimini; and in Jutland.

EIGHTH SUBSPECIES.

Columnar Heavy-Spar.

Stangenspath, *Werner.*

External Characters.—Colour white. Occurs crystallized, in acicular oblique four-sided prisms, which are always columnarly aggregated, and intersect each other. Externally frequently invested with iron-ochre, but when unsoiled, shining and pearly. Cleavage the same as that of lamellar heavy-spar. Translucent.

Geognostic and Geographic Situations.—It was formerly found in the vein of Lorenzgegentrum, near Freyberg in Saxony, along with ores of different kinds, and also fluor-spar, quartz, and straight and curved lamellar heavy-spar.

NINTH SUBSPECIES.

Prismatic Heavy-Spar.

Saulenspath, *Werner.*

External Characters.—Principal colours grey, white, olive-green, flesh-red, and indigo-blue. Seldom occurs massive, or in angulo-granular and promiscuous prismatic concretions, generally crystallized, and in the following figures:

1. Slightly oblique four-sided prism, rather acutely bevelled on the extremities, and the bevelling planes set on the acuter lateral edges. 2. Oblique four-sided prism, rather acutely acuminated on the extremities with four planes, which are set on the lateral edges. 3. Unequiangular six-sided prism, with two opposite acuter lateral edges, and with the same terminal bevelment and acuminations as in figures 1. and 2. 4. Flat double four-sided pyramid, in which the la-

teral planes of the one are set on the lateral planes of the other.

Surface of crystals splendent, and lateral planes transversely streaked. Internally shining or splendent, and lustre pearly, inclining to resinous. Alternates from translucent to semi-transparent.

Geognostic Situation.—Occurs in veins, along with fluor-spar, and ores of silver and cobalt; in gneiss, mica-slate, and other primitive rocks. Is rare in clay-slate, and very rare in secondary rocks.

Geographic Situation.—Occurs at Kongsberg in Norway; Mies in Bohemia; and Freyberg, Marienberg, and Ehrenfriedersdorf in Saxony.

4. Prismatoidal Baryte, or Celestine.

Prismatoidischer Hal-Baryt, *Mohs.*—Cœlestin, *Werner.*—Strontiane sulphatée, *Haüy.*

Specific Character.—Prismatic. Pyramid $= 128° \; 14'$; $113° \; 26'$; $90° \; 57'$. $P + \infty = 115° \; 42'$. Cleavage, $Pr = 104° \; 48'$. More distinct, $\breve{P}r + \infty$. Less distinct, $P - \infty$. $\bar{P}r + \infty$. Hardness $= 3.0,—3.5$. Sp. gr. $= 3.6,—4.0$.

This species is divided into five subspecies, viz. Foliated, Prismatic, Fibrous, Radiated, and Fine Granular.

FIRST SUBSPECIES.

Foliated Celestine.

Blättricher Cœlestin, *Karsten.*—Shaaliger Cœlestin, *Werner.*

External Characters.—Colours milk-white, blue, and red. Occurs massive; also in lamellar distinct concretions; and crystallized in the following figures: 1. Rectangular four-sided table, in which the terminal planes are bevelled, and the lateral planes are truncated. 2. Rectangular four-sided table, bevelled on the terminal edges. Externally shining and splendent; internally shining, and lustre pearly, inclining to vitreous. Fracture uneven. Fragments rhomboidal, or indeterminate angular, and rather sharp-edged. Translucent, semi-transparent, or transparent. Rather sectile, and very easily frangible.

Chemical Characters.—It melts before the blowpipe into a white friable enamel, without very sensibly tinging the flame: after a short exposure to heat it becomes opaque, and has then acquired a somewhat caustic acrid flavour, very different from that of sulphuretted hydrogen, which heavy-spar acquires in similar circumstances. These characters apply also to the other subspecies.

Constituent Parts.—

Strontian and Sulphuric Acid,	97.601
Sulphate of Barytes, -	00.975
Silica, - - -	00.107
Oxide of Iron, and intermixed Hydrate of Iron, -	00.646
Water, - - -	00.248
	99.577 *Stromeyer.*

Geognostic and Geographic Situations.—Occurs in trap-tuff in the Calton Hill at Edinburgh *, and in red sandstone at Inverness. Is frequent along with some of the other subspecies at Aust Passage, and elsewhere in the neighbourhood of Bristol, and in the islands in the Bristol Channel, particularly in Bary Island, on the coast of Glamorganshire; also in amygdaloid at Becheley in Gloucestershire †; and it has been found on the banks of the Nidd, near Knaresborough, Yorkshire.

SECOND SUBSPECIES.

Prismatic Celestine.

Saulenförmiger Cœlestin, *Werner.*

External Characters.—Colours white and blue. Occurs massive, also in prismatic distinct concretions, but most frequently crystallized. The following are the most frequent crystallizations: 1. Long oblique four-sided prism, flatly bevelled on the extremities, the bevelling planes set on the obtuse lateral edges. Sometimes the angles between the bevel-

* It was discovered in the Calton Hill by Mr Sivright of Meggetland.

† It was discovered in the Becheley amygdaloid by Dr Daubeny.

ling and lateral planes are more or less deeply truncated, and thus form a four-planed acumination, in which the acuminating planes are set on the lateral edges. 3. Sometimes the acute edges of the preceding figure are truncated, and thus a six-sided prism is formed. Externally smooth, splendent, and resinous. Internally glistening, and lustre pearly, inclining to resinous. Fracture uneven. Fragments wedge-shaped and indeterminate angular. Translucent, or transparent. In other characters agrees with the preceding subspecies.

Geognostic and Geographic Situations.—Occurs in drusy cavities in a bed of sulphur, which is associated with gypsum and marl, in the valleys of Noto and Mazzara, in Sicily.

THIRD SUBSPECIES.

Fibrous Celestine.

Fasriger Cœlestin, *Werner.*

External Characters.—Colours blue, grey, and white. Occurs massive, also in distinct concretions, which are straight, parallel, and sometimes curved, fibrous. Internally glistening and pearly. Cleavage indistinct. Fragments splintery. Translucent. In other characters it agree with the preceding subspecies.

Constituent Parts.—

Strontian,	56.0	
Sulphuric Acid,	42.0	
	98.0	*Klaproth.*

Geognostic and Geographic Situations.—Occurs in the red sandstone formation near Bristol; imbedded in marl, which is probably connected with gypsum, at Frankstown in Pennsylvania; and at Bouveron, near Toul, in the department of Meurthe in France.

FOURTH SUBSPECIES.

Radiated Celestine.

Strahliger Cœlestin, *Werner.*

External Characters.—Colour white. Occurs massive; also in prismatic concretions, which are scopiformly radiated, collected into others which are wedge-shaped, and these again into very large and angulo-granular concretions. Internally shining and splendent, and lustre pearly, slightly inclining to vitreous. Fragments wedge-shaped and splintery. Translucent or semi-transparent. In other characters agrees with the other subspecies.

FIFTH SUBSPECIES.

Fine Granular Celestine.

Fein Körniger Cœlestin, *Werner.*

External Characters.—Colours grey, and olive-green. Occurs massive, in fine granular concretions, in spheroidal or reniform masses, which are often traversed by fissures that divide its surface into quadrangular pieces, which are sometimes lined with minute crystals of celestine. Towards the surface it has a marly aspect. Internally dull, glimmering, and pearly. Fracture fine splintery, passing into uneven. Fragments blunt-edged. Opaque, or translucent on the edges. In other characters it agrees with the preceding subspecies.

Constituent Parts.—

Sulphate of Strontian,	-	91.42
Carbonate of Lime,	-	8.33
Oxide of Iron,	-	0.25
		100.00 *Vauquelin.*

Geognostic and Geographic Situations.—Occurs imbedded in marly clay, with gypsum, at Montmartre, near Paris; and is said to form a whole bed in Champagne.

Gen. VI. Lead-Spar.

Blei-Baryt, *Mohs.*

Rhomboidal, pyramidal, prismatic. Hardness, 2.5,—4.0. If above 3.5, the sp. gr. is equal to 6.5, and more. Sp. gr. = 6.0,—7.2.

1. Di-Prismatic Lead-Spar.

Di-prismatischer Blei-Baryt, *Mohs.*—Plomb carbonatée, *Haüy.*

Specific Character.—Prismatic. Pyramid = 130°; 108° 28′; 92° 19′. $P + \infty = 108° 16′$. Cleavage, $\bar{Pr} = 117° 13′$. $(\breve{Pr} + \infty)^3 = 69° 20′$. Hardness = 3.0,—3.5. Sp. gr. = 6.3, —6.6.

This species is divided into three subspecies, viz. White Lead-Spar, Black Lead-Spar, and Earthy Lead-Spar.

FIRST SUBSPECIES.

White Lead-Spar.

Weiss Bleierz, *Werner.*—Plomb carbonatée, *Haüy.*—White Lead-ore, *Jameson,* 3d edit.

External Characters.—Principal colour white; occurs also yellow, brown, and grey; and sometimes with a tempered-steel tarnish. It is sometimes coloured externally yellow or brown, by yellow or brown iron-ochre; occasionally green, by earthy malachite; and blue, by earthy blue copper. Occurs massive, disseminated, in membranes, seldom reticulated; and crystallized in the following forms:—1. Unequiangular six-sided prism, in which the terminal edges are truncated. 2. Unequiangular six-sided prism, acutely acuminated with six planes, which are set on the lateral planes. 3. Acute double six-sided pyramid, which is perfect. 4. Unequiangular six-sided prism, acuminated with four planes, two of which are set on the lateral planes, bounded by the obtuse lateral edges, but the other two are set on the acuter lateral edges. 5. Long acicular and capillary crystals, columnarly aggregated. 7. Occurs also in twin and triple crystals. Crystals occur superimposed, and either single or in druses; more frequently columnarly and scopiformly, or promiscuously aggregated. Externally, alternates from specular-splendent to glistening. Internally, alternates from shining to glistening, and lustre adamantine, sometimes inclining to semi-metallic, sometimes to resinous. Fracture small conchoidal, which sometimes passes into uneven and splintery. Alternates from translucent to transparent; and refracts double in a high degree. Brittle, and very easily frangible.

Chemical Characters.—Insoluble in water. Dissolves with effervescence in muriatic and nitric acids. Before the blowpipe it decrepitates, becomes yellow, then red, and is soon reduced to a metallic globule.

		Lead-hills.
Constituent Parts.—Oxide of Lead,	- - -	82
Carbonic Acid,	- - -	16
Water,	- - - - -	2
		100 *Klaproth.*

Geognostic Situation.—Occurs in veins, and sometimes also in beds, in gneiss, mica-slate, clay-slate, foliated granular limestone, grey-wacke, grey-wacke-slate, and secondary limestone.

Geographic Situation.—Occurs at Lead-hills in Lanarkshire, in veins that traverse transition rocks, in which it is associated with galena or lead-glance, earthy white lead-spar, green lead-spar, lead-vitriol or sulphate of lead, sparry iron, iron-pyrites, brown hematite, calamine, and blue copper; and the vein-stones are quartz, lamellar heavy-spar, calcareous-spar, brown-spar, and mountain-cork. It is found along with galena or lead-glance at Allonhead and Teesdale in Durham; with the same ore at Alston in Cumberland, and Snailback in Shropshire.

SECOND SUBSPECIES.

Black Lead-Spar.

Schwarz Bleierz, *Werner.*

External Characters.—Colour black, which sometimes passes into ash-grey. Occurs massive, disseminated, corroded, cellular, and seldom crystallized, in small six-sided prisms. Externally generally splendent, and sometimes shining. Internally only shining, sometimes passing into glistening, and lustre metallo-adamantine. Fracture small-grained uneven, which sometimes passes into imperfect conchoidal. Alternates from translucent to opaque. Streak whitish-grey. In other characters agrees with the preceding.

Constituent Parts.—Oxide of Lead,	- -	79
Carbonic Acid,	- -	18
Carbon,	- - - -	2
		99 *Lampadius.*

Geognostic Situation.—Generally occurs in the upper part of veins, associated with white lead-spar, and galena or lead-glance.

Geographic Situation.—Occurs at Lead-hills; at Fair Hill and Flow Edge, Durham.

THIRD SUBSPECIES.

Earthy Lead-Spar.

Bleierde, *Werner*.

This subspecies is divided into two kinds, viz. Indurated and Friable.

First Kind.

Indurated Earthy Lead-Spar.

Verhärtete Bleierde, *Werner*.

External Characters.—Colours grey, yellow, and brown. Occurs massive. Internally glimmering, inclining to glistening; and lustre resinous *. Fracture small and fine grained uneven, which passes on the one side into fine splintery, on the other into earthy. Usually opaque, or extremely faintly translucent on the edges. Yields a brown coloured streak.

Chemical Characters.—It is very easily reduced before the blowpipe; effervesces with acids, and becomes black with sulphuret of ammonia.

		Tarnowitz.
Constituent Parts.—	Oxide of Lead, - -	66.00
	Carbonic Acid, - -	12.00
	Water, - - -	2.25
	Silica, - - -	10.50
	Alumina, - - -	4.75
	Iron, and Oxide of Maganese,	2.25
		97.75 *John.*

Geognostic Situation.—The yellow-coloured varieties occur in a bed in primitive limestone in the Bannat; the grey-coloured varieties occur sometimes in veins, sometimes in beds, and either in transition or secondary rocks.

Geographic Situation.—Found in the lead-veins of Wanlockhead and Lead-hills; also at Grassfield Mine near Nenthead in Durham, and in Derbyshire.

* This lustre is accidental, and appears to be owing to intermixed white lead-ore, or lead-vitriol.

Second Kind.

Friable Earthy Lead-Spar.

Zerreibliche Bleierde, *Werner.*

External Characters.—Colours grey and yellow. Occurs massive, disseminated, and in crusts. It is composed of dull dusty particles, which are feebly cohering. Soils feebly. Is meagre, and rough to the feel. Is heavier than earthy heavy-spar.

Geognostic Situation.—Occurs on the surface, or in the hollows of other minerals, and is usually accompanied with galena or lead-glance, and lead-spars.

Geographic Situation.—It is found at Wanlockhead and Lead-hills, and Zellerfeld in the Hartz.

2. Rhomboidal Lead-Spar.

Rhomboedrisches Blei-Baryt, *Mohs.*—Plomb Phosphaté,—*Haüy.*

Specific Character.—Di-rhomboidal. Rhomboid $= 117°$ $23'$. Cleavage, $P + 1 = 141° \ 47'$; $81° \ 46'$. Hardness $= 3.5$, —4.0. Sp. gr. $= 6.9$,—7.2.

This species contains two subspecies, viz. Green Lead-spar and Brown Lead-spar.

FIRST SUBSPECIES.

Green Lead-Spar.

Grün Bleierz, *Werner.*—Plomb Phosphaté, *Haüy.*

External Characters.—Colour green; also yellow and white. Seldom occurs massive, sometimes stalactitic, reniform, and botryoidal, sometimes in distinct concretions, which are granular or prismatic; but most commonly crystallized. The following are the secondary forms:—1. Equiangular six-sided prism. 2. Six-sided prism, truncated on all the lateral edges, thus forming a twelve-sided prism. 3. Six-sided prism, flatly acuminated on the extremities with six planes, which are set on the lateral planes. Sometimes they form velvety or moss-like drusy crusts. Externally smooth and shining, or splendent; internally glistening, and lustre resinous. Fracture small grained uneven, passing on the one hand into splintery, on the other into conchoidal. More or less translucent, seldom nearly transparent, and sometimes only translucent on the edges. Brittle, and easily frangible.

Chemical Characters.—Dissolves in acids without effervescence.

Constituent Parts.—

	Wanlockhead.
Oxide of Lead, - -	80.00
Phosphoric Acid, -	18.00
Muriatic Acid, - -	1.62
Oxide of Iron,—a trace.	
	99.96 *Klaproth.*

Geognostic Situation.—Occurs in veins and beds in primitive, transition, and secondary rocks.

Geographic Situation.—Occurs along with galena or lead-glance, and other ores of lead, at Lead-hills and Wanlockhead. In England, it is met with at Alston in Cumberland, Allonhead, Grasshill, and Teesdale, in Durham, and Nithisdale in Yorkshire.

SECOND SUBSPECIES.

Brown Lead-Spar.

Braun Bleierz, *Werner.*—Plomb phosphaté, *Haüy.*

External Characters.—Colour clove-brown, of different degrees of intensity, rarely approaching to liver-brown, sometimes so pale that it inclines to white. Occurs massive, also in distinct concretions, which are thin prismatic, and curved lamellar; and crystallized in the following figures:—1. Equiangular six-sided prism, which is sometimes bulging. 2. Six-sided prism, converging towards both ends, and thus inclining to the pyramidal form. 3. Acute double three-sided pyramid, in which the lateral planes of the one are set on the lateral planes of the other, and in which the common basis is sometimes more or less deeply truncated. The crystals sometimes short and acicular, occasionally singly imbedded, or scopiformly or globularly aggregated. Surface of the crystals is sometimes blacksih or yellowish brown, and rough. Internally glistening, and lustre resinous. Fracture small and fine-grained uneven, and sometimes passes into small splintery. Feebly translucent, or translucent on the edges. Streak greyish-white. Rather brittle, and easily frangible.

Geognostic Situation.—Occurs in veins that traverse gneiss, clay-slate, and porphyry. The veins generally contain lead and silver ores, also native silver, iron and copper pyrites, green malachite, blende, ochry ironstone, heavy-spar, and quartz.

Geographic Situation.—Is found at Miess in Bohemia; near Schemnitz in Hungary; Saska in the Bannat; Zschoppau in Saxony; Huelgoët and Poullaouen in Lower Brittany.

3. Hemi-Prismatic Lead-Spar, or Red Lead-Spar.

Hemi-prismatischer Blei-Baryt, *Mohs.*—Roth Bleierz, *Werner.* —Plomb chromaté, *Haüy.*

Specific Character.—Hemi-prismatic. Pyramid unknown. Cleavage, $P + \infty = 90°$ (nearly) $\breve{P}r + \infty$. $\bar{P}r + \infty$. Hardness $= 2.5$. Sp. gr. $= 6.0,—6.1$.

External Characters.—Colour hyacinth-red. Seldom occurs massive, generally in flakes; and crystallized in the following figures: 1. Long slightly oblique four-sided prism. 2. Prism acutely and obliquely bevelled on the extremities, the bevelling planes set on the lateral edges. 3. Prism acuminated with four planes, which are set on the lateral planes.

Internally shining or splendent, and lustre adamantine. Fracture small-grained uneven, sometimes passing into imperfect and small conchoidal. More or less translucent. Streak intermediate between lemon-yellow and orange-yellow. Almost sectile, and easily frangible.

Chemical Characters.—Before the blowpipe it crackles and melts into a grey slag. With borax is partly reduced. Does not effervesce with acids.

Constituent Parts.—

Oxide of Lead,	- -	63.96
Chromic Acid,	- -	36.40
		100.36 *Vauquelin.*

Geognostic and Geographic Situations.—Occurs in veins in gneiss, in the gold-mines of Beresofsk, in the Uralian Mountains, where it is associated with brown iron-ore, cubes of iron-pyrites, native gold, green lead-spar, galena, and quartz.

4. Pyramidal Lead-Spar, or Yellow Lead-Spar.

Pyramidaler Blei-Baryt, *Mohs.*—Gelb Bleierz, *Werner.*—Plomb molybdaté, *Haüy.*

Specific Character.—Pyramidal. Pyramid = 99° 40′; 131° 35′. Cleavage, P — ∞. P. Hardness = 3.0. Sp. gr. = 6.5,—6.9.

External Characters.—Most frequent colour wax-yellow. Occurs massive, in crusts, cellular; and crystallized in the following figures:—1. Pyramid truncated on the angles and summits. 2. Pyramid so deeply truncated in all the angles, and on the common base, that the original faces disappear, when there is formed a regular eight-sided table, which is sometimes so thick as to appear as an eight-sided prism. Sometimes four of the terminal edges are truncated, when a twelve-sided table is formed. 3. Pyramid deeply truncated on the summits, and on the common base, and the angles of the common base bevelled, which gives rise to the rectangular four-sided table, bevelled on the terminal edges. 4. Pyramid truncated on the lateral edges, which gives rise to the double eight-sided pyramid. When this figure is deeply truncated on the summits, there is formed, 5. A regular eight-sided table, bevelled on the terminal planes.

Tables usually broad and thin; frequently intersect each other, and are often closely aggregated. Externally generally splendent or shining; internally shining or glistening, and the lustre resinous, inclining to adamantine. Fracture small and fine grained uneven, or small conchoidal. Generally translucent, or only translucent on the edges; some rare crystals are semi-transparent. Rather brittle, and easily frangible.

Chemical Characters.—Decrepitates before the blowpipe, and then melts into a dark greyish-coloured mass, in which the globules of reduced lead are dispersed.

Constituent Parts.—	Oxide of Lead,	58.40	
	Molybdic Acid,	38.00	
	Oxide of Iron,	2.08	
	Silica,	0.28	
		96.66	*Hatchett.*

Geognostic and Geographic Situations.—Occurs at Bleiberg in Carinthia, in a compact limestone.

5. Prismatic Lead-Spar, or Sulphate of Lead.

Prismatischer Blei-Baryt, *Mohs.*—Vitriol Bleierz, *Werner.*—Plomb sulphatée, *Haüy.*

Specific Character.—Prismatic. Pyramid $= 122° 35'$; $94° 25'$; $112° 37'$. $P + \infty = 109° 28'$. Cleavage, $P\bar{r} = 78° 28'$. More distinct $P\mathring{r} + \infty$. Hardness $= 3.0$. Sp. gr. $= 6.2$,—6.3.

External Characters.—Colours yellowish and greyish-white, occasionally stained pale yellowish, from brown iron-ochre. Occurs massive, disseminated, and in angulo-granular distinct concretions, but most frequently crystallized, and of the secondary forms, the most common resembles an elongated octahedron.

Externally splendent and shining; internally shining, and lustre adamantine. Fracture small conchoidal. Alternates from transparent to translucent. Streak white. Rather brittle, and easily frangible.

Chemical Characters.—Decrepitates before the blowpipe, then melts, and is soon reduced to the metallic state.

		Wanlockhead.	
Constituent Parts.—	Oxide of Lead,	70.50	
	Sulphuric Acid,	25.75	
	Water of Crystallization,	2.25	
		98.0	*Klaproth.*

Geognostic and Geographic Situations.—Occurs in veins, along with galena and lead-glance, and different spars of lead, at Wanlockhead in Dumfriesshire, and Lead-hills in Lanarkshire; at Pary's Mine in Anglesea, and Penzance in Cornwall.

ORDER III. KERATE *.

No metallic lustre. Streak white or grey.
No single distinct cleavage.
Hardness = 1.0,—2.0.
Sp. gr. = 5.5.

GENUS I. CORNEOUS SILVER.

Tessular. Hardness = 1.0,—2.0. Sp. gr. = 5.5, 5.6.

1. Hexahedral Corneous Silver.

Hexedrisches Perl Perat, *Mohs.*—Hornerz, *Werner.*—
Argent Muriaté, *Haüy.*

Specific Character.— Tessular. Cleavage not visible. Malleable.

External Characters.—Most frequent colour pearl-grey, from which it passes on the one side into blue, on the other into white, and further, into leek-green. On exposure to light, it becomes brownish. Occurs massive, in prismatic and granular concretions, disseminated in thick flakes, in egg-shaped pieces, hollow in the centre, and the hollows lined with crystals. The crystals are the following:

1. Cube. 2. Octahedron. 3. Rhomboidal dodecahedron.

Crystals small and very small, occasionally aggregated in rows, or in a scalar-like form. External surface smooth, sometimes marked with little hollows. Externally shining, but becomes gradually duller on exposure: internally intermediate between shining and glistening, and lustre resinous. Fracture conchoidal, sometimes inclines to earthy. Translucent, or only feebly translucent on the edges. Retains its colour, and becomes more shining in the streak. Malleable. Flexible, but not elastic.

Chemical Characters.—Fusible in the flame of a candle.

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* *Kerate*, from the Greek word κερας, *horn*, given it on account of the species resembling horn in general aspect and tenacity.

Constituent Parts.—

Silver,	67.75	
Muriatic Acid,	14.75	
Oxygen,	6.75	
Oxide of Iron,	6.00	
Alumina,	1.75	
Sulphuric Acid,	0.25	
	97.25	*Klaproth.*

Geognostic Situation.—Occurs in silver veins, and generally in their upper part. These veins traverse gneiss, mica-slate, clay-slate, grey-wacke, porphyry, and limestone, and contain, besides the corneous silver, various ores.

Geographic Situation.—At Huel-Mexico in Cornwall, and in different mines in Siberia and America.

Genus II. Corneous Mercury.

Pyramidal. Hardness = 1.0, 2.0. Sp. gr. unknown.

1. Pyramidal Corneous Mercury.

Pyramidales Perl Kerate, *Mohs.*—Quecksilber Hornerz, *Werner.*—Murcure Muriaté, *Haüy.*

Specific Character.—Pyramidal. Pyramid unknown. Cleavage, $P + \infty$, imperfect. Sectile.

External Characters.—Colour grey. Occurs very rarely massive, almost always in small vesicles crystallized in the interior. The crystals are the following:

1. Rectangular four-sided prism, acuminated on the extremities with four planes, which are set on the lateral planes. 2. Rectangular four-sided prism, acuminated with four planes, which are set on the lateral edges. 3. Double four-sided pyramid.

Crystals always so minute, that it is with difficulty their forms can be determined. External surface sometimes smooth, sometimes drusy, and in general shining and adamantine. Internally shining, and adamantine. Faintly translucent, or only translucent on the edges. Sectile, and easily frangible.

Chemical Characters.—Is totally volatilized before the blowpipe, and emits a garlic smell. Soluble in water, and the solution mixed with lime-water gives an orange-coloured precipitate.

Constituent Parts.—

Oxide of Mercury,	-	76.00
Muriatic Acid,	-	16.40
Sulphuric Acid,	-	7.60
		100.00 *Klaproth.*

Geognostic and Geographic Situations.—In the quicksilver mines of the Palatinate, and Duchy of Deux Ponts.

Order IV. *MALACHITE.*

No metallic lustre. Colour blue, green, brown. If brown, in colour or in streak, the hardness = 3.0 and less; and the specific gravity above 2.5. If white in the streak, the specific gravity = 2.2 and less; and the hardness under 3.0.

No single distinct faces of cleavage.

Hardness = 2.0,—5.0.

Sp. gr. = 2.0,—4.6.

Genus I. Copper Green.

Staphylin Malachit, *Mohs.*

Uncleavable. Hardness = 2.0,—3.0. Sp. gr. = 2.0,—2.2.

1. Uncleavable Copper Green.

Untheilbarer Staphylin-Malachit, *Mohs.*—Kupfergrün, *Werner.*—Cuivre Carbonaté, *Haüy.*

Specific Character.—Uncleavable. Reniform botryoidal, and massive. Streak white.

This species is divided into three subspecies, viz. 1. Conchoidal, 2. Earthy Iron-shot, 3. Slaggy Iron-shot.

FIRST SUBSPECIES.

Conchoidal Copper-Green.

Kupfergrün, *Werner.*

External Characters.—Principal colour verdigris-green. Occurs massive, disseminated, and coating or incrusting green malachite, sometimes small reniform, and small botryoidal. Internally shining, passing into glistening, and lustre resinous.

Fracture small conchoidal. Fragments determinate angular, and more or less sharp-edged. Alternates from translucent to translucent on the edges. Colour not changed in the streak. Easily frangible, and rather brittle.

Chemical Characters.—Before the blowpipe, it become first black, then brown, but is infusible.

Constituent Parts.—Copper,	40.00	
Oxygen,	10.00	
Carbonic Acid,	7.00	
Water,	17.00	
Silica,	26.00	
	100.00	*Klaproth.*

Geognostic Situation.—Is met with in the same geognostic situations as green malachite.

Geographic Situation.—Occurs in Cornwall, along with olivinite, and also in the vale of Newlands, near Keswick.

SECOND SUBSPECIES.

Earthy Ironshot Copper-Green.

Erdiches Eisenschüssiges Kupfergrün, *Werner.*

External Characters.—Colour olive-green, which sometimes passes into pistachio-green, and inclines to leek-green. Occurs massive, and in crusts. Generally of friable consistence, and composed of dull, dusty particles, which are more or less cohering, and that do not soil. Compact varieties have an earthy fracture. Opaque. Very soft, passing into friable. Sectile, and easily frangible.

THIRD SUBSPECIES.

Slaggy Ironshot Copper-Green.

Schlakiges-eisenschüssiges Kupfergrün, *Werner.*

External Characters.—Colours blackish-green, and dark pistachio-green. Occurs massive and disseminated. Internally shining or glistening, lustre resinous. Fracture small conchoidal. Fragments indeterminate angular, and more or less sharp-edged. Opaque. Colour becomes paler in the streak. Very soft. Easily frangible.

Constituent Parts.—Is probably a compound of Conchoidal Copper-Green and Oxide of Iron.

Geognostic Situation.—Both subspecies usually occur together, and they frequently pass into each other.

Geographic Situation.—Occurs in Cornwall, along with olivinite.

Genus II. Liriconite *.

Lirikon-Malachit, *Mohs.*

Tessular, prismatic. Hardness = 2.5. Sp. gr. = 2.8,—3.0.

1. Prismatic Liriconite.

Prismatischer Lirikon-Malachit, *Mohs.*—Linsenerz, *Werner.*—Cuivre arseniaté, *Haüy.*—Diprismatic Olivenite, or Lenticular Copper, *Jameson,* 3d edit.

Specific Character.—Prismatic. Pyramid unknown. Cleavage, $P\bar{r}$. $P + \infty$. Streak pale verdigris-green,…sky-blue. Hardness = 2.5. Sp. gr. = 2.8,—3.0.

External Characters.—Colour sky-blue, which sometimes passes into verdigris-green. Scarcely occurs massive, generally crystallized: 1. Very oblique four-sided prism, acutely bevelled on the extremities, and the bevelling planes set on the obtuse lateral edges. 2. Very flat, longish, double four-sided pyramid, in which the lateral planes of the one are set on the lateral planes of the other †.

Externally smooth and shining; internally glistening and shining, and pearly, inclining to vitreous. Fracture small-grained uneven, which sometimes passes into imperfect conchoidal. Translucent. Brittle, and uncommonly easily frangible.

Chemical Characters.—Before the blowpipe is converted into a black friable scoria.

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* From λειρὸς, *pale*, and κονια, *the dust*, (the streak).

† The double four-sided pyramid is so flat that it has a lenticular aspect; hence the name *Lenticular Copper* sometimes given to this species.

Constituent Parts.—

Oxide of Copper,	49	
Arsenic Acid,	14	
Water,	35	
	98	*Chenevix.*

Geognostic and Geographic Situations.—It has been hitherto found only in Cornwall, where it is associated with copper-mica, and other cupreous minerals.

2. Hexahedral Liriconite.

Hexaedrischer Lirikon-Malachit, *Mohs.*—Wurfelerz, *Werner.*—Fer arseniaté, *Haüy*—Hexahedral Olivenite, or Cube-ore, *Jameson,* 3d edit.

Specific Character.—Tessular. Cleavage, hexahedral. Streak pale olive-green,...brown. Hardness = 2.5. Sp. gr. = 2.9,—3.0.

External Characters.—Colour pistachio-green, which passes into olive and blackish green. Occurs massive; and crystallized in the following figures: 1. Perfect cube. 2. Cube, in which four diagonally opposite angles are truncated. 3. Cube truncated on all the edges. 4. Cube truncated on all the edges and angles.

Faces of the crystals smooth and splendent. Internally glistening, and lustre intermediate between vitreous and resinous. Translucent, or translucent on the edges. Rather brittle, and easily frangible.

Chemical Characters.—Before the blowpipe, it melts, and gives out arsenical vapours.

Constituent Parts.—

Arsenic Acid,	31.0	
Oxide of Iron,	45.5	
Oxide of Copper,	9.0	
Silica,	4.0	
Water,	10.5	
	100.0	*Chenevix.*

Geognostic and Geographic Situations.—Occurs in veins, accompanied with ironshot quartz, copper-glance or vitreous copper, copper-pyrites, and brown iron-ore, in Cornwall.

Genus III. Olivinite.

Oliven-Malachit, *Mohs.*

Prismatic. Colour or streak neither blue nor bright green. Hardness = 3.0, 4.0. Sp. gr. = 3.6,—4.6.

1. Prismatic Olivenite.

Prismatischer Oliven-Malachit, *Mohs.*—Olivenerz, *Werner.*—Cuivre arseniaté, *Haüy.*—Acicular Olivenite, *Jameson,* 3d edit.

Specific Character.—Prismatic. Pyramid unknown. Cleavage, P + ∞. Streak olive-green,...brown. Hardness = 3.0. Sp. gr. = 4.2,—4.6.

This species is subdivided into three subspecies, viz. Foliated, Fibrous, and Earthy.

FIRST SUBSPECIES.

Foliated Acicular Olivenite.

Blättriches Olivenerz, *Werner.*

External Characters.—Colour olive-green, and sometimes pistachio and blackish green. Seldom occurs massive, and in angulo-granular concretions, generally in drusy crusts, and in small crystals, which present the following varieties of form: 1. Oblique four-sided prism, acutely bevelled on the extremities, the bevelling planes set on the acute lateral edges. 2. Preceding figure, in which the obtuse lateral edges are more or less deeply truncated. 3. Acute double four-sided pyramid; sometimes the angles on the common base flatly bevelled; and the bevelling planes set on the lateral edges.

Faces of the crystals smooth, shining, and splendent. Internally glistening, and lustre resinous, inclining to pearly. Fracture small and imperfect conchoidal, which passes into uneven. Ranges from translucent to translucent on the edges. Rather brittle, and easily frangible. Streak olive-green.

Chemical Characters.—Before the blowpipe, it first boils, and then gives a hard reddish-brown scoria.

Constituent Parts.—

Oxide of Copper,	- -	60.0
Arsenic Acid,	- -	39.7
		99.7 *Chenevix.*

Geognostic and Geographic Situations.—Has been hitherto found only in the copper-mines of Cornwall.

SECOND SUBSPECIES.

Fibrous Acicular Olivenite.

Fasriges Olivenerz, *Werner*.

External Characters.—Colours green, yellow, brown, and white. Colours sometimes arranged in curved and striped delineations. Occurs massive, and reniform; also in fibrous concretions, which are delicate, straight, and scopiform, and these are collected into coarse or small granular concretions, and are sometimes traversed by others, which are curved lamellar; also crystallized in capillary and acicular oblique four-sided prisms, in which the obtuse lateral edges are truncated, and bevelled on the extremities, the bevelling planes being set on the acute edges. Crystals sometimes scopiformly aggregated. Internally the massive varieties are glistening or glimmering, with a pearly or silky lustre. Fragments indeterminate angular, and wedge-shaped. Opaque, seldom translucent on the edges, and only translucent in the crystals. Rather brittle. Fibres sometimes flexible *. Streak brown.

Constituent Parts.—	Oxide of Copper,	50
	Arsenic Acid,	29
	Water,	21
		100 *Chenevix*.

Geognostic and Geographic Situations.—Occurs in primitive rocks with various ores of copper; and principally in Cornwall.

* The fibres are sometimes so delicate, so short, and so confusedly grouped together, that the whole appears like a dusty cottony mass, the true nature of which is discoverable only by the lens. At other times, this variety appears in thin laminæ, rather flexible, sometimes scarcely perceptible to the naked eye, sometimes tolerably large, and perfectly like Amianthus papyraceus.—*Bournon*, Phil. Trans. for 1801, part i. p. 180.

THIRD SUBSPECIES.

Earthy Acicular Olivenite.

External Characters.—Colour olive-green. Occurs massive, disseminated, in crusts, and in concentric lamellar concretions. Dull. Fracture fine earthy. Opaque.

Geognostic and Geographic Situations.—Occurs along with the other subspecies of olivenite in the copper-mines of Cornwall.

2. Diprismatic Olivenite.

Diprismatischer Oliven-Malachit, *Mohs.*

Specific Character.—Prismatic. Pyramid unknown. Cleavage, unknown. Streak olive-green. Hardness = 4.0. Sp. gr. = 3.6,—3.8.

Constituent Parts.—Said to be Phosphate of Copper.

Geognostic and Geographic Situations.—Occurs at Libethen, near Newsohl in Hungary, in a bed of copper-ore, along with quartz, and in mica-slate.

GENUS IV. BLUE MALACHITE, OR BLUE COPPER.

Lazur Malachit, *Mohs.*

Prismatic. Blue. Hardness = 3.5,—4. Specific gr. = 3.5,—3.7.

1. Prismatic Blue Malachite.

Prismatischer Lazur Malachit, *Mohs.*—Kupferlazur, *Werner.*—Cuivre carbonaté bleu, *Haüy.*—Blue Copper, or Prismatic Malachite, *Jameson,* 3d edit.

Specific Character.—Hemiprismatic. Pyramid unknown. Cleavage prismatic. Streak blue.

This species is divided into two subspecies, viz. Radiated and Earthy.

FIRST SUBSPECIES.

Radiated Prismatic Blue Malachite, or Blue Copper.

Feste Kupferlazur, *Werner.*

External Characters.—Principal colour azure-blue, which often passes into blackish-blue, seldomer into Berlin-blue and smalt-blue. Occurs massive, disseminated, in plates, in crusts; also globular, botryoidal, reniform, stalactitic, and cellular: in radiated distinct concretions which are straight, narrow, scopiform, and stellular; and these are again traversed by others which are curved lamellar. Sometimes there is a tendency to granular concretions. Very frequently crystallized. Generally occurs in oblique four-sided prisms, rather acutely bevelled on the terminal planes, and the bevelling planes set on the acute lateral edges. The crystals sometimes occur aggregated in globular and botryoidal forms; other crystals occur in druses, or singly superimposed. External surface of the particular external shapes drusy and glimmering; that of the crystals sometimes smooth and splendent. Externally the crystallized varieties are shining, but the massive and particular external shapes dull. Internally shining and glistening, and lustre intermediate between vitreous and resinous. Fracture small and imperfect conchoidal. Fragments of the prismatic or radiated varieties wedge-shaped; those of the foliated and conchoidal, splintery. Crystals translucent, passing into semitransparent, sometimes only translucent on the edges. Colour becomes lighter in the streak. Brittle, and rather easily frangible.

Chemical Characters.—Is soluble with effervescence in nitric acid.

		Chessy.	
Constituent Parts.—	Copper, - -	56.00	
	Carbonic Acid, -	25.00	
	Oxygen, - -	12.50	
	Water, - -	6.50	
		100.00	*Vauquelin.*

Geognostic Situation.—This mineral occurs in veins that traverse primitive, transition, and secondary or flœtz rocks: in smaller quantity and less frequently in beds.

Geographic Situation.—Occurs at Lead-hills in Lanarkshire, and Wanlockhead in Dumfriesshire. Huel-Virgin and Carharrack in Cornwall; Buckingham mine, near Bridgewater, Somersetshire; Alderley Edge, Cheshire, and Wassinghope lead-mine, near Stanhope in Durham.

SECOND SUBSPECIES.

Earthy Prismatic Blue Malachite, or Earthy Blue Copper.

Erdiger Kupferlazur, *Werner.*

External Characters.—Colour smalt-blue, which sometimes inclines slightly to sky-blue. Massive, often disseminated, thinly coating, and rarely small botryoidal. Of friable consistence, and composed of dull and fine dusty particles that soil very faintly, and which are more or less cohering.

Geognostic and Geographic Situations.—Occurs in small quantity, and usually accompanied with common malachite and copper-green. In Silesia, found incrusting bituminous marl-slate; in Thuringia, coating varieties of the old red sandstone; and in Siberia, disseminated in sandstone.

GENUS V. EMERALD MALACHITE.

Smaragd-Malachite, *Mohs.*

Rhomboidal. Hardness = 5.0. Sp. gr. = 3.3,—3.4.

1. Rhomboidal Emerald Malachite.

Rhomboedrischer Smaragd-Malachit, *Mohs.* — Kuferschmaragd, *Werner.* —Cuivre Dioptase, *Haüy.* — Rhomboidal Emerald Copper, *Jameson,* 3d edit.

Specific Character.—Rhomboidal. Rhomboid = 123° 58′. Cleavage, rhomboidal. Streak green.

External Characters.—Colour emerald green, which sometimes inclines to pistachio and blackish green. Occurs only crystallized. The only secondary form at present known, is the equi-angular six-sided prism, rather acutely acuminated on both extremities by three planes set on the alternate lateral edges. Lateral planes smooth. Internally shining, and lustre pearly. Fracture small conchoidal. Translucent, passing to semi-transparent. Brittle, and easily frangible.

Chemical Characters.—It becomes of a chesnut-brown colour before the blowpipe, and tinges the flame green, but is infusible; with borax it gives a bead or globule of copper.

Constituent Parts.—

Oxide of Copper,	28.57	
Carbonate of Lime,	42.85	
Silica,	28.57	
	99.99	*Vauquelin.*

Geognostic and Geographic Situations.—Found, according to Herman, in the land of the Kirguise, 125 leagues from the Russian frontier, where it is associated with fibrous and compact malachite, calcareous-spar, and limestone.

Genus VI. Green Malachite.

Habronem-Malachit, *Mohs*.

Prismatic. Colour or streak, bright green. Hardness = 3.5,—5. Sp. gr. = 3.5,—4.3.

1. Prismatic Green Malachite.

Prismaticher Habronem Malachit, *Mohs.*—Phospher Kupfererz, *Werner.* Cuivre phosphaté, *Haüy.*—Prismatic Olivenite or Phosphat of Copper, *Jameson,* 3d edit.

Specific Character.—Prismatic. Pyramid unknown. Cleavage, $P + \infty = 110°$ (nearly). Streak emerald-green. Hardness = 5.0. Sp. gr. = 4.0,—4.3.

External Characters.—Principal colour emerald-green, which passes into blackish-green; externally, sometimes greenish-black. Occurs massive, in imperfect reniform masses, with a very drusy surface, and in coarse fibrous distinct concretions, which are straight and scopiform. Crystals small and very small, superimposed and in druses. Externally shining; internally passes from shining, through glistening, to glimmering, and lustre resinous, inclining to pearly. Fracture splintery. Fragments wedge-shaped splintery, or indeterminate angular, and rather blunt-edged. Opaque. Brittle and easily frangible.

Chemical Characters.—On the first impression of the heat it fuses into a brownish globule, which, by the further action of the blowpipe, extends on the surface of the charcoal, and acquires a reddish-grey metallic colour.

Constituent Parts.—Oxide of Copper, - - 68.13
Phosphoric Acid, - 30.95

99.08. *Klaproth.*

Geognostic and Geographic Situations.—The principal locality of this rare mineral is Virneberg, near Rheinbreitenbach, on the Rhine, where it occurs along with quartz, calcedony, red copper-ore, and common malachite, in greywacke. Also occurs in Cornwall in Gunnis Lake mine on the banks of the Tamar.

2. Diprismatic Green Malachite, or Common Malachite.

Diprismatischer Habronem-Malachit, *Mohs.*—Malachit, *Werner.*—Cuivre carbonaté vert, *Haüy.*—Common or Acicular Malachite, *Jameson,* 3d Edit.

Specific Character. — Prismatic. Pyramid unknown. Cleavage $P\bar{r}.P+\infty=103°$ (nearly). Streak grass or apple-green. Hardness = 3.5,...4.0. Sp. gr. = 3.5,...3.7.

This species is divided into two subspecies, viz. Fibrous and Compact.

FIRST SUBSPECIES.

Fibrous Common Malachite.

Fasricher Malachit, *Werner.*

External Characters.—Most common colour perfect emerald-green, sometimes inclining to grass-green, and sometimes to dark leek-green. Seldom massive, sometimes disseminated, tuberose, stalactitic, reniform, botryoidal, fruticose, most frequently as a coating, also in fibrous distinct concretions, which are delicate and scopiform or stellular, and collected into others which are large, coarse, and sometimes longish granular, or wedge-shaped. Frequently crystallized; and the following are the figures which have been observed: 1. Rather oblique four-sided prism, bevelled on the extremities, the bevelling planes set on the obtuse lateral edges. 2. The preceding figure truncated on the obtuse lateral edges, which thus forms a six-sided prism, in which the bevelling planes are set on two opposite lateral planes.

Crystals generally short, capillary, and acicular. When very short, they form velvety drusy pellicles; and when longer, they are scopiformly aggregated. Internally intermediate between glistening and glimmering, and the lustre pearly or silky. Fragments wedge-shaped and splintery. Crystals translucent, but the massive varieties only translucent on the edges, or opaque. Brittle, inclining to sectile, and easily frangible.

Chemical Characters.—Before the blowpipe it decrepitates and becomes black, and is partly infusible, partly reduced to a black slag.

		Chessy.
Constituent Parts.—	Copper, - -	56.10
	Carbonic Acid, - - - -	21.25
	Oxygen, - - -	14.00
	Water, - - - -	8.75
		100.00 *An. Mus.*

Geognostic Situation.—Occurs principally in veins that traverse primitive, transition, and secondary rocks.

Geographic Situation.—Occurs at Sandlodge in Mainland, one of the Shetland Islands, in veins that traverse red sandstone, in which it is associated with grey copper, copper-pyrites, and brown iron-ore; at Landidno in Caernarvonshire; and in various mines in other parts of the world.

SECOND SUBSPECIES.

Compact Common Malachite.

Dichter Malachit, *Werner.*

External Characters.—Colour intermediate between emerald-green and verdigris-green; but in general inclining more to the first. Colours often disposed in concentric delineations, and varied with dark-coloured dendritic markings. Occurs massive, disseminated, and in membranes; most frequently reniform and botryoidal; frequently tuberose, stalactitic, fruticose, cellular, and amorphous; also in distinct concretions, which are sometimes extremely delicate and scopiform fibrous; more frequently thin lamellar, or large, coarse, and small angulo-granular; and sometimes crystallized in oblique four-sided prisms. External surface of the particular shapes generally rough and drusy, seldomer smooth, and then it is shining and glistening. Surface of the distinct concretions apparently covered with a greenish-white film. Internally it passes from glistening through glimmering to dull, but most commonly glimmering, and the lustre silky. Fracture small and fine grained uneven, which sometimes passes into small and flat conchoidal, and even. Fragments indeterminate angular, and rather sharp-edged. Opaque. Rather brittle, and easily frangible.

Chemical Characters and Constituent Parts nearly the same as in the preceding subspecies.

Geognostic Situation.—Occurs in veins, which traverse primitive, transition, and secondary rocks.

Geographic Situation.—Europe.—In the copper-mines of Huel-Carpenter and Huel-Husband, in Cornwall; in the copper-mines of Aardal in Norway; and in many other mines on the Continent of Europe.

Asia.—In the mines of Kolwyan, Gamasherk, Turja, &c. in Siberia, where the most beautiful and largest specimens of this mineral are met with, along with tile-ore, red copper-ore, brown iron-ore, copper-glance or vitreous copper, blue copper, copper-green, white lead-spar, brown-spar, ironshot quartz, hornstone, &c. It is also met with in different parts of China.

Uses.—It was formerly esteemed as a precious stone, and was cut into ornamental forms of various descriptions. Even at present it is highly prized, and is cut into consoles, candlesticks, snuff-boxes, and other similar articles. Where it occurs in quantity, it is smelted as an ore of copper, and is sometimes used as a green pigment.

* ATACAMITE

Streak leek....grass green. Soft. Sp. gr. = 4.4.

1. Prismatic Atacamite.

Salz Kupfererz, *Hoffman.*—Cuivre Muriaté, *Haüy*

Specific Character.—Prismatic. Cleavage, very perfectly prismatoidal.

This species is divided into two subspecies, viz. Compact and Arenaceous.

FIRST SUBSPECIES.

Compact Atacamite.

Festes Salzkupfererz, *Werner*.

External Characters.—Colour leek-green, inclining to blackish pistachio-green. Occurs massive, disseminated, imperfect reniform, in prismatic or radiated distinct concretions, which are short, small, and scopiform, also in granular concretions; in crusts or investing; and in short needle-shaped crystals, of the following forms: 1. Oblique four-sided prism, bevelled on the extremities; the bevelling planes set on the acute lateral edges. 2. The preceding figure, in which the acuter lateral edges are deeply truncated, thus forming a six-sided prism. Internally shining and glistening, and pearly. Translucent on the edges. Brittle, and easily frangible.

Chemical Characters.—Tinges the flame of the blowpipe of a bright green and blue, muriatic acid rises in vapours, and a bead of copper remains on the charcoal. Soluble in nitric acid without effervescence.

Constituent Parts.—		
Oxide of Copper,	73.0	
Water,	16.9	
Muriatic Acid	10.1	
	100.0	*Klaproth.*

Geognostic and Geographic Situation.—Occurs in veins in Chili; also at Virneberg near Rheinbreitenbach on the Rhine, and at Schwartzenberg in Saxony. In the fissures of the lavas of Vesuvius, particularly those of the years 1804 and 1805.

SECOND SUBSPECIES.

Arenaceous Atacamite, or Copper-Sand.

Kupfersand, *Werner*.

External Characters.—Colour grass-green, inclining to emerald green. Occurs in scaly particles, which are shining, glistening and pearly. Does not soil. Translucent.

Constituent Parts.—		
Oxide of Copper,	70.5	
Water,	18.1	
Muriatic Acid,	11.4	
	100.0	*Proust.*

Geognostic and Geographic Situations.—It is found in the sand of the river Lipes, 200 leagues beyond Copiapu, in the desert of Atacama, which separates Chili from Peru.

ORDER V. *MICA.*

If metallic lustre, the specific gravity is under 2.2. If no metallic lustre, the specific gravity is above 2.2. If the streak is yellow, it is pyramidal.

Single, perfect cleavage.

Hardness = 1.0,—4.5. If above 2.5, it is rhomboidal.

Sp. gr. = 1.8,—5.6. If under 2.5, it is metallic. If above 4.4, the streak is white or grey.

GENUS I. COPPER-MICA.

Streak green. Hardness = 2.0. Sp. gr. = 2.5,—2.6.

1. Hemiprismatic Copper-Mica.

Hemiprismatischer Euchlor-glimmer, *Mohs.*—Kupferglimmer, *Werner.*—Cuivre Arseniaté, *Haüy.*—Prismatic Copper-Mica,—*Jameson,* 3d Edit.

Specific Character.—Hemiprismatic. Pyramid unknown $\frac{\bar{P}}{2}$. Cleavage, $\bar{Pr} + \infty$. Streak emerald,...apple-green.

External Characters.—Colour emerald-green, sometimes inclining into verdigris-green. Occurs massive, disseminated, and in granular distinct concretions; seldom crystallized in very thin six-sided tables, in which the terminal planes incline alternately in contrary directions. Externally smooth and splendent; internally splendent, and lustre pearly. Fracture small-grained, uneven, inclining to conchoidal. Fragments indeterminate angular and tabular. Massive varieties translucent; crystallized transparent. Sectile. Rather brittle.

Chemical Characters.—Decrepitates before the blowpipe; and passes, first, to the state of a black spongy scoria, after which it melts into a black globule, of a slightly vitreous appearance.

Constituent Parts.—Oxide of Copper,	58	
Arsenic Acid,	21	
Water,	21	
	100	*Chenevix.*

Geognostic and Geographic Situations.—Has been hitherto found only in veins in the copper-mines of Cornwall.

GENUS II. URAN-MICA, OR URANITE.

Streak green,...yellow. Hardness = 2.0,—2.5. Sp. gr. = 3.0,—3.2.

1. Pyramidal Uran-Mica.

Pyramidaler Euchlor-glimmer, *Mohs.*—Uranglimmer, *Werner.*—Uran Oxydé, *Haüy.*

Specific Character.—Pyramidal. Pyramid = 95° 13′; 144° 56′. Cleavage, P — ∞.

External Characters.—Chief colours green and yellow. Seldom massive, sometimes in flakes; the massive varieties are disposed in angulo-granular concretions. Frequently crystallized. The secondary forms are the following:

1. Rectangular four-sided table, or short prism. Sometimes elongated. 2. The four-sided table bevelled on the terminal planes, and the bevelling planes set on the lateral planes. 3. The terminal edges of the table truncated, thus forming an eight-sided table. 4. The terminal planes of the four-sided table bevelled; and sometimes the edges of the bevelment truncated. 5. When the bevelling planes of N° 4. increase very much in size, there is formed a very acute double four-sided pyramid, in which the apices are more or less deeply truncated. 6. Sometimes the figure N° 4. is acuminated on both extremities with four planes, which are set on the lateral planes, and the apices of the acuminations deeply truncated.

Terminal planes of the table streaked, but the lateral planes smooth. Externally usually shining, and sometimes splendent. Internally shining, approaching to glistening; lustre pearly. Transparent and translucent. Sectile. Not flexible. Easily frangible.

Chemical Characters.—Decrepitates violently before the blowpipe on charcoal; loses about 33 *per cent.* by ignition, and acquires a brass-yellow colour.

Constituent Parts.

	Cornwall.
Oxide of Uranium, with a trace of Oxide of Lead,	74.4
Oxide of Copper,	8.2
Water,	15.4
Loss,	2.0
	100 *Gregor.*

Geognostic and Geographic Situations.—Occurs in veins, in primitive rocks. In Cornwall in tinstone and copper veins that traverse granite and clay-slate.

Werner describes a soft mineral, found along with Uranite, under the name Uran-Ochre. It does not appear to form a distinct species, nor can it be considered as a subspecies of Uranite. It is here placed immediately after Uranite.

* Uran-Ochre.

Uran-Ocker, *Werner.*

There are two kinds of this mineral, viz. Friable and Indurated.

a. Friable Uran-Ochre.

Zerreibliche Uranocker, *Werner.*

External Characters.—Colour lemon-yellow, which passes into straw-yellow and sulphur-yellow, and also into orange-yellow. Occurs usually as a coating or efflorescence on pitch-ore, and sometimes small reniform. Is friable, and composed of dull, dusty, and weakly cohering particles. Feels meagre.

Geognostic Situation.—Occurs always on pitch-ore.

b. Indurated Uran-Ochre.

Feste Uranocker, *Werner.*

External Characters.—Colours straw-yellow, lemon-yellow, and orange-yellow; and this latter passes into aurora red and hyacinth-red, and reddish and yellowish brown. Occurs massive, disseminated, and superimposed; and sometimes there is a tendency to fibrous concretions. Internally glimmering, glistening, and resinous. Fracture imperfect conchoidal. Opaque. Soft and very soft. Rather sectile. Specific gravity, 3.1500, *La Metherie*,—3.2438, *Haüy*.

Chemical Characters.—According to Klaproth, the yellow varieties are pure oxide of Uranium, but the brownish and reddish contain also a little iron.

Geognostic and Geographic Situations.—Is found at Joachimsthal, and Gottesgab in Bohemia, and at Johanngeorgenstadt in Saxony.

GENUS III. COBALT-MICA, OR RED COBALT.

Kobalt Glimmer, *Mohs*.

Prismatic. Hardness = 2.5. Sp. gr. = 4.0,...4.3.

1. Prismatic Red Cobalt.

Prismatischer Kobalt Glimmer, *Mohs*.—Rother Erd Kobalt, *Werner*.—Cobalt Arseniaté, *Haüy*.

Hemiprismatic. Pyramid unknown. $\frac{\bar{P}}{2}$. Cleavage, $\breve{P}r + \infty$. Streak red,...green.

This species is divided into three subspecies, viz. Radiated, Earthy and Slaggy.

FIRST SUBSPECIES.

Radiated Cobalt-Mica, or Cobalt-Bloom.

Kobold-bluthe, *Werner*.

External Characters.—Principal colour red; rarely greenish-grey, and olive-green. Occurs massive, disseminated, often in membranes, small reniform, small botryoidal; also in stellular and scopiform radiated or fibrous concretions, which are sometimes collected into granular concretions; also crystallised in rectangular four-sided prisms. Crystals generally acicular or capillary, and scopiformly or stellularly aggregated. Externally shining, passing into splendent. Internally shining and glistening, and lustre pearly. Fragments splintery and wedge-shaped. More or less translucent; sometimes translucent on the edges. Rather sectile. Easily frangible.

Chemical Characters.—Before the blowpipe it becomes grey, emits an arsenical odour, and tinges borax-glass-blue.

Constituent Parts.—

Cobalt,	39	
Arsenic Acid,	38	
Water,	23	
	100	*Bucholz.*

Geognostic Situation.—Occurs in veins in primitive, transition, and secondary rocks, along with various metalliferous compounds.

Geographic Situation.—Occurs in veins in secondary rocks at Alva, in Stirlingshire; in limestone of the coal formation in Linlithgowshire; formerly in small veins in sandstone of the coal formation, along with galena and blende, at Broughton, in Edinburgh; in the Clifton lead-mines near Tyndrum; and at Dolcoath in Cornwall.

SECOND SUBSPECIES.

Earthy Cobalt Mica, or Cobalt-Crust.

Kobold-beschlag, *Werner.*

External Characters.—Colour red. Seldom occurs massive, or disseminated, generally in velvety crusts, and also small reniform and botryoidal. Generally friable, and composed of scaly and dusty particles, which are feebly glimmering or dull. The massive varieties have a fine earthy fracture. Fragments indeterminate angular, and blunt-edged. Very easily frangible. Very soft or friable. Sectile. Streak shining. Does not soil.

THIRD SUBSPECIES.

Slaggy Cobalt Mica.

Schlackige Kobalt-bluthe, *Hausmann.*

External Characters.—Colours muddy crimson-red, and dark hyacinth-red, which passes into chesnut-brown. Occurs in thin crusts, and sometimes reniform. Externally smooth. Lustre shining and resinous. Fracture conchoidal. Translucent. Soft and brittle.

Geognostic and Geographic Situations.—Occurs in veins along with other cobaltic minerals, in the mine of Sophia, at Wittichen in Furstemberg.

Cobalt-Ochre.

The Black, Brown, and Yellow Cobalt-Ochres, and other similar minerals, ought to be arranged together, and form a particular order by themselves. In the mean time, we place them beside the Cobalt-Mica, on account of their being often associated in nature with that mineral.

1. Black Cobalt-Ochre.

Schwarz Erdkobold, *Werner.*

It is distinguished into Earthy and Indurated.

a. Earthy Black Cobalt-Ochre.

Schwarzer Kobold Mulm, *Werner.*—Cobalt Oxide Noire Terreux, *Haüy.*

External Characters.—Colour intermediate between brownish-red and blackish-brown. Friable, and composed of dull coarse particles, which soil very little. Streak shining. Meagre to the feel. Light.

Chemical Characters.—Before the blowpipe it yields a white arsenical vapour; and colours borax blue.

b. Indurated Black Cobalt-Ochre.

Fester Schwarz Erdkobold, *Werner.*

External Characters.—Colour distinct bluish-black. Occurs massive, disseminated, in crusts, small botryoidal, small reniform, fruticose, moss-like, stalactitic, corroded, specular, and with pyramidal impressions; and sometimes in thin and curved lamellar concretions. Surface feebly glimmering. Fracture fine earthy, sometimes passing into conchoidal. Fragments indeterminate angular, and blunt-edged. Opaque. Streak shining and resinous. Very soft, approaching to soft. Soils feebly. Sectile. Very easily frangible. Specific gravity, 2.019 to 2.425. *Gellert.*—2.200, *Breithaupt.*

Chemical Characters.—Before the blowpipe it yields an arsenical odour, and colours glass of borax smalt-blue.

Constituent Parts.—Is considered as Black Oxide of Cobalt, with Arsenic and Oxide of Iron.

Geognostic Situation.—Both sorts usually occur together, and in the same kind of repository; but the first is the rarest. They are found sometimes in primitive mountains, but most frequently in secondary mountains.

Geographic Situation.—Is found at Alderly Edge, Cheshire, in red-sandstone; in slate-clay in the peninsula of Howth near Dublin; at Riegelsdorf in Hessia, and in many other countries on the Continent.

Uses.—Is fused in the making of smalt, and affords a good blue colour, but not so fine as that obtained from grey cobalt. Of the two kinds of black cobalt-ochre, the compact is that which affords the most esteemed blue colour.

2. Brown Cobalt-Ochre.

Brauner Erdkobold, *Werner.*

External Characters.—Principal colours brown, grey, and brownish-black. Occurs massive, disseminated, and sometimes very much cracked. Internally dull. Fracture fine earthy, approaching to conchoidal in the large. Fragments indeterminate angular, and blunt-edged. Opaque. Streak shining and resinous. Very soft. Sectile. Very easily frangible. Light.

Chemical Character.—Before the blowpipe it emits an arsenical odour, and communicates a blue colour to borax.

Constituent Parts.—Is considered to be a compound of Brown Ochre of Cobalt, Arsenic, and Oxide of Iron.

Geognostic Situation.—Appears to occur principally in secondary mountains, and is generally accompanied with the other ochres of cobalt, ochry-brown ironstone, and lamellar heavy-spar.

Geographic Situation.—Is found at Kamsdorf and Saalfield in Saxony; Alpirsbach in Wurtemberg; and in the valley of Gistain in Spain.

Use.—Is used for making smalt, but is not so valuable as the black cobalt.

Observations.—It is distinguished from *Umber*, *Bole*, and other minerals of the same description, by its streak and softness.

3. Yellow Cobalt-Ochre.

Gelber Erdkobold, *Werner*.—Cobald Arseniaté Terreux Argentifère, *Haüy*.

External Characters.—Colour yellow, which in some varieties is grey and white. Occurs massive, disseminated, corroded, and incrusting. Frequently appears rent in different directions. Internally dull. Fracture fine earthy in the small, conchoidal in the large. Fragments indeterminate angular, and blunt-edged. Streak shining. Is soft, passing into friable. Sectile. Very easily frangible.

Specific gravity 2.677, *Kirwan*, after having absorbed water.

Chemical Characters.—Emits an arsenical odour before the blowpipe, and colours borax blue. Appears to be the purest of the cobalt ochres. Generally contains a portion of silver.

Geognostic Situation.—Occurs in the same geognostic situation as the preceding, and is almost always associated with earthy red cobalt, and sometimes with radiated red cobalt, nickel-ochre, iron-shot copper-green, and azure copper.

Geographic Situation.—Occurs at Saalfeld in Thuringia; Kupferberg in Silesia; Wittichen in Furstenberg; and Alpirsbach in Wurtemberg, in Swabia: and Allemont in France.

Use.—Affords a better smalt than the preceding, and, owing to the silver it contains, in the countries where it occurs is also valued as an ore of silver.

Genus IV. Antimony-Mica, or White Antimony.

Spiessglass-glimmer, *Mohs*.

Prismatic. Hardness = 1.5,—2.0. Sp. gr. = 5.0,—5.6.

1. Prismatic White Antimony.

Prismatischer Spiessglass-glimmer, *Mohs*.—Weiss-spiessglaserz, *Werner*.—Antimoine Oxidé, *Haüy*.

Specific Character.—Prismatic. Cleavage prismatoidal. Streak white or grey.

External Characters.—Colours white and grey. Seldom massive, more frequently disseminated, and in membranes; also in distinct concretions, which are coarse and small granular, and scopiform and stellular radiated. Often crystallized. The following figures have been observed: 1. Rectangular four-sided prism, bevelled on the extremities; 2. Oblique four-sided prism; 3. Rectangular four-sided table; 4. Six-sided prism; 5. Acicular and capillary crystals. The tables are small and very small, usually adhering by their lateral planes, and sometimes, although seldom, manipularly aggregated, and often intersecting each other, in such a manner as to form cellular groups. The crystals are sometimes smooth, sometimes feebly longitudinally streaked, and splendent. Internally shining, and lustre intermediate between pearly and adamantine. Fragments indeterminate angular, or wedge-shaped. Translucent. Rather sectile.

Chemical Characters.—Before the blowpipe it melts very easily, and is volatilized in the form of a white vapour.

		Allemont.
Constituent Parts.—	Oxide of Antimony, -	86
	Oxides of Antimony and Iron,	3
	Silica, - - - -	8
		98 *Vauquelin.*

Geognostic and Geographic Situations.—Occurs in veins in primitive rocks. At Prizbram, in Bohemia, it occurs along with crystallized galena or lead-glance; and at Allemont, with native antimony, and grey and red antimony. Has also been found in Malaxa in Hungary.

* Antimony Ochre.

Spiesglanzocker, *Werner.*

External Characters.—Colours yellow, grey, and brown. Scarcely occurs massive, and disseminated, generally incrusting crystals of grey antimony. Dull. Fracture earthy, and sometimes inclines to radiated. Opaque. Soft, passing into very soft. Brittle, and easily frangible.

Chemical Characters.—Before the blowpipe, on charcoal, it becomes white, and evaporates without melting. With borax, it intumesces, and is partly reduced to the metallic state.

Geognostic and Geographic Situations.—Occurs always in veins, and accompanied with grey antimony, and sometimes with red antimony. Is found at Huel Boys, in Endellion, in Cornwall.

Genus V. Blue Iron, or Iron-Mica.

Eisen Glimmer, *Mohs.*

Prismatic. Streak white, grey,...blue. Hardness = 2.0. Sp. gr = 2.6,—2.7.

1. Prismatic Blue Iron.

Prismatisches Eisen Glimmer, *Mohs.*

Specific Character.—Hemi-prismatic. Pyramid unknown. $\frac{\overline{P}}{2}$. Cleavage, $P\breve{r} + \infty$.

This species is divided into three subspecies, viz. Foliated, Fibrous, and Earthy.

FIRST SUBSPECIES.

Foliated Blue Iron.

Blättriches Eisenblau, *Hausmann.*—Vivianit, *Werner.*

External Characters.—Colours blue and green. Crystallized. The following are its secondary forms:

1. Broad rectangular four-sided prism, in which the lateral edges are truncated, (the truncating planes are set obliquely on the smaller lateral planes, and are the original planes of the oblique four-sided prism,) flatly bevelled on the extremities; the bevelling planes set obliquely on the broader lateral planes. 2. Eight-sided prism, acuminated with four planes. The crystals are sometimes acicular, and deeply longitudinally streaked. Externally shining or splendent. Internally shining, passing into splendent, and pearly inclining to adamantine. Fragments long tabular, or splintery. Translucent on the edges, or strongly translucent. Colour paler blue in the streak. Sectile, and easily frangile. Flexible in thin pieces.

Constituent Parts.—

	From the Isle of France.
Oxide of Iron,	41.25
Phosphoric Acid,	19.25
Water,	31.25
Ironshot Silica,	1.25
Alumina,	5.00
	98

Fourcroy and *Laugier*.

Geognostic and Geographic Situations.—Occurs in Wheal-kind Mine, in St Agnes's, in Cornwall; along with iron-pyrites, and magnetic-pyrites, in gneiss, in the Silberberg, at Bodenmais, in Bavaria; and in the department of Allier, in France.

SECOND SUBSPECIES.

Fibrous Blue Iron.

Fasriges Eisenblau, *Hausmann*.

External Characters.—Colour indigo-blue. Occurs massive, sometimes intimately connected with hornblende, and in roundish blunt angular pieces; also in delicate fibrous concretions, which are scopiform or promiscuous. Internally glimmering and silky. Opaque. Soft.

Geognostic and Geographic Situations.—Occurs in transition syenite at Stavern in Norway, and also in West Greenland.

THIRD SUBSPECIES.

Earthy Blue Iron.

Blau Eisenerde, *Werner*.—Erdiches Eisenblau, *Hausmann*.

External Characters.—In its original repository it is said to be white, but afterwards becomes indigo-blue, of different degrees of intensity, which sometimes passes into smalt-blue. Usually friable, sometimes loose, and sometimes cohering. Occurs massive, disseminated, and thinly coating. Particles dull and dusty. Soils slightly. Feels fine and meagre.

Chemical Characters.—Communicates to glass of borax a brown colour, which at length becomes dark yellow. Dissolves rapidly in acids.

		From Eckartsberg.
Constituent Parts.—Oxide of Iron,	-	47.50
Phosphoric Acid,	-	32.00
Water, - -	-	20.00
		99.50 *Klaproth.*

Geognostic Situation.—Occurs in nests and beds in clay-beds, also disseminated in bog iron-ore, or incrusting turf and peat.

Geognostic Situation.—On the surface of peat-mosses in several of the Shetland Islands; in river mud at Toxteth, near Liverpool; and in many other countries.

Uses.—Is sometimes used as a pigment. Is principally employed in water-colours, because, when mixed with oil, the colour is said to change into black.

GENUS VI. GRAPHITE *.

Graphite Glimmer, *Mohs.*

Rhomboidal. Hardness = 1.0,—2.0. Sp. gr. = 1.8,—2.1.

1. Rhomboidal Graphite.

Rhomboedrischer Graphit-Glimmer, *Mohs.*—Graphit, *Werner.* —Graphit, *Haüy.*

Specific Character.—Dirhomboidal. Rhomboid unknown. Cleavage, R — ∞. Metallic lustre. Streak black.

This species is divided into two subspecies, viz. Scaly, and Compact.

FIRST SUBSPECIES.

Scaly Graphite.

Schuppiger Graphit, *Werner.*

External Characters.—Colour dark steel-grey, which approaches to light iron-black. Occurs massive, disseminated; in coarse, small, and fine granular concretions; and crystallized. Only secondary form hitherto met with, is the equiangular six-sided table. Internally shining, passing into splendent, and lustre metallic. Fracture scaly foliated. Fragments indeterminate angular, and blunt-edged. Streak shining,

* *Graphite*, from γραφω, *I write*, on account of its writing quality.

even splendent, and lustre metallic. Perfectly sectile. Rather difficultly frangible. Writes and soils. Feels very greasy.

SECOND SUBSPECIES.

Compact Graphite.

Dichter Graphit, *Werner.*

External Characters.—Colour nearly the same with the preceding, only rather blacker. Occurs massive and disseminated, also in columnar concretions. Internally glimmering, sometimes glistening, and lustre metallic. Fracture small and fine-grained uneven, which passes into even, and also into large and flat conchoidal; in the large the fracture sometimes slaty longitudinal. Fragments indeterminate angular and blunt-edged, and sometimes also tabular. In other characters it agrees with the preceding subspecies.

Chemical Characters.—When heated in a furnace it burns without flame or smoke, and during combustion emits carbonic acid, and leaves a residuum of red oxide of iron.

Constituent Parts.—

Carbon,	90.0	
Iron,	9.1	
	100.0	*Berthollet.*

Geognostic Situation.—Occurs usually in beds, sometimes disseminated, and in imbedded masses, in granite, gneiss, mica-slate. clay-slate, foliated granular limestone, coal and trap formations.

Geographic Situation.—Occurs in imbedded masses, and disseminated in gneiss in Glen Strath Farrar, in Inverness-shire; in the coal-formation, near Cumnock in Ayrshire, where it is imbedded in greenstone, and in columnar glance-coal. At Borrodale in Cumberland, it occurs in a bed or beds of very varying thickness, included in a bed of trap, which is subordinate to clay-slate.

Uses.—The finer kinds are first boiled in oil, and then cut into tables or pencils: the coarser parts, and the refuse of the sawings, are melted with sulphur, and then cast into coarse pencils for carpenters; they are easily distinguished by their sulphureous smell. It is also used for brightening and preserving grates and ovens from rust; and on account of its greasy quality, for diminishing the friction in machines. Crucibles are made with it, which resist great degrees of heat, and have more tenacity and expansibility than those manufactured with the usual clay mixtures.

GENUS VII. TALC-MICA.

Talc-Glimmer, *Mohs.*

Rhomboidal. Prismatic. Streak white, grey,......green. Hardness = 1.0,—2.5. Sp. gr. = 2.7,—3.0.

1. Prismatic Talc-Mica.

Prismatischer Talc-Glimmer, *Mohs.*

Specific Character.—Prismatic. Pyramid unknown. $P + \infty = 120°$ (nearly). Cleavage, $P - \infty$. Flexible. Hardness = 1.0,—1.5. Sp. gr. = 2.7,—2.8.

This species is divided into the following subspecies, viz. 1. Chlorite; 2. Talc; 3. Potstone; * Nacrite: ** Steatite; *** Figurestone.

FIRST SUBSPECIES.

Chlorite.

Chlorit, *Werner.*

This subspecies is divided into five kinds, viz. Foliated, Slaty, Common, Earthy, and Compact.

First Kind.

Foliated Chlorite.

Blättriger Chlorit, *Werner.*

External Characters.—Colour dark blackish-green, which in some rare varieties is dark olive-green. Occurs massive, disseminated, in granular concretions, and crystallized in oblique four-sided prisms, and in irregular six-sided tables. These tables are aggregated together, in such a manner as to form the two following figures: A. Cylinder terminated by two cones. B. Two truncated cones, joined base to base.

Crystals generally longitudinally streaked, and are small or middle-sized. Externally glistening, approaching to shining, and resinous. Internally shining, and pearly. Fragments indeterminate angular, and tabular. Opaque; translucent on the edges. Sectile. Rather difficultly frangible. Feels rather greasy. Colour lighter in the streak.

Geognostic and Geographic Situations.—Occurs in the island of Jura, one of the Hebrides, in quartz rock.

Second Kind.

Slaty Chlorite, or Chlorite-Slate.

Chlorit-Schiefer, *Werner.*—Schiefriger Chlorit, *Karsten.*

External Characters.—Colour intermediate between dark mountain and leek green; sometimes passes into blackish-green and greenish-black. Occurs massive, and in whole beds. Lustre glistening, sometimes inclining to shining, and intermediate between pearly and resinous. Fracture more or less perfect slaty, seldom straight, generally waved slaty, and sometimes scaly foliated. Fragments tabular. Opaque. Affords a pale mountain-green streak. Sectile; rather easily frangible. Does not adhere to the tongue. Feels slightly greasy.

Geognostic Situation.—Occurs principally in beds, subordinate to clay-slate, and occasionally associated with potstone and talc-slate.

Geographic Situation.—Occurs in beds, in the clay-slate districts of the Grampians, and other parts of Scotland.

Third Kind.

Common Chlorite.

Gemeiner Chlorit, *Werner.*

External Characters.—Colour intermediate between dark blackish-green and leek-green. Occurs massive and disseminated. Lustre glimmering, or glistening, and pearly, inclining to resinous. Fracture fine earthy; fine scaly foliated. Fragments blunt-edged. Opaque. Becomes light mountain-green in the streak, with feeble lustre. Soft. Sectile. Does not adhere to the tongue. Feels somewhat greasy.

Geognostic and Geographic Situations.—Occurs not only disseminated through rocks of different kinds, as granite and mica-slate, but also in beds and veins. Is met with in Arran, Bute, &c.

Fourth Kind.

Earthy Chlorite.

Erdiger Chlorit, *Karsten.*

External Characters.—Colour green. Occurs massive, disseminated, in crusts, and moss-like, inclosed in adularia and rock-crystal. Glimmering or glistening; lustre pearly. Consists of fine scaly particles, which are more or less cohering, and feel rather greasy. Does not soil. Streak mountain green.

Chemical Characters.—Melts before the blowpipe into a blackish slag.

Constituent Parts.—

Silica, - - - -	26.00
Alumina, - - - -	18.50
Magnesia, - - - -	8.00
Muriate of Soda, or Potash,	2.00
Oxide of Iron, - -	43.00
Loss, - - - -	2.50
	99.00 *Vauquelin.*

Geognostic and Geographic Situations.—Occurs in veins along with common chlorite at Forneth Cottage in Perthshire.

Fifth Kind.

Compact Chlorite, or Green Earth.

Grünerde, *Werner.*

External Characters.—Colour green. Occurs massive, seldomer disseminated, more frequently in globular and amygdaloidal-shaped pieces, which are sometimes hollow, in crusts lining the vesicular cavities in amygdaloid, or on the surface of agate balls. Internally dull. Fracture earthy, sometimes small-grained uneven. Opaque. Feebly glistening in the streak, but without any change of colour. Feels rather greasy. Adheres slightly to the tongue.

Chemical Characters.—Before the blowpipe it is converted into a black vesicular slag.

		From the Veronese.
Constituent Parts.—	Silica,	53.0
	Oxide of Iron,	28.0
	Magnesia,	2.0
	Potash,	10.0
	Water,	6.0
		99.0 *Klaproth.*

Geognostic Situation.—Occurs principally in the amygdaloidal cavities of amygdaloid, and incrusting the agates found in that rock. It also occasionally colours sandstone, and is disseminated in porphyry.

Geographic Situation.—It is a frequent mineral in the amygdaloid of Scotland; occurs also in that of England and Ireland.

Uses.—It is used as a pigment in water-painting, and is the *mountain-green* of painters.

SECOND SUBSPECIES.

Talc.

Talk, *Werner.*

This subspecies is divided into two kinds, viz. Common and Indurated.

First Kind.

Common Talc.

Gemeiner Talk, *Werner.*

External Characters.—Colours greenish-white, green, and sometimes blue. Occurs massive, disseminated, in plates, reniform, and botryoidal; in distinct concretions, which are large, coarse and small granular; also narrow or broad and stellular or promiscuous radiated, which are again collected into other concretions, having a wedge-shaped prismatic form. Sometimes crystallized in small six-sided tables, which are in druses. Splendent or shining, and lustre pearly or semi-metallic. Fragments wedge-shaped, seldom splintery. Translucent; in thin folia transparent. Flexible; not elastic. Sectile. Feels very greasy.

Chemical Characters.—Becomes white before the blowpipe, and at length, with difficulty, affords a small globule of enamel.

Constituent Parts.—	Silica,	61.75
	Magnesia,	30.50
	Potash,	2.75
	Oxide of Iron,	2.50
	Water,	0.25
	Loss,	2.25
		Klaproth.

Geognostic Situation.—Occurs in beds in mica-slate and clay-slate, and in a similar situation in granular limestone and dolomite; also in cotemporaneous veins, in beds of indurated talc, serpentine, and porphyry; and in the reniform external shape, in tinstone veins.

Geographic Situation.—Is found in Aberdeenshire, Banffshire, and Perthshire.

Uses.—Enters into the composition of the cosmetic named *rouge.*

Second Kind.

Indurated Talc, or Talc-Slate.

Verhärteter Talk, *Werner.*

External Characters.—Colours grey and green. Occurs massive, and rarely in fibrous distinct concretions. Lustre shining, passing to glistening and pearly. Fracture curved slaty, passing into imperfect foliated. Fragments tabular. Strongly translucent on the edges, or only feebly translucent. Rather sectile. Rather easily frangible. Not flexible. Feels greasy.

Geognostic Situation.—Occurs in primitive mountains, where it forms beds in clay-slate and serpentine, and associated with amianthus, chlorite, rhombspar, garnet, actynolite, quartz, kyanite, and grenatite.

Geographic Situation.—Occurs in Perthshire, Banffshire, and the Shetland islands.

Uses.—Is employed for drawing lines by carpenters, tailors, hat-makers, and glaziers. The lines are not so easily effaced as those made by chalk, and besides remain unaltered under water.

THIRD SUBSPECIES.

Potstone, or Lapis Ollaris.

Topfstein, *Werner.*

External Characters.—Colour greenish-grey, of different degrees of intensity; darker varieties incline to leek-green, and blackish-green. Occurs massive, and in indistinct granular concretions. Internally glistening, inclining to shining, and pearly, inclining to resinous. Fracture curved, and imperfect foliated, which passes into slaty. Fragments indeterminate angular, or slaty. Translucent on the edges. Affords a white coloured streak. Perfectly sectile. Feels greasy. Rather difficultly frangible.

Chemical Character.—Is infusible before the blowpipe.

Geognostic Situation.—Occurs in thick beds, in primitive clay-slate.

Geographic Situation.—Occurs abundantly on the shores of the Lake of Como in Lombardy, and at Chiavenna in the Valteline; also in different parts in Norway, Sweden, and Finland.

Uses.—When newly extracted from the quarry it is very soft and tenacious, so that it is frequently fashioned into various kinds of culinary vessels, which harden in drying, and are very refractory in the fire.

* Nacrite.

Nacrite, *Brongniart.*—Erdiger Talk, *Werner.*

External Characters.—Colours greenish-white, and greenish-grey. Consists of scaly parts, which are more or less compacted; the most compact varieties have a thick or curved slaty fracture. Strongly glimmering, and pearly, inclining to resinous. Friable. Feels very greasy; and soils.

Chemical Characters.—Melts easily before the blowpipe.

Constituent Parts.—

Alumina,	81.75	
Magnesia,	0.75	
Lime,	4.00	
Potash,	0.50	
Water,	13.50	
	100.00	*John.*

Geognostic and Geographic Situations.—It is a very rare mineral. It occurs in veins with sparry iron, galena, iron-pyrites and quartz, in the mining district of Freyberg in Saxony; Gieren in Silesia; and Sylva in Piedmont.

** Steatite, or Soapstone.

Speckstein, *Werner.*

External Characters.—Colours white, red, and yellow. Sometimes marked with spotted and dendritic greyish-black delineations. Occurs massive, disseminated, in crusts, reniform; and also in the following figures: 1. Equiangular six-sided prism, acutely acuminated on both extremities with six planes. 2. Acute double six-sided pyramid. 3. Rhomboid.

The six-sided prism, and six-sided pyramid are said to be from rock-crystals, and the rhomboid from calcareous-spar. Both appear to be supposititious, and are generally imbedded in massive steatite. Fracture coarse splintery, passing into coarse and fine-grained uneven. Internally dull, seldom feebly glimmering. Fragments indeterminate angular, and blunt-edged. Translucent on the edges. Becomes shining in the streak. Writes but feebly. Very sectile. Rather difficultly frangible. Does not adhere to the tongue. Feels very greasy.

Chemical Characters.—Before the blowpipe, it loses its colour, but is infusible without addition.

		Steatite of Monte Ramuzo.
Constituent Parts.—	Silica, - - -	44.00
	Magnesia, - - -	44.00
	Alumina, - - -	2.00
	Iron, - - - -	7.30
	Manganese, - - -	1.50
	Chrome, - - -	2.00
	Trace of Lime and Muriatic Acid.	
		100.80 *Vauquelin.*

Geognostic Situation.—Occurs frequently in small cotemporaneous veins, that traverse serpentine in all directions; in angular and other shaped pieces in secondary trap rocks, and also in metalliferous veins that traverse primitive rocks.

Geographic Situation.—Occurs in the serpentine of Portsoy and Shetland; in the limestone of Icolmkill; and in the trap-rocks of Fifeshire, the Lothians, Arran, Skye, Canna, and other parts in Scotland. In England, in the serpentine of Cornwall, and at Almwich in Anglesey.

Uses.—The steatite of Cornwall is used at Worcester, in the manufacture of porcelain. Like fullers earth and indurated talc, it readily absorbs oily and greasy matter, and hence it is used for extracting spots of grease from silk and woollen stuffs. It is also employed in polishing gypsum, serpentine, and marble. When pounded and slightly burnt, it forms the basis of certain cosmetics. It writes readily on glass, in which character it differs from common chalk, which leaves no trace; hence it is used by glaziers in marking plates of glass before they be cut with diamond.

*** Figurestone, or Agalmatolite †.

Bildstein, *Werner.*—Agalmatolith, *Klaproth.*

External Characters.—Colours grey, green, white, red, and brown. Occurs massive. Internally dull or feebly glimmering. Fracture large and flat conchoidal in the large, splintery in the small, and sometimes imperfect slaty. Fragments indeterminate angular, rather sharp-edged, or imperfect tabular. Translucent, sometimes only on the edges. Becomes feebly resinous in the streak. Intermediate between sectile and brittle. Feels rather greasy.

Chemical Characters.—Is infusible before the blowpipe.

Constituent Parts.—

	Chinese Figurestone.	
Silica,	35.00	
Alumina,	29.00	
Lime,	2.00	
Potash,	7.00	
Iron,	1.00	
Water,	5.00	
	99.00	*Vauquelin.*

† *Agalmatolite*, from the Greek words *αγαλμα* and *λιθος*, which signifies *figure-stone*, because it is cut into figures of different kinds in the countries where it is principally found.

Geographic Situation.—Occurs in China, and at Nagyag in Transylvania, but the geognostic situations are unknown.

Uses.—This mineral, owing to its softness, can easily be fashioned into various shapes with the knife: hence, in China, where it frequently occurs, it is cut into human figures, also into pagodas, cups, snuff-boxes, &c.

2. Rhomboidal Talc-Mica.

Rhomboedrischer Talk-glimmer, *Mohs.*

Specific Character.—Di-rhomboidal. Rhomboid unknown. Cleavage, R — ∞. Elastic. Hardness = 2.0,—2.5. Sp. gr. = 2.8,—3.0.

This species contains the following subspecies, 1. Common Mica, 2. Lepidolite.

FIRST SUBSPECIES. Case 2nd of ye Museum Region

Common Talc-Mica,* or Common Mica.

Glimmer, *Werner.*

External Characters.—Common colours grey, brown, black, and white, and rarely peach-blossom red. Occurs massive, disseminated; also in distinct concretions, which are large, coarse, and small granular, and wedge-shaped prismatic. The following are its secondary crystallizations:

1. Equiangular six-sided prism. 2. Equiangular six-sided table. 3. Equiangular six-sided table, truncated on four of the terminal edges. 4. Equiangular six-sided table, bevelled on the terminal planes, and the edges of the bevelment truncated.

Internally generally splendent, seldom shining, generally pearly, sometimes semi-metallic. Fracture not discernible. Fragments tabular and splintery. Translucent or transparent in thin plates, but rarely in crystals of considerable thickness or length. Sectile. Affords a grey-coloured dull streak. Feels fine and meagre. Smooth. Elastic-flexible.

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* *Mica*, from the Latin word *mico*, I shine, given it on account of its lustre.

Chemical Characters.—Before the blowpipe it melts into a greyish-white enamel.

Constituent Parts.—

	Black Mica from Siberia.
Silica, - -	42.50
Alumina, - -	11.50
Oxide of Iron, -	22.00
Oxide of Manganese, -	2.00
Potash, - -	10.00
Magnesia, - -	9.00
Loss by heating, -	1.00
	98.00 *Klaproth.*

Geognostic Situation.—Occurs as an essential constituent part of granite, gneiss, and mica-slate, and is occasionally intermixed with other rocks, of the primitive, transition, secondary, volcanic, and alluvial classes.

Geographic Situation.—The rocks in which mica occurs are so universally distributed, that it is not necessary to enter into any detail of localities. occurs sometimes [illegible]

Uses.—In Siberia, where window-glass is scarce, it is used for windows; also for a similar purpose in Peru, and, I believe, also in New Spain, as it appears that the mineral named *Teculi* by Ulloa, and which is used for that purpose, is a variety of mica. It is also used in lanterns, in place of glass, as it resists the alternations of heat and cold better than that substance. In Russia, it is employed in different kinds of inlaid work. It is sometimes intermixed with the glaze in particular kinds of earthen-ware; the heat which melts the glaze has no effect on the mica; hence it appears dispersed throughout the glaze, like plates or scales of silver or gold, and thus gives to the surface of the ware a very agreeable appearance. Some artists use it in the making of artificial aventurines.

SECOND SUBSPECIES.

Lepidolite. from [illegible]

Lepidolith, *Werner.*

External Characters.—Colours peach-blossom-red, inclining sometimes to rose-red, sometimes to lilac-blue; passes into pearl-grey, yellowish-grey, and greenish-grey. Occurs massive, and in small granular distinct concretions. Internally lustre glistening, passing into shining, and pearly. Fracture coarse splintery. Fragments indeterminate angular and blunt-edged. Feebly translucent. Soft. Rather sectile. Rather easily frangible. rather un[illegible]

Chemical Characters.—Before the blowpipe intumesces, and melts very easily into a milk-white nearly translucent globule.

Constituent Parts.—Silica,	54.00	
Alumina,	20.00	
Potash,	18.00	
Fluate of Lime,	4.00	
Manganese,	3.00	
Iron,	1.00	
	100	*Vauquelin.*

Geognostic and Geographic Situations.—Occurs disseminated, in foliated granular limestone, at Dalmally, and in other quarters of the Highlands.

Genus VIII. Pearl-Mica.

Perl-Glimmer, *Mohs.*

Rhomboidal. Hardness = 3.5,—4.5. Sp. gr. = 3.0,—3.1.

1. Rhomboidal Pearl-Mica.

Rhomboedrischer Perl-Glimmer, *Mohs.*

Specific Character.—Dirhomboidal. Rhomboid unknown. Cleavage, $R - \infty$. Streak white or grey.

Order VI. Spar. + [illegible] [illegible]

No perfect metallic lustre. Streak white or grey,.... and brown.

If rhomboidal, the Sp. gr. = 2.2. and less, or the Hardness = 6.0.

Hardness = 3.5,—7.0. If 4.0 and less, there is a single highly perfect cleavage. If above 6.0, the Sp. gr. is under 2.5, or above 2.8; and the lustre is pearly.

Sp. gr. = 2.0,—3.7. If above 3.3, it is hemiprismatic, or the hardness = 6.0; and no adamantine lustre. If 2.4 and less, there are traces of form and cleavage.

Genus I. Schiller-Spar.

Schiller-Spath, *Mohs.*

Prismatic. Single highly perfect faces of cleavage. Hardness = 3.5,—6.0. If = 6.0, the lustre is metallic-pearly. Sp. gr. = 2.6,—3.4. lustre inclining to metallic.

1. Diatomous * Schiller-Spar.

Diatomer Schiller-Spath, *Mohs.*—Schiller-Stein, *Werner.*—Diallage Metalloide, *Haüy.*—Schiller-spar, *Jameson,* 2d & 3d edit.

Specific Character. — Prismatic. Pyramid unknown. Cleavage prismatoidal. Hardness = 3.5,—4.0. Sp. gr. = 2.6,—2.8.

External Characters.—Colours green, grey, and brown. Seldom occurs massive, generally disseminated, and sometimes in granular distinct concretions. Internally shining and splendent, and lustre pearly, or metallic-pearly. Fragments indeterminate angular or tabular. Faintly translucent on the edges, or opaque. Streak greenish-grey, and dull. Easily frangible, and slightly inclining to sectile.

Geognostic and Geographic Situations.—Occurs imbedded in Serpentine, in Fetlar, and Unst in Shetland, and at Portsoy in Banffshire; in the greenstone rocks of the island of Skye; also in the greenstone rocks of Fifeshire; in the porphyritic rock of the Caltonhill, and the trap-rocks of Craig Lockhart, near Edinburgh.

2. Axotomous Schiller-Spar †, or Green Diallage.

Axentheilender Schiller-Spath, *Mohs.* — Körniger Strahlstein, *Werner.*—Diallage Verte, *Haüy.*—Green Diallage, *Jameson,* 3d edit.—Diallage, *Jameson,* 2d edit.

Specific Character. — Prismatic. Pyramid unknown.

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* From δια through, and τεμνω, I cut. Cleavage very distinct in one direction.

† From αξων, the axis, and τεμνω, I cut. Cleavage perpendicular to the axis.

Cleavage, P — ∞. Common pearly lustre. Hardness = 4.5, —5.5. Sp. gr. = 3.0,—3.2.

External Characters.—Colour green. Occurs massive and disseminated. Internally shining, glistening, and pearly. Fragments indeterminate angular, and rather sharp-edged. Translucent on the edges, sometimes passing into translucent. Brittle.

Chemical Character.—Melts before the blowpipe into a grey or greenish enamel.

Constituent Parts.—

Silica,	50.0	
Alumina,	11.0	
Magnesia,	6.0	
Lime,	13.0	
Oxide of Iron,	5.3	
Oxide of Copper,	1.5	
Oxide of Chrome,	7.5	
	94.3	*Vauquelin.*

Geognostic and Geographic Situations.—Occurs in the island of Corsica, along with Saussurite; and with the same mineral in Mont Rosa in Switzerland, and at La Rivera, in the Valley of Susa in Piedmont.

Uses.—The compound of green diallage and Saussurite; named *Gabbro* by the Italians, *Euphotide* by the French, and by artists *Verde di Corsica duro,* when cut and polished has a beautiful appearance, and is much prized as an ornamental stone. It is cut into snuff-boxes, ring-stones, for inlaid-work and other similar purposes.

3. Hemiprismatic Schiller-Spar, or Bronzite.

Hemiprismatischer Schiller-Spath, *Mohs.*—Blättriger Anthophyllite, *Werner.*—Diallage metalloide, *Haüy.*—Bronzite, *Jameson,* 2d edit.—Schiller-Spar, *Jameson,* 3d edit.

Specific Character.—Hemiprismatic. Pyramid unknown. Cleavage, $\frac{P\bar{r}}{2}$. $P\bar{r}+\infty$. Perfect $P\overset{o}{r}+\infty$. Lustre metallic-pearly. Hardness = 4.0,—5.0. Sp. gr. = 3.0,—3.3.

External Characters.—Colours brown and grey. Occurs massive, and in coarse and small granular distinct concretions.

I 2

+ looks like Bronze

Internally shining, and the lustre metallic pearly. The cleavages are curved, and their surface streaked. Sometimes the cleavages appear fibrous. Fragments indeterminate angular and blunt-edged. Translucent on the edges, sometimes approaching to translucent. Affords a white streak. Difficultly frangible.

Chemical Characters.—Infusible before the blowpipe.

Constituent Parts.—

Silica,	60.00	
Magnesia,	27.50	
Iron,	10.50	
Water,	0.50	
	98.50	*Klaproth.*

Geognostic and Geographic Situations.—Occurs in greenstone in the island of Skye; near to Drimnadrochit in Inverness-shire; in large masses in a bed of serpentine near Kraubat in Upper Stiria, &c.

4. Prismatoidal Schiller-Spar, or Hypersthene.

Prismatoidischer Schiller-Spath, *Mohs.*—Paulit, *Werner.*—Hypersthene, *Haüy.* — Hyperstene or Labrador Schiller-Spar, *Jameson,* 3d edit.

Specific Character. — Prismatic. Pyramid unknown. Cleavage, $P+\infty = 100°$ (nearly). $P\bar{r}+\infty$. Perfect $\breve{P}r+\infty$. Lustre metallic-pearly. Hardness = 6.0. Sp. gr. = 3.3,—3.4.

External Characters.—Colour intermediate between greyish and greenish black; nearly copper-red on the cleavage, and brownish-black, or blackish-brown on the fracture surface. Occurs massive, disseminated, also in thin curved lamellar concretions, which are collected into others which are coarse granular. On the cleavage, the lustre shining and glistening, and metallic-pearly, on the fracture glimmering and pearly. Fragments indeterminate angular, or rhomboidal. Opaque, or feebly translucent on the edges. Greenish-grey in the streak. Brittle, and rather easily frangible.

Chemical Character.—Infusible before the blowpipe.

Constituent Parts.—Silica,	54.25	
Magnesia,	14.00	
Alumina,	2.25	
Lime,	1.50	
Oxide of Iron,	24.50	
Water,	1.00	
Oxide of Manganese, a trace.		
	97.50	*Klaproth.*

Geognostic and Geographic Situations.—It was first discovered on the coast of Labrador, where it forms a constituent part of a granitous rock. In this country it is met with in the Island of Skye in greenstone, and in a similar rock in Banffshire.

Uses.—When cut and polished, it has a beautiful copper-red colour, and metallic pearly-lustre, and is made into ring-stones and brooches. occurs as a constituent of Greenstone

5. Prismatic Schiller-Spar, or Anthophyllite.

Prismatischer Schiller-Spath, *Mohs.*—Strahliger Anthophyllit, *Werner.*—Anthopyllite, *Haüy.*—Anthopyllite, *Jameson,* 3d edit.

Specific Character.—Prismatic. Pyramid unknown. Cleavage, $P+\infty = 106°$ (nearly). $P\breve{r}+\infty$. Perfect $P\bar{r}+\infty$. Lustre almost metallic-pearly. Hardness $= 5.0$—5.5. Sp. gr. $= 3.0$,—3.3.

External Characters.—Colour intermediate between dark yellowish-grey and clove-brown. Generally occurs massive; also in narrow or broad prismatic distinct concretions, which are scopiform or promiscuous, and in which the surface is streaked. Rarely crystallized, in reed-like, very oblique four-sided prisms. Surface of the crystals longitudinally streaked. Lustre shining and glistening. Fragments wedge-shaped and splintery; and sometimes rhomboidal. Translucent on the edges, or translucent.

Chemical Characters.—It becomes dark greenish-black before the blowpipe, but is infusible.

Constituent Parts.—

Silica,	56.00
Alumina,	13.30
Magnesia,	14.00
Lime,	3.33
Iron,	6.00
Oxide of Manganese,	3.00
Water,	1.43
	John

Geognostic and Geographic Situations.—Occurs in beds in mica-slate at Kongsberg in Norway, along with common hornblende, mica, and asbestous-tremolite; at Modum cobalt mines, also in Norway, along with common hornblende, cobalt-glance, and copper-pyrites.

GENUS II. KYANITE *.

Disthen Spath, *Mohs.*

Prismatic. Hardness = 5.0,—7.0. Sp. gr. = 3.5,—3.7.

1. Prismatic Kyanite.

Disthen Spath, *Mohs.*—Kyanite and Rhätizit, *Werner.*—Disthene, *Haüy.*

Specific Character.—Tetarto-prismatic. Pyramid unknown. Cleavage, two faces, the one more distinct than the other. Incidence = 102° 50′.

External Characters.—Colours azure and sky blue, bluish-grey, white, celandine-green, and greenish-grey. Often marked with blue-coloured flame delineations. Occurs massive and disseminated; also in distinct concretions, which are large and longish angulo-granular, and also wedge-shaped prismatic, which are straight or curved, and sometimes disposed in scopiform or stellular directions. It is sometimes regularly crystallized, and the following are some of its crystallizations. 1. Oblique four-sided prism, truncated on the two opposite acute lateral edges. 2. Preceding figure, in which all the lateral edges are truncated. 3. Twin-crystal: it may be considered as two flat four-sided prisms joined together by their broader lateral planes.

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* *Kyanite*, from the Greek word κυανος, *sky-blue*, a frequent colour of this mineral.

The narrow lateral planes are longitudinally streaked, and glistening: the broad are smooth, or delicately transversely streaked and splendent. Crystals are singly imbedded, or intersect one another. Lustre splendent and pearly. Fragments splintery, or imperfectly rhomboidal. Massive varieties translucent. Crystals in general transparent. Rather brittle. Easily frangible.

Chemical Character.—Infusible before the blowpipe.

Constituent Parts.—

Silica,	43.00
Alumina,	55.50
Iron,	0.50
Trace of Potash.	
	99.00 *Klaproth.*

Geognostic Situation.—It has been hitherto fonnd only in primitive mountains, where it occurs in compact granite, mica-slate, and talc-slate, accompanied with several other minerals.

Geographic Situation.—Occurs in primitive rocks near Banchory in Aberdeenshire, and Boharm, in Banffshire; in mica-slate near Sandlodge, in Mainland, the largest of the Shetland Islands.

Uses.—In India it is cut and polished, and sold as an inferior kind of sapphire.

Genus III. Spodumene *.

Prismatischer Triphan-Spath, *Mohs.*

Prismatic. Hardness = 6.0,—7.0. Sp. gr. = 3.0,—3.1.

1. Prismatic Spodumene.

Spodumen, *Werner.*—Triphane, *Haüy.*

Specific Character.—Prismatic. Pyramid unknown. Cleavage, $P+\infty = 100°$ (nearly). Somewhat more distinct $P\breve{r}+\infty$.

* On exposure to the blowpipe, it first separates into golden-coloured scales, and then into a kind of powder or ash; hence the name *Spodumene*, from σποδύω, *I change into ash*, or σποδος, *ashes*.

External Characters.—Colour intermediate between greenish-white and mountain-grey, and sometimes passes into oil-green. Occurs massive, disseminated, and in large and coarse granular concretions. Cleavage shining. Fracture glistening. Lustre pearly. Fracture fine-grained uneven. Translucent. Uncommonly easily frangible.

Chemical Characters.—Before the blowpipe, it first separates into small golden-yellow coloured folia; and if the heat is continued, they melt into a greenish-white coloured glass.

Constituent Parts.—

Silica,	64.4	
Alumina,	24.4	
Lime,	3.0	
Potash,	5.0	
Oxide of Iron,	2.2	
	99.0 *	*Vauquelin.*

Geognostic and Geographic Situations.—This mineral, which occurs in primitive rocks, was first discovered in Sudermanland, in Sweden, afterwards in Ireland, and in other countries.

GENUS IV. PREHNITE.

Axentheilender Triphan-Spath, *Mohs.*—Prehnite, *Werner* and *Haüy.*

Prismatic. Hardness = 6.—7. Sp. gr. = 2.8,—3.—0. Not blue.

1. Axotomous Prehnite.

Specific Character.—Prismatic. Pyramid unknown. Cleavage $P + \infty = 103°$ (nearly). More distinct $P - \infty$.

This species is divided into two subspecies, viz. Foliated and Fibrous.

FIRST SUBSPECIES.

Foliated Prehnite.

Blättriger Prehnite, *Werner.*

External Characters.—Colours green, white, and grey. Occurs massive, and in distinct concretions, which are large,

* According to some analyses, it contains 8 *per cent.* of a new alkali named *lithina.*

coarse, and fine angulo-granular, and also thick and wedge-shaped prismatic. Sometimes crystallized. The following are some of the secondary forms which the species assumes: 1. Oblique four-sided table, sometimes truncated either on all its terminal edges, or only on the acute edges. When the truncations on the edges increase very much, there is formed, 2. An irregular eight-sided table. When the truncations on the acute edges increase considerably, there is formed, 3. An irregular six-sided table. When these truncating planes increase in magnitude, and the table at the same time becomes thicker, and the obtuse edges are slightly truncated, there is formed, 4. A broad rectangular four-sided prism, rather flatly bevelled on the extremities, in which the bevelling-planes are set on the smaller lateral planes, and the edge of the bevelment slightly truncated. Externally crystal almost always shining. Internally shining, or glistening, and pearly. Fracture fine-grained uneven. Alternates from translucent, through semitransparent into transparent. Rather easily frangible.

Chemical Characters.—Intumesces before the blowpipe, and melts into a pale green or yellow, or greenish-black frothy glass, but does not gelatinate with acids.

Physical Characters.—According to the observations of M. De Dree, it becomes electric by heating.

Constituent Parts.—Silica,	48	
Alumina,	24	
Lime,	23	
Oxide of Iron,	4	
	99	*Vauquelin.*

Geognostic and Geographic Situations.—Occurs in veins in primitive and secondary rocks, in France, Tyrol, Greenland, and Cape of Good Hope.

SECOND SUBSPECIES.

Fibrous Prehnite.

Fasriger Prehnite, *Werner.*

External Characters.—Colours green and greenish white. Occurs massive, reniform, in straight scopiform and stellular fibrous, and radiated distinct concretions, which are collected into large and coarse angulo-granular concretions; also crystallized in acicular four-sided prisms. Internally glistening; lustre pearly. Translucent. Easily frangible.

Chemical Characters.—Before the blowpipe it melts into a vesicular enamel.

Physical Character.—It becomes electric by heating.

Constituent Parts.—

Silica,	42.50
Alumina,	28.50
Lime,	20.40
Natron and Potash,	0.75
Oxide of Iron,	3.00
Water,	2.00
	97.15 *Laugier.*

Geognostic Situation.—This subspecies appears to be confined to secondary mountains; at least it has hitherto been found only in secondary trap-rocks, as basalt, amygdaloid, basaltic greenstone, and common greenstone. Occurs either in cotemporaneous veins, or in amygdaloidal and other shaped cavities in these trap-rocks.

Geographic Situation.—In Scotand, it occurs in veins and cavities in trap-rocks near Beith in Ayrshire; Bishoptown in Renfrewshire; also at Hartfield, near Paisley; near Frisky Hall, in Cockney Burn, Old Kilpatrick, and Loch Humphrey, in Dunbartonshire; in Salisbury Craig, the Castle Rock, and Arthur Seat near Edinburgh; in Berwickshire; and in the islands of Mull and Raasay.

Genus V. Datolite *.

Dystom-Spath, *Mohs.*—Esmarkite, *Hausmann.*

Prismatic. Internally, lustre resinous. Colour not blue. Hardness = 5.0,—5.5. Sp. gr. = 2.9,—3.0.

* The name *Datolite* refers to the granular concretions which this species exhibits in the massive varieties, and was given to it by its discoverer M. Esmark.

1. Prismatic Datolite.

Prismatischer Dystom-Spath, *Mohs.*

Specific Character.—Hemiprismatic. Pyramid $= 129° 1'$; $105° 2'$; $96° 23'$, $\frac{P}{2} = 129° 1'$. Cleavage, $P + \infty = 109° 28'$ imperfect.

This species is divided into two subspecies, viz. Common and Botryoidal.

FIRST SUBSPECIES.

Common Datolite.

Datholit, *Werner.*—Chaux Boratée Siliceux, *Haüy.*

External Characters.—Colours white, and grey, which latter inclines to celandine-green, and rarely to muddy honey-yellow. Occurs in massive portions, which are divided into large coarse and small granular distinct concretions; crystallized. The principal secondary forms are the following:

1. Low oblique four-sided prism. 2. Rectangular four-sided prism, flatly acuminated on the extremities, with four planes which are set on the lateral planes.

Externally shining. Internally intermediate between shining and glistening, and lustre resinous. Fracture intermediate between fine-grained uneven and imperfect conchoidal. Translucent, and sometimes transparent. Very brittle. Difficultly frangible.

Chemical Characters.—When exposed to the flame of a candle, it becomes opaque, and may then be easily rubbed down between the fingers. Before the blowpipe, it intumesces into a milk-white coloured mass, and then melts into a globule of a pale rose-colour.

Constituent Parts.—Silica,	37.0	
Lime,	28.0	
Boracic Acid,	31.0	
Alumina,	1.0	
Iron, Manganese, and Nickel,	1.5	
Water,	1.4	
	100	*Esmark.*

Geognostic and Geographic Situations.—Is associated with calcareous-spar, more rarely with fluor-spar, quartz, and sometimes prehnite, in a bed of magnetic ironstone in gneiss, at the mine of Nodebroe, near Arendal in Norway. Is said also to occur in small veins in greenstone, in the Geisalp in Sonthofen; and in the Syseralp.

SECOND SUBSPECIES.

Botryoidal Datolite, or Botryolite.

Botryolith, *Hausmann.*

This subspecies is divided into two kinds, viz. Fibrous and Earthy.

First Kind.

Fibrous Botryoidal Datolite.

Fasriger Botryolith, *Hausmann.*

External Characters.—Externally grey; internally white, which passes into pale rose-red. The colours are in concentric stripes. Occurs reniform, botryoidal, small globular; in fibrous concretions which are scopiform and stellular; these concretions are again collected into granular concretions, which are traversed by very thin curved lamellar concretions. Surface granulated or rough, and dull. Internally glimmering and pearly. Fracture splintery. Translucent on the edges.

Geognostic and Geographic Situations.—Occurs in the Kjenlie mine, near Arendal in Norway, along with common quartz, schorl, calcareous-spar, and iron-pyrites, in a bed of magnetic ironstone, in gneiss.

Second Kind.

Earthy Botryoidal Datolite.

Erdiger Botryolith, *Hausmann.*

External Characters.—Colour snow-white. Small botryoidal. Dull. Fracture earthy.

Geognostic and Geographic Situations.—Occurs along with the fibrous kind.

Genus VI. Zeolite.

Kouphon-Spath, *Mohs.*

Tessular, rhomboidal, pyramidal, prismatic. If the most distinct cleavage be parallel to a rectangular prism, the Sp. gr. = 2.4, and less. Hardness = 3.5,—6.0. Sp. gr. = 2.0,—2.5.

1. Trapezoidal Zeolite, or Leucite *.

Trapezoidaler Kuphon-Spath, *Mohs.*—Leuzit, *Werner.*—Amphigène, *Haüy.*—Dodecahedral Zeolite, *Jameson,* 3d edit.

Specific Character.—Tessular. Cleavage, hexahedral, dodecahedral, imperfect. Hardness = 5.5,—6.0. Sp. gr. = 2.4,—2.5.

External Characters.—Colours white and grey. Seldom occurs massive, and in granular concretions, most frequently in roundish imbedded grains, and crystallized in acute double eight-sided pyramids, in which the lateral planes of the one are set on the lateral planes of the other, and the summits deeply and flatly acuminated by four planes, which are set on the alternate lateral edges. Surface of the grains rough, and dull, or feebly glimmering; that of the crystals is smooth, seldom slightly streaked, in the direction of the diagonal, and glistening. Internally, lustre shining, approaching to glistening, and vitreous, inclining to resinous. Fracture imperfect, and flat conchoidal. Translucent, semi-transparent, and some varieties approach to transparent. Refracts single. Brittle. Easily frangible.

Chemical Characters.—Before the blowpipe it is infusible without addition; with borax it forms a brownish transparent glass.

		Mean of different analyses.
Constituent Parts.—	Silica,	54
	Alumina,	24
	Potash,	21
	Loss,	1
		100 *Klaproth.*

* *Leucite,* from λευκος, *white,* and refers to its frequent white colour.

Geognostic and Geographic Situations.—Occurs principally in secondary trap-rocks, and in lavas, and appears to be almost exclusively a production of Italy.

*. N.B. Lava generally contains a good deal of soda

2. Dodecahedral Zeolite, or Sodalite.

Dodecaedrischer Kuphon-Spath, *Mohs.*—Sodalite, *Thomson,* and *Jameson,* 3d edit.

Specific Character.—Tessular. Cleavage, dodecahedral, and perfect. Hardness = 5.5,—6.0. Sp. gr. = 2.2,—2.4.

External Characters.–Colour intermediate between mountain and celandine green. Occurs massive, and crystallized in rhomboidal dodecahedrons. Externally smooth, shining, or glistening; internally the longitudinal fracture vitreous, and cross fracture resinous. Fracture conchoidal. Translucent. Brittle. Easily frangible.

Chemical Characters.—When heated to redness, it does not decrepitate, nor fall to powder, but becomes dark-grey. Infusible before the blowpipe.

Constituent Parts.—

Silica, - - - -	38.58
Alumina, - - -	27.58
Lime, - - -	2.70
Oxide of Iron, -	1.00
Soda, - -	25.50
Muriatic Acid, -	3.00
Volatile Matter, -	2.10
Loss, - - -	1.70
	100 *Thomson.*

Geognostic and Geographic Situations.—Occurs in a bed from six to twelve feet thick in mica-slate, associated with sahlite, common augite, hornblende and garnet, in West Greenland.

3. Hexahedral Zeolite, or Analcime.

Hexaedrischer Kuphon-Spath, *Mohs.*—Analcime, *Haüy.*—Kubizit, *Werner.*

Tessular. Cleavage hexahedral, imperfect. Hardness = 5.5. Sp. gr. = 2.0,—2.2.

External Characters.—Colour white, which passes into flesh-red. Seldom occurs massive, and this variety is disposed in coarse and small angulo-granular concretions, which are in general very closely aggregated; generally crystallized, and in the following figures. 1. Perfect cube. 2. Cube flatly and deeply acuminated on all the angles, with three planes, which are set on the lateral planes. 3. Acute double eight-sided pyramid, deeply and somewhat flatly acuminated on both extremities, with four planes which are set on the alternate lateral edges. Surface of the crystals smooth, and splendent or shining. Internally intermediate between shining and glistening, and lustre vitreous, inclining to pearly. Fracture small, or fine-grained uneven, or conchoidal. Fragments generally indeterminate angular, seldom more or less cubical, owing to the imperfection of the cleavage. Translucent or semi-transparent, and the crystals transparent. Easily frangible.

Chemical Characters.—Melts with intumescence before the blowpipe, into a transparent glass.

Physical Characters.—By friction, but not by heating, it becomes electric.

		Analcime of Montecchio-Maggiore.
Constituent Parts.—	Silica, - -	58.0
	Alumina, - -	18.0
	Lime, - -	2.0
	Natron, - -	10.0
	Water, - -	8.5
		96.5 *Vauquelin.*

Geognostic Situation.—Occurs in primitive and secondary rocks, but more abundantly in secondary than in primitive rocks.

Geographic Situation.—Occurs in the secondary greenstone of Salisbury Craigs, in the porphyritic rock of the Calton-Hill, near Edinburgh, and in many other places in Scotland.

4. Pyramido-Prismatic Zeolite, or Cross-stone.

Pyramido-Prismatischer Kuphon-spath, *Mohs.*—Kreutzstein, *Werner.*—Harmotome, *Haüy.*

Specific Character.—Prismatic. Pyramid unknown. Cleavage pyramidal. $\overset{\circ}{P}r + \infty$. $\bar{P}r + \infty$. Hardness $= 4.5$. Sp. gr. $= 2.3, -2.4$.

External Characters.—Colours white, grey, yellow, and red. Occurs very rarely massive; most frequently crystallized. The following are the principal secondary forms which have been observed: 1. Broad, rectangular four-sided prism, rather acutely acuminated on the extremities with four planes, which are set on the lateral edges. 2. Twin-crystal, which is formed by two crystals of N° 1. intersecting each other, in such a manner that a common axis and acumination is formed, and the broader lateral planes make four re-entering right angles. The surface of the smaller lateral planes is double plumosely streaked, the broader lateral planes transversely streaked, and the acuminating planes streaked parallel with the smaller lateral planes. Internally glistening, and lustre intermediate between vitreous and pearly. Fracture small and perfect conchoidal, passing into uneven. Translucent, sometimes passing into semi-transparent. Easily frangible.

Chemical Characters.—Before the blowpipe it exhibits a greenish-yellow phosphorescence, and then melts with intumescence into a colourless glass.

Constituent Parts.—

Silica,	49	
Alumina,	16	
Barytes,	18	
Water,	15	
	98	*Klaproth.*

Geognostic and Geographic Situations.—Occurs principally in mineral veins and in agate balls. At Andreasberg in the Hartz, it occurs in veins that traverse clay-slate and greywacke rocks, along with galena or lead-glance; at Kongsberg in Norway, in veins containing native silver, ores of silver, lead, zinc, arsenic, and iron; and at Strontian in Argyleshire, in galena veins that traverse gneiss. At Oberstein it occurs in agate balls, in trap-rocks, and in a similar situation near the village of Old Kilpatrick in Dunbartonshire.

5. Rhomboidal Zeolite, or Chabasite *.

Rhomboedrischer Kuphon-Spath, *Mohs.*—Chabasie, *Haüy.*—Schabasit, *Werner.*

Specific Character.—Rhomboidal. Rhomboid, $= 93° 48'$. Cleavage rhomboidal. Hardness $= 4.0,—4.5$. Sp. gravity $= 2.0,—2.1$.

External Characters.—Colour greyish-white, approaching to yellowish-white. Seldom occurs massive; almost always crystallized. The following are the most frequent secondary forms: 1. Rhomboid truncated on the six obtuse lateral edges. 2. Rhomboid truncated on the six obtuse lateral edges, and on the six obtuse angles. 3. Rhomboid in which each of the original planes is divided into two. The lateral planes of the crystals are streaked in a peculiar manner; the streaks shoot from the shorter diagonal, (the dividing edge of the plane,) and run parallel with the two adjoining lateral edges of the rhomb. The truncating planes are smooth. Externally the crystals are splendent; internally glistening and the lustre vitreous. Fracture imperfect conchoidal, and also small-grained uneven. Fragments indeterminate angular. Translucent; the crystals sometimes pass into semi-transparent. Easily frangible.

Chemical Characters.—Before the blowpipe it melts easily into a spongy white enamel.

Constituent Parts.—

	Chabasite of the Faroe Islands.
Silica,	43.33
Alumina,	22.66
Lime,	3.34
Natron, with Potash,	9.34
Water,	21.00
	99.67 *Vauquelin.*

Geognostic Situation.—Occurs principally in secondary trap-rocks; most frequently in cavities of amygdaloid, where it is often associated with agate, calcareous-spar, zeolite, and green-earth.

* The name *Chabasie*, is from Chabasion, a stone described by Orpheus in his Poems, but unknown to us at present.

Geographic Situation.—The vesicular cavities of the trap-rocks of Mull and Skye afford crystals of Chabasite; it occurs in similar rocks in the north of Ireland; and beautiful specimens are found in the amygdaloid of Iceland, and of the Faroe Islands.

6. Diatomous Zeolite, or Laumonite.

Diatomer Kuphon-spath, *Mohs.*—Laumonite, *Werner.*—Di-prismatic Zeolite, *Jameson*, 3d edit.—Laumonite, *Haüy.*

Specific Character.—Hemiprismatic. Pyramid $= 129° 7'$; $120° 48'$; $81° 6'$. $\frac{P}{2} = 120° 48'$. $P + \infty = 98° 13'$. Cleavage, $\bar{Pr} + \infty$. More distinct $\breve{Pr} + \infty$. Hardness $= 4.5$? Sp. gr. $= 2.3$,—2.4.

External Characters.—Colours yellowish-white, snow-white, and greyish-white. Occurs massive, in granular distinct concretions; also crystallized. Internally sometimes shining, sometimes glistening, and lustre pearly. When in a fresh state is transparent, but on exposure to the atmosphere, it very soon becomes opaque. When fresh, is rather harder than fluor-spar; but on exposure to the atmosphere, it soon becomes so soft as to yield to the mere pressure of the finger. Uncommonly easily frangible.

Chemical Characters.—Forms a jelly with acids.

Constituent Parts.—

Silica,	49.0
Alumina,	22.0
Lime,	9.0
Water,	17.5
Carbonic Acid,	2.5
	100.0 *Vogel.*

Geognostic and Geographic Situations.—This mineral was found in the year 1785, in the lead-mines of Huelgoet in Brittany, by M. Gillet Laumont, a distinguished French mineralogist. Since that period, it has been discovered in other parts of the world, as in Scotland, Ireland, Faroe Islands, &c.

7. Prismatic Zeolite, or Mesotype.

Prismatischer Kuphon-Spath, *Mohs.*—Mesotype, *Haüy.*

Specific Character.—Prismatic. Pyramid unknown. Cleavage, $P + \infty = 120° 25'$. Hardness $= 5.0,—5.5$. Sp. gr. $= 2.0,—2.3$.

This species is divided into three subspecies, viz. Fibrous Zeolite, Natrolite, and Mealy Zeolite.

FIRST SUBSPECIES.

Fibrous Zeolite.

Gemeiner Faser Zeolith, *Werner.*

External Characters.—Colours white, red, yellow, and yellowish-brown. Occurs massive, in blunt-angular pieces, in balls, and small reniform, and these forms are composed of distinct concretions, which are fibrous and granular. The fibrous concretions are thin, straight, scopiform, and stellular; the granular, which include the fibrous, are large and coarse longish or angulo-granular, and are very much grown together. Occurs in capillary crystals. Internally it is strongly glimmering, passing into glistening, and lustre pearly. Faintly translucent. Brittle, and easily frangible.

Chemical Characters.—Intumesces before the blowpipe, and forms a jelly with acids.

Constituent Parts.—

Silica,	54.46	
Alumina,	19.70	
Lime,	1.61	
Soda,	15.09	
Water,	9.83	
	100.00	*Gehlen.*

Geognostic and Geographic Situations.—Occurs in drusy cavities and veins in secondary trap-rocks, in most of the trap districts in Scotland.

SECOND SUBSPECIES.

Natrolite.

Natrolith, *Werner.*

External Characters.—Colours yellow, yellowish-brown, or yellowish-white. Colours generally arranged in narrow striped delineations, which are parallel with the reniform external shape. Occurs massive, in plates, and reniform; also in distinct concretions, which are fibrous, granular, and lamellar; the fibrous are straight, and scopiform, or stellular; these are collected into large and coarse granular, and both are intersected by curved lamellar concretions. Internally glistening, passing into glimmering, and lustre pearly. Fracture not visible. Translucent on the edges.

Chemical Characters.—Before the blowpipe, it becomes first black, then red, intumesces, and melts into a white compact glass.

Constituent Parts.—

Silica, - - -	48.00	
Alumina, - -	24.25	
Natron, - - -	16.50	
Oxide of Iron, - -	1.75	
Water, - - -	9.00	
	99.50	*Klaproth.*

Geognostic and Geographic Situations.—Occurs in small cotemporaneous veins in clinkstone-porphyry, in the hills of Hohentwiel.

THIRD SUBSPECIES.

Mealy Zeolite.

Mehlzeolith, *Werner.*

External Characters.—Colours white and red. Occurs massive, reniform, coralloidal, sometimes it forms a crust over the other subspecies of zeolite, or is disposed in delicate fibrous concretions. Internally dull, or very feebly glimmering. Fracture coarse earthy. Opaque. Mass very soft, but the individual parts as hard as fibrous zeolite. Uncommonly easily frangible. Feels rough and meagre; and when we draw our finger across it, it emits a grating sound. Sometimes so light as nearly to swim in water.

Chemical Characters.—Intumesces before the blowpipe, and forms a jelly with acids.

Constituent Parts.—

Silica, - - -	60.0	
Alumina, - -	15.6	
Lime, - - -	8.0	
Oxide of Iron, - -	1.8	
Loss by exposure to heat,	11.6	
	97.0	*Hisinger.*

Geognostic Situation.—Occurs in similar repositories with the other subspecies.

Geographic Situation.—Is found near Tantallon Castle in East Lothian, in the islands of Skye, Mull, and Canna, also in the Faroe Islands, Iceland, Sweden.

8. Prismatoidal Zeolite or Stilbite.

Prismatoidischer Kuphon-spath, *Mohs.*—Stilbite, *Haüy.*—Strahlzeolith, *Werner.*—Radiated Zeolite, *Jameson,* 3d edit.

Specific Character.—Prismatic. Pryamid $= 123° 33'$; $112° 16'$; $93° 7'$. $P + \infty . = 99° 22'$. Cleavage, $\breve{Pr} + \infty$. very perfect. Hardness $= 3.5,—4.0$. Sp. gr. $= 2.0,—2.2$.

External Characters.—Occurs almost always white; sometimes grey, yellow, flesh-red, and blood-red. Is found massive, in angular pieces, and globular; also in distinct concretions, which are radiated and granular; the radiated are broad and narrow scopiform, and stellular, and are collected into large, coarse, and small angulo-granular concretions. Frequently crystallized; and exhibits the following secondary forms: 1. Broad rectangular four-sided prism, rather acutely acuminated on both extremities with four planes, which are set on the lateral edges. 2. Sometimes N° 1. is so thin, that it may be considered as a long six-sided table, bevelled on the shorter terminal planes.

The broader lateral planes of the crystals are smooth, the smaller longitudinally streaked, and the acuminating planes smooth or rough. The surfaces of the broader lateral planes of the crystals N° 1, 2. are splendent and pearly: the other planes shining and vitreous: internally the lustre more or less shining and pearly. Crystals strongly translucent, sometimes passing into semi-transparent. Brittle. Easily frangible.

Geognostic and Geographic Situations.—Occurs principally in secondary amygdaloid, either in drusy cavities along with calcareous-spar and calcedony, or in cotemporaneous veins. It is also met with in transition and primitive mountains. Occurs in Dunbartonshire, Angusshire, Stirlingshire, and in the trap-rocks of the Hebrides, &c.

9. Hemiprismatic Zeolite.

Hemiprismatischer Kuphon-spath, *Mohs.*—Blätter Zeolith, *Werner.*—Foliated Zeolite, *Jameson*, 3d edit.—Stilbite, *Haüy.*

Specific Character.—Hemiprismatic. Pyramid unknown. $\frac{\bar{P}}{2}$. Cleavage, $\breve{P}r + \infty$ very perfect. Hardness = 3.5,—4.0. Sp. gr. = 2.0,—2.2.

External Characters.—Colours white, red, yellowish-grey, and pinchbeck-brown. Occurs massive, disseminated, globular, in amygdaloidal-shaped pieces; also in distinct concretions, which are angulo-granular; seldom thin and curved lamellar, which are again collected into granular. Frequently crystallized; and the following secondary forms occur: 1. Low, oblique, sometimes rather broad, four-sided prism. 2. Low six-sided prism. 3. Eight-sided prism.

Lateral planes of the prisms are transversely streaked, the terminal planes smooth. Planes sometimes shining, sometimes splendent, and the lustre vitreous. Internally alternates from shining to splendent, and the lustre pearly: the pinchbeck-brown has a pearly metallic lustre. Fracture conchoidal. Massive varieties are strongly translucent: some varieties, particularly the pinchbeck-brown, are only translucent on the edges; but the crystals are generally semi-transparent and transparent. Refracts single. Brittle, and easily frangible.

Chemical Characters.—Intumesces and melts before the blowpipe, and during its intumescence emits a phosphoric light. Does not form a jelly with acids.

Constituent Parts.—

Silica,	52.6	
Alumina,	17.5	
Lime,	9.0	
Water,	18.5	
	97.0	*Vauquelin.*

Geognostic and Geographic Situations.—Occurs principally in secondary trap-rocks in the Hebrides, and other parts of Scotland.

10. Pyramidal Zeolite or Apophyllite.

Pyramidaler Kuphon-spath, *Mohs.*—Ichthyophthalm, & Albin, *Werner.*—Apophyllite, & Mesotype épointée, *Haüy.*—Axifrangible Zeolite, *Jameson,* 3d edit.

Specific Character.—Pyramidal. Pyramid unknown. Cleavage, $P - \infty$. very perfect. $[P + \infty]$ imperfect. Hardness $= 4.5, - 5.0$. Sp. gr. $= 2.0, - 2.5$.

External Characters.—Principal colour white. Surface of the cleavage strongly iridescent. Occurs massive, and disseminated; massive varieties composed of straight and curved lamellar distinct concretions, with feebly streaked splendent pearly surfaces. The following are the secondary forms: 1. Rectangular four-sided prism, sometimes so low as to appear tabular, and resemble a cube. 2. The preceding figure truncated on all the angles: when the truncating planes become so large that they touch each other, the prism appears acuminated with four planes, which are set on the lateral edges, and the apex of the acumination truncated. 3. Rectangular four-sided prism, in which all the lateral edges are truncated, thus forming an eight-sided prism; sometimes the eight solid angles of this figure are truncated. 4. Rectangular four-sided prism bevelled on all the edges, or only on some of them: sometimes one of the bevelling planes is awanting, when the edge appears to be only obliquely truncated. 5. Rectangular four-sided prism, in which the angles are truncated, and the edges bevelled. 6. Rectangular four-sided table, in which the two opposite broader terminal planes are doubly bevelled, and the two smaller planes very flatly acuminated with four planes, of which two are set on the lateral planes, the other two on the terminal planes, and the terminal edges bevelled.

Surface of the crystals Nos. 1, 2. and 4. smooth; surface of Nos. 3. and 5. and the acuminating planes of No. 6. longitudinally furrowed; bevelling planes of No. 4, 5. and 6. transversely streaked. All the other planes of the secondary crystals are smooth. The middle point of the end of the crystals is often concave. Lateral planes occasionally bulging, and the terminal planes rose-like. Externally splendent; but only the terminal planes of the prism pearly. Fracture small and perfect conchoidal, and lustre glistening and vitreous. Semi-transparent, passing into transparent, and into translucent. Refracts single. Brittle, and easily frangible.

Chemical Characters.—Exfoliates very readily before the blowpipe, (it even exfoliates when held in the flame of a candle,) and melts easily into a white-coloured enamel.

Physical Character.—Becomes feebly electric by rubbing.

Constituent Parts.—

	Apophyllite of Utön.
Silica, - -	52.00
Lime, - -	24.50
Potash, - - -	8.10
Water, - - -	15.00
	99.60 *Rose.*

Geognostic and Geographic Situations.—Occurs in the secondary trap-rocks of the island of Skye: in rocks of the same description in the Faroe islands; in the island of Disco in West Greenland, and on the mainland of Greenland. One of the earliest known localities of this mineral is the island of Utön, not far from Stockholm, where it occurs in beds of magnetic iron-ore, along with common felspar, calcareous-spar, and hornblende.

Genus VI. Petalite.

Petalit, *Arfvedson.*—Petalin-Spath, *Mohs.*

Prismatic. Hardness $= 6.0,—6.5$. Sp. gr. $= 2.4,—2.5$.

1. Prismatic Petalite.

Prismatischer, Petalin-Spath,—*Mohs.*

Specific Character. — Prismatic. Pyramid unknown. Cleavage, $P + \infty = 137° \, 8'$. $P \breve{r} + \infty$.

External Characters.—Colours white, and red. Occurs masssive. Internally glistening, shining, and nearly pearly. Translucent. Brittle, and rather easily frangible.

Constituent Parts.—

Silica,	79.212	Silica, -	80.00
Alumina,	1.722	Alumina,	15.00
Lithia,	3.761	Lithia, -	1.75
		Manganese,	2.50
	Arfvedson.	Water, -	0.25
			Clarke & Holme.

Geognostic and Geographic Situations.—Hitherto it has been found only in primitive mountains at Utön, Sahla, and Fingrufan, in Sweden.

Genus VII. Felspar.

Rhomboidal, pyramidal, prismatic. Axotomous, but not very perfect. Hardness = 5.0,—6.0. Sp. gr. = 2.5—2.8. If 2.7 and more, the cleavage is in the direction of a rectangular prism.

1. Rhomboidal Felspar, or Nepheline.

Rhomboedrischer Feldspath, *Mohs*.—Nepheline, *Haüy* and *Werner*.

Specific Character.—Dirhomboidal. 2 R = 152° 44′; 56° 15′. Cleavage, R — ∞. R + ∞. Hardness = 6.0. Sp. gr. = 2.5,—2.6.

External Characters.—Colours white and grey. Occurs massive and crystallized. The secondary forms are the following: 1. Perfect equiangular six-sided prism. 2. The preceding figure, truncated on the terminal edges. 3. Thick six-sided table, in which the lateral edges are truncated. Externally crystals splendent: internally shining, and lustre vitreous. Fracture conchoidal. Strongly translucent, passing into transparent.

Chemical Characters.—Melts with difficulty before the blowpipe into a dark glass.

Constituent Parts.—

Silica,	46
Alumina	49
Lime,	2
Oxide of Iron,	1
	98 *Vauquelin.*

Geognostic and Geographic Situations.—Occurs in drusy cavities in granular limestone, along with ceylanite, vesuvian, and meionite, at Monte Somma, near Naples; also in fissures of basalt at Capo di Bove, near Rome. It is mentioned also as a production of the Isle of Bourbon.

2. Prismatic Felspar.

Prismatischer Feldspath, *Mohs.*

Hemiprismatic. Pyramid $= 134° \ 26'$; $126° \ 52'$; $72° \ 32'$. $\frac{P}{2} = 126° \ 52'$. $P + \infty = 81° \ 47'$. Cleavage, $\frac{P\breve{r}}{2}$. $\bar{P}r + \infty$. Both perfect. Less distinct $(P\breve{r} + \infty)^3 = 120'$. Sometimes only one of the faces. Hardness $= 6.0$. Sp. gr. $= 2.5, -2.8$.

This species is divided into ten subspecies, viz. 1. Adularia, 2. Glassy-Felspar, 3. Ice-spar, 4. Common Felspar, 5. Labrador Felspar, 6. Compact Felspar, 7. Slaty Felspar, or Clinkstone, 8. Earthy Common Felspar, 9. Porcelain Earth; and, 10. Claystone.

FIRST SUBSPECIES.

Adularia.

Adular, *Werner.*

External Characters.—Principal colour greenish-white, which sometimes passes into greyish-white and milk-white, and even inclines to asparagus-green. It is frequently iridescent; and the milk-white varieties, in thin plates, when held between the eye and the light, sometimes appear pale flesh-red. Occurs massive, and this variety is composed of granular and thick lamellar concretions; and frequently crystallized. The following are the most common secondary figures: 1. Oblique four-sided prism, flatly bevelled on the extremities, and the bevelling planes set on the obtuse lateral edges. 2. Broad six-sided prism, flatly bevelled on both extremities, and the bevelling planes set on those lateral edges which are formed by the smaller lateral planes. 3. Rectangular four-sided prism, in which the terminal planes are obliquely bevelled.

Lateral planes of the prism longitudinally streaked. Externally splendent, internally cleavage splendent, and the fracture shining and glistening. Lustre intermediate between vitreous and pearly. Fracture more or less perfect conchoidal. Fragments indeterminate angular, and sharp-edged.

Semi-transparent, sometimes inclining to transparent, or is translucent. Translucent varieties, when viewed in a certain direction, sometimes exhibit a silvery or pearly light. Refracts double. Brittle, and easily frangible.

Chemical Characters.—Melts before the blowpipe, without addition, into a white-coloured transparent glass.

Constituent Parts.—Silica,	64	
Alumina,	20	
Lime,	2	
Potash,	14	
	100	*Vauquelin.*

Geognostic Situation.—Occurs in cotemporaneous veins and in drusy cavities in granite and gneiss.

Geographic Situation.—Occurs in the granite of the island of Arran; and in the granite and gneiss rocks of Norway, Switzerland, France, and Germany.

Uses.—The variety of Adularia which exhibits the bluish pearly light, is valued by jewellers, and is sold by them under the name *Moonstone.* Another variety of adularia, found in Siberia, is known to jewellers under the name *Sunstone.* It is of a yellowish-grey colour, and numberless golden spots appear distributed throughout its whole substance.

SECOND SUBSPECIES.

Glassy Felspar.

Glasiger Feldspath, *Werner.*

External Characters.—Colour greyish-white, sometimes passing into grey. Occurs always crystallized, in broad rectangular four-sided prisms, bevelled on the extremities. These crystals are often very much cracked, and always imbedded. Internally splendent, and lustre vitreous. Fracture uneven, or small and imperfect conchoidal. Transparent.

Constituent Parts.—Silica,	68.0	
Alumina,	15.0	
Potash	14.5	
Oxide of Iron,	0 5	
	98.0	*Klaproth.*

Geognostic and Geographic Situations.—Occurs imbedded in pitchstone and other porphyries in Arran and Rume; in a porphyritic rock in the Siebengebirge; also in a rock composed of white felspar, and very small blackish-brown scales of mica, and fine disseminated magnetic iron-ore, in the Drachenfels on the Rhine. appear to have [illegible]

THIRD SUBSPECIES.

Ice-Spar.

Eisspath, *Werner.*

External Characters.—Colour white. Occurs massive, cellular, and porous; also in large granular concretions, which are composed of thin and straight lamellar concretions. Frequently crystallized in the form of small thin longish six-sided tables, in which the shorter terminal planes are bevelled. Externally crystals shining, and sometimes splendent; internally shining, and lustre vitreous. Massive and other varieties strongly translucent; crystals transparent.

Geognostic and Geographic Situations — Occurs along with nepheline, meionite, mica, and hornblende, at Monte Somma, near Naples.

FOURTH SUBSPECIES.

Common Felspar.

Frischer Gemeiner Feldspath, *Werner.*

External Characters.—Most frequent colours white and red, seldom grey, and rarely green and blue. Occurs most frequently massive and disseminated, seldom in blunt angular rolled pieces and grains, and frequently in granular distinct concretions, from the smallest to the largest size; and sometimes crystallized, in the same forms nearly as adularia. Internally cleavage shining, and sometimes splendent; but the fracture only glistening, or feebly glistening. Lustre intermediate between vitreous and pearly, but inclining rather more to the former than to the latter. Fracture uneven or splintery. Fragments rhomboidal, and have only four splendent shining faces. Translucent, or only translucent on the edges. Brittle, and easily frangible.

Chemical Characters.—Before the blowpipe, it is fusible without addition into a grey semi-transparent glass.

		Felspar from Passau.
Constituent Parts.—	Silica,	60.25
	Alumina,	22.00
	Lime,	0.75
	Potash,	14.00
	Oxide of Iron a trace,	
	Water,	1.00
		100 *Buchols.*

Geognostic Situation.—Felspar occurs in most of the primitive rocks; in many of the species of the transition class, and also associated with secondary and volcanic rocks.

Uses.—It is one of the ingredients in the finer kinds of earthen-ware, and is said to be the substance used by the Chinese under the name *Petunse* or *Petunze*, in the manufacture of their porcelain. The green varieties of felspar, which are rare, are considered as ornamental stones, and are cut and polished, and made into snuff-boxes and other similar articles. When the green varieties are spotted with white, they are named *Aventurine Felspar*, and are prized by collectors.

FIFTH SUBSPECIES.

Labrador Felspar. contains Soda not like the

Labradorstein, *Werner.* other Felspars, Colour

External Characters.—Most frequent colours light and dark ash-grey, and smoke-grey, seldom yellowish-grey. When light falls on it in determinate directions, it exhibits a great variety of colours; of these the most frequent are blue and green, more seldom yellow and red, and the rarest variety is pearl grey. Occurs massive, or in rolled pieces; also in large, coarse, seldom in small granular, very seldom in thick and straight lamellar concretions. Cleavage splendent, fracture glistening, and the lustre intermediate between vitreous and pearly. Translucent, but in a low degree.

Chemical Characters.—According to Mr Kirwan, it is more infusible than common felspar.

Geognostic and Geographic Situations.—Occurs in rolled masses of syenite, in which it is associated with common hornblende, hyperstene, and magnetic iron-ore, in the Island of St Paul, on the coast of Labrador, where it was first discovered, upwards of thirty years ago, by the Moravian Missionaries settled in that remote and dreary region. Since that time it has been found in Scotland, Norway, and other countries.

Uses.—On account of its beautiful colours, it is valued as an ornamental stone, and is cut into ring-stones, snuff-boxes, and other similar articles. It receives a good polish; but the streaks caused by the edges of the folia of the cleavage are frequently so prominent as to injure its appearance.

SIXTH SUBSPECIES.

Compact Felspar.

Dichter Feldspath, *Werner.*

External Characters.—Colours white, grey, green, and red. Occurs massive, disseminated, in blunt angular rolled pieces, and in small angulo-granular concretions; also crystallized in rectangular four-sided prisms. Crystals always imbedded. Internally sometimes glistening, sometimes glimmering. Fracture even and splintery. Feebly translucent, sometimes only translucent on the edges.

Chemical Characters.—Before the blowpipe it melts with difficulty into a whitish enamel.

Constituent Parts.—

Silica,	51.00
Alumina,	30.50
Lime,	11.25
Iron,	1.75
Natron,	4.00
Water,	1.26
	99.75 *Klaproth.*

Geognostic Situation.—This mineral occurs in mountain-masses, beds and veins, either pure, or intermixed with other minerals, in primitive, transition, and secondary rocks. Salisbury Crags

Geographic Situation.—The Pentland Hills, near Edinburgh, contain beds of compact felspar, associated with clay-stone, red sandstone, and conglomerate. It occurs in a similar situation on the hill of Tinto, and in the Ochil Hills; and associated with rocks of the same nature in the Island of Papa Stour, one of the Shetland group.

SEVENTH SUBSPECIES.

Slaty Felspar, or Clinkstone.

Klingstein, *Werner.*—Phonolith, *Daubuisson.*

External Characters.—Colours grey, green, and brown. Occurs massive; also in granular, columnar, globular, and tabular distinct concretions. Lustre of the principal fracture glistening and pearly; that of the cross fracture faintly glimmering, almost dull. Principal fracture slaty, generally thick, and often curved slaty, with a scaly foliated aspect; the cross fracture splintery, passing into even, and flat conchoidal. Strongly translucent on the edges, sometimes even translucent. In thin plates, it emits when struck, a ringing sound.

Chemical Characters.—It melts before the blowpipe into a grey coloured glass, but is more difficultly fusible than basalt.

Constituent Parts.—

Silica,	57.25
Alumina,	23.50
Lime,	2.75
Natron,	8.10
Oxide of Iron,	3.25
Oxide of Manganese,	0.25
Water,	3.00
	98.10 *Klaproth.*

Geognostic Situation.—This subspecies of felspar frequently contains imbedded crystals, when it forms the rock named Clinkstone Porphyry. It is generally associated with secondary trap and porphyry rocks.

Geographic Situation.—The Bass rock at the mouth of the Frith of Forth, North Berwick Law, Traprain Law, and the Girleton Hills, all in East Lothian, and many other hills in Scotland, contain beds and veins of this mineral.

EIGHTH SUBSPECIES.

Earthy Common Felspar.

Aufgelöster Gemeiner Feldspath, *Werner.*

External Characters.—Colours white and grey. Generally occurs massive, and disseminated, and sometimes in imbedded crystals, which agree in form with those of common felspar. Internally sometimes glistening, sometimes glimmering, or even dull. Has sometimes an imperfect cleavage. Fracture coarse and small grained uneven, which approaches to earthy. Breaks into blunt angular pieces. Either translucent on the edges, or opaque. In general, it is so soft as to yield to the nail: sometimes, however, it approaches in hardness to common felspar. Sectile, and easily frangible.

The chemical characters and composition of this substance have not been ascertained.

Geognostic and Geographic Situations.—Occurs in granite and gneiss districts, as in Cairngorm and Arran in Scotland, and Cornwall in England. It is well known in Saxony, and other countries.

NINTH SUBSPECIES.

Porcelain-Earth, or Kaolin.

Porcellanerde, *Werner.*

External Characters.—Most frequent colour reddish-white, of various degrees of intensity; also snow-white and yellowish-white. Generally friable, and sometimes approaches to compact. Composed of dull dusty particles, which are feebly cohering. Soils strongly. Feels fine and soft, but meagre. Adheres slightly to the tongue. Sp. gr. 2216, *Karsten.*

Chemical Characters.—Infusible before the blowpipe.

Constituent Parts.—	Silica,	55.0
	Alumina,	42.5
	Iron,	1.0
	Lime,	1.0
		99.5 *Gehlen.*

Geognostic Situation.—Generally occurs in granite and gneiss countries, either in beds contained in the granite or gneiss, when it appears to be an original deposite, or on the sides and bottom of granite and gneiss hills, where it is certainly formed by the decomposition of the felspar of these rocks.

Geographic Situation.—Occurs in different granite and gneiss districts in Scotland, and in the Shetland Isles; also in England and Ireland, and in many places on the Continent of Europe.

Uses.—This mineral forms a principal ingredient in the different kinds of porcelain. It is not used in the state in which it is found in the earth, but is previously repeatedly washed, in order to free it from impurities. After the process of washing, only fifteen parts of pure white clay remain, which is the *kaolin* of the Chinese. Porcelain has been manufactured in China and Japan from a very early period. The art itself was discovered in Europe by a German named Bötticher, who made his first porcelain-vessels in Dresden in the year 1706. These were of a brown and red colour. The white was not attempted until the year 1709; and the famous manufactory at Meissen, the earliest in Europe, was established in 1710. For the proofs of making [illegible]

TENTH SUBSPECIES.

Claystone.

Thonstein, *Werner*.

External Characters.—Colours grey, white, blue, and red. Sometimes veined, spotted, and striped. Occurs massive. Internally dull, when it does not contain accidentally mixed glimmering particles. Fracture fine earthy, but sometimes passes to fine-grained uneven, and even inclines to slaty and conchoidal. Opaque. Semi-hard, sometimes soft, and even very soft. Sp. gr. 2.210, *Karsten.*

Geognostic Situation.—Occurs in beds, along with porphyry; also forming the basis of clay-porphyry, in beds, along with black-coal, and as a constituent of some kinds of tuff.

Geographic Situation.—Occurs along with secondary porphyry in the Pentland Hills; in a similar situation in the Island of Arran; on the Mountain of Tinto; in the Ochil Hills; and in many other places in Scotland.

Uses.—When of sufficient hardness, it is used as a building-stone; also for lintels and door-posts, and can be formed into water-troughs. It forms an indifferent paving-stone.

Pyramidal Felspar.

Pyramidaler Feldspath, *Mohs.*—Meionit, Scapolith, Schmelzstein, *Werner.*—Paranthine, Meionite, Wernerite, Dipyre, *Haüy.*—Pyramidal Felspar or Scapolite. Prismato-pyramidal Felspar or Meionite, *Jameson,* 3d edit.

Specific Character.—Pyramidal. Pyramid $= 136° \ 7'$; $63° \ 48'$. Cleavage, $P - \infty$. More perfect $P + \infty$. $[P + \infty]$. Hardness $= 5.0, -5.5$. Sp. gr. $= 2.5, -2.8$.

This species is divided into two subspecies, viz. Meionite and Scapolite.

FIRST SUBSPECIES.

Meionite.

Meionit, *Werner.*

External Characters.—Colour greyish-white. Occurs sometimes massive, but more frequently crystallized. The following are the secondary figures: 1. Rectangular four-sided prism, flatly acuminated with four planes, which are set on the lateral edges. 2. The preceding figure truncated on the lateral edges. 3. No. 1. bevelled on the lateral edges, and the edges of the bevelment truncated; and the edges between the acuminating planes and the lateral planes also truncated.

Externally crystals smooth and splendent, internally splendent and vitreous. Generally transparent or semi-transparent, seldom translucent. Brittle, and easily frangible.

Chemical Characters.—Fusible without addition before the blowpipe.

Constituent Parts.—

Silica, -	58.75	Silica, -	40.8
Alumina -	19.25	Alumina, -	30.6
Potash, -	21.80	Soda, with Lithia, -	2.4
Lime, -	1.36	Carbonated,	3.1
Oxide of Iron,	0.40	Oxide of Iron,	1.0
	Arfvedson.		100.0
			Gmelin.

Geognostic and Geographic Situations.—Occurs along with ceylanite and nepheline, in granular limestone, at Monte Sommo, near Naples. It is said also to occur in basalt, along with augite and leucite, at Capo di Bove, near Rome.

SECOND SUBSPECIES.

Scapolite.

Scapolit, *Werner.*—Paranthin, *Haüy.*

This subspecies is divided into three kinds, viz. Radiated, Foliated, and Compact.

First Kind.

Radiated Scapolite.

External Characters.—Most frequent colours grey, seldomer white and green. Occurs massive, and in distinct concretions; concretions radiated or fibrous, and scopiform diverging, and collected into others which are thick and wedge-shaped. Frequently crystallized. The secondary forms are the following: 1. Rectangular four-sided prism, flatly acuminated on the extremities with four planes, which are set on the lateral planes. 2. The preceding figure, in which the lateral edges are truncated.

Lateral planes of the crystals deeply longitudinally streaked, and shining. Internally intermediate between shining and glistening, and lustre intermediate between resinous and pearly. Fracture fine-grained uneven. Translucent, and semitransparent in crystals. Brittle, and rather easily frangible.

Chemical Characters.—Green scapolite, before the blowpipe, becomes white, and melts into a white glass.

Constituent Parts.—

Silica,	45.0
Alumina,	33.0
Lime	17.6
Natron,	1.5
Potash,	0.5
Iron and Manganese,	1.0
	98.6 *Laugier.*

Geognostic and Geographic Situations.—This mineral occurs in the neighbourhood of Arendal in Norway, where it is associated with magnetic iron-ore, felspar, quartz, mica, garnet, augite, hornblende, actynolite and calcareous-spar.

Second Kind.

Foliated Scapolite.

External Characters.—Principal colours grey, green, and black. Occurs massive, disseminated, and in large, coarse, and long angulo-granular concretions; also crystallized in low eight-sided prisms, flatly acuminated with four planes, which are set on the alternate lateral planes. Externally crystals shining or splendent, and vitreous. Cleavage shining, but the fracture only glistening; lustre intermediate between resinous and pearly. Generally translucent, and passes sometimes into transparent, sometimes to translucent on the edges. Yields a white streak. Brittle, and easily frangible.

Geognostic and Geographic Situations.—Occurs in Norway in primitive rocks.

Third Kind.

Compact Scapolite.

External Characters.—Colour dark brick-red, passing into pale blood-red. Seldem occurs massive, more frequently crystallized, in long, frequently acicular, four-sided prisms, which are often curved, and are without terminal crystallizations. Externally crystals rough and dull. Internally very feebly glistening, almost glimmering. Fracture fine-grained uneven, approaching to splintery. Opaque, or very faintly translucent on the edges. Easily frangible.

Geognostic and Geographic Situations.—Occurs along with the other subspecies, in metalliferous beds at Arendal in Norway.

GENUS VIII. AUGITE.

Prismatic. Lustre not metallic-pearly. Hardness $= 4.5, —7.0$. If above 6.0, the Sp. gr. $= 3.2$, and more. Sp. gr. $= 2.7, —3.5$. If under 3.2, the cleavage is perfect, and in the direction of oblique angular prisms.

1. Pyramido-Prismatic Augite.

Pyramido-Prismaticher Augit-Spath, *Mohs.* — Oblique-edged Augite, *Jameson*, 3d edit. II. 99.

Specific Character.—Hemiprismatic. Pyramid $= 152° 12'$; $120°$; $61° 2'$; $\frac{P}{2} = 120°$. $P + \infty = 51° 19'$. Cleavage, $(\breve{P}r + \infty)^3 = 87° 42'$. $\breve{P}r + \infty$. $\bar{P}r + \infty$. Sometimes $\frac{P}{2}$. Hardness $5.0, —6.0$. Sp. gr. $= 3.2, —3.5$.

This species contains ten subspecies, viz. Foliated A., Granular A., Conchoidal A., Common A., Coccolite, Baikalite, Omphacite, Fassaite, Diopside, and Sahlite.

FIRST SUBSPECIES.

Foliated Augite.

Blättriger Augit, *Werner*.

External Characters.—Colours black and green. Crystallized in six-sided prisms, bevelled on the extremities and also in twin-crystals. Internally shining, inclining to splendent, and lustre resino-vitreous. Distinct cleavage. Fracture conchoidal. Opaque, or translucent on the edges. Rather easily frangible.

Chemical Characters.—Fusible with difficulty into a black enamel.

Constituent Parts.—

	From Ætna.
Silica,	52.00
Alumina,	3.33
Magnesia,	10.00
Lime,	13.20
Oxide of Iron,	14.66
Oxide of Manganese,	2.00
	95.19 *Vauquelin.*

Geognostic Situation.—Occurs only in secondary trap-rocks, and in lava.

Geographic Situation.—Found in basalt in different districts in Scotland, and abundantly on the Continent.

SECOND SUBSPECIES.

Granular Augite.

Körniger Augit, *Werner.*

External Characters.—Colour greenish-black. Occurs massive, in coarse and small angulo-granular concretions. Also crystallized in broad six-sided prisms, bevelled, or acuminated on the extremities with four planes. Surface rough and glistening. Internally glistening and resinous. Cleavage imperfect. Fracture uneven. Opaque.

Geognostic and Geographic Situations.—This subspecies of augite has been hitherto found principally in primitive rocks at Arendal in Norway, in several of the iron-mines, particularly that named Ulve-Grube.

THIRD SUBSPECIES.

Conchoidal Augite.

Muschlicher Augit, *Werner.*

External Characters.—Colours black, green, and sometimes even liver-brown. Occurs in imbedded grains. Lustre splendent, and resino-vitreous. Fracture imperfect, and flat conchoidal. Translucent on the edges, or translucent. Agrees in its other characters with the foregoing subspecies.

Geognostic and Geographic Situations.—Occurs only in secondary trap-rocks, and is the rarest of the subspecies of this species. The finest specimens, from two to three inches in diameter, are found in the vesicular basalt of Fulda.

FOURTH SUBSPECIES.

Common Augite.

Gemeiner Augit, *Werner.*

External Characters.—Colours blackish-green and velvet-black. Occurs in large and small imbedded grains. Internally lustre intermediate between shining and glistening, and resinous. Fracture coarse, and small-grained uneven. Sometimes inclining to imperfect conchoidal. Translucent on the edges, seldom translucent. Its other characters agrees with the foliated subspecies.

Geognostic and Geographic Situations.—Occurs principally in secondary trap-rocks, as basalt and greenstone, and also in lavas. The secondary trap-rocks of France, Germany, and Britain, and the lavas of Vesuvius and Iceland, in many cases abound with this mineral.

FIFTH SUBSPECIES.

Coccolite. from Coccus a grain

Kokkolith, *Werner.*

External Characters.—Principal colour leek-green; and rarely greenish-white and greenish-grey. Occurs massive, also in granular concretions, which are often very loosely aggregated. Internally shining, sometimes approaching to glistening, and lustre vitreous, inclining to resinous. Cleavage rather distinct. Fracture uneven. Translucent, or translucent on the edges.

Geognostic Situation.—Occurs in limestone, also in mineral beds subordinate to the primitive trap formation, where it is associated with granular limestone, garnet, and magnetic ironore.

Geographic Situation.—Occurs in limestone in the Island of Tiree; at Arendal in Norway; in the iron mines at Hellsta and Assebro in Sudermannland; and in many places in Nericke, in Sweden.

SIXTH SUBSPECIES.

Baikalite.

Baikalit, *Werner.*

External Characters.—Colour blackish-green, leek-green, and sometimes velvet-black. Occurs massive, in granular concretions, and crystallized in low rather oblique four-sided prisms, truncated on the lateral edges. Lateral edges longitudinally streaked. Externally shining and splendent; internally shining and splendent, and resinous. Fracture conchoidal. Varies from translucent to transparent.

Geognostic and Geographic Situations.—Occurs in primitive limestone in Rannoch; and in granite, along with calcareous-spar and mica, on the shores of Lake Baikal; and in a similar situation in Scandinavia.

SEVENTH SUBSPECIES.

Omphacite.

Omphacit, *Werner.*

External Characters.—Colour leek-green, inclining to grass-green. Occurs massive, disseminated, and in granular and radiated concretions. Internally glistening or glimmering, and lustre resinous. Fracture uneven. Translucent.

Geognostic and Geographic Situations.—Occurs along with precious garnet, kyanite, mica, and actynolite, near Hoff in Baireuth, and in the Saualp in the Tyrol.

EIGHTH SUBSPECIES.

Fassaite.

Fassait, *Werner.*

External Characters.—Colour blackish and leek green, and also olive and asparagus green. Occurs massive, in granular concretions, and crystallized in four-sided prisms, acutely acuminated with four planes, which are set on the lateral planes. Internally glistening and vitreo-resinous. Fracture uneven. Translucent on the edges.

Geognostic and Geographic Situations.—Occurs in primitive greenstone, along with calcareous-spar, and vesuvian, in the Valley of Fassa in the Tyrol.

NINTH SUBSPECIES.

Diopside.

Diopsid, *Werner.*

External Characters.—Colours greenish-white, greenish-grey, and pale mountain-green. Occurs massive, disseminated, in lamellar concretions, which sometimes approach to prismatic; and crystallized in low, oblique four-sided prisms, and also in six and eight-sided prisms. Externally shining, glistening, and pearly; internally shining and vitreous. Cleavage distinct. Fracture uneven, sometimes inclining to imperfect and small conchoidal. Translucent.

Geognostic and Geographic Situations.—Is found in the hill of Ciarmetta in Piedmont; also in the Black Rock at Mussa, near the town of Ala, in veins, along with epidote or pistacite, and hyacinth-red garnets; and in the same district, in a vein traversing serpentine, along with prehnite, calcareous-spar, and iron-glance or specular iron-ore.

TENTH SUBSPECIES.

Sahlite.

Sahlit, *Werner.*

External Characters.—Colours greenish-white and greenish-grey, mountain, leek, and blackish green; and rarely pale blue. Occurs massive, and in straight lamellar and coarse granular concretions; also crystallized in four-sided prisms. Internally the lustre of the principal fracture is shining, splendent and vitreous; that of the cross fracture is dull. Distinct cleavage. Fracture uneven. Translucent on the edges. Rather brittle, and rather easily frangible.

Geognostic and Geographic Situations.—Occurs in the island of Unst in Shetland: in granular limestone in the island of Tiree, one of the Hebrides: in limestone in Glen Tilt, Glen Elg, Rannoch, and Island of Harris; also in the silver mines of Sala, in Westmannland in Sweden, associated with asbestous actynolite, calcareous-spar, iron-pyrites, and galena.

Observation.—Some of the varieties of asbestus and actynolite of authors belong to augite, particularly those varieties met with in secondary trap-rocks.

2. Hemiprismatic Augite.

Hemiprismatischer Augit-Spath, *Mohs.*—Hornblende, *Werner.*—Amphibole, *Haüy.*—Straight-edged Augite, *Jameson,* 3d edit. III. 117.

Specific Character.—Hemi-prismatic. Pyramid $= 151° 8'$; $148° 39'$; $42° 22'$; $\frac{P}{2} = 148° 39'$. $P + \infty = 87° 11'$. Cleavage $(\breve{P}r + \infty)^3 = 124° 34'$. Less distinct $\bar{P}r + \infty$. $\breve{P}r + \infty$. Hardness $= 5.0, — 6.0$. Sp. gr. $= 2.7, — 3.2$.

This species contains six subspecies, viz. Carinthine, Calamite, Hornblende, Actynolite, Tremolite, and Asbestus.

FIRST SUBSPECIES.

Carinthine.

Karinthin, *Werner.*

External Characters.—Colours greenish and velvet-black. Occurs massive and disseminated; and the massive varieties in coarse granular concretions. Internally splendent, and lustre resino-vitreous. Distinct cleavage of 124° 34′. Fracture conchoidal. Greenish-black varieties are strongly translucent on the edges, but the velvet-black opaque.

Geognostic and Geographic Situations.—Occurs in the Saualpe in Carinthia, in a bed in primitive rock, associated with quartz, kyanite, garnet, and zoisite.

SECOND SUBSPECIES.

Calamite.

Kalamit, *Werner.*

External Characters.—Colour asparagus-green; crystallized in long reed-like crystals, truncated on the acute lateral edges. Longitudinally streaked. Externally shining; internally splendent and vitreo-resinous. Fracture uneven. Transparent.

Geognostic and Geographic Situations.—Occurs in primitive serpentine along with common magnetic iron-ore and calcareous-spar, near Normark in Sweden.

THIRD SUBSPECIES.

Hornblende.

Hornblende, *Werner.*

This species is divided into three kinds, viz. Common, Hornblende-slate, and Basaltic.

First Kind.

Common Hornblende.

Gemeiner Hornblende, *Werner.*

External Characters.—Colours black and green. Occurs massive, disseminated, and in granular concretions. Rarely crystalltzed in oblique four-sided prisms, sometimes bevelled on the extremity, and also in six-sided prisms, sometimes flatly acuminated with three planes, which are set on the alternate lateral edges. Internally lustre shining and pearly. Distinct cleavage. Fracture coarse and small-grained uneven. Black coloured varieties opaque, but the green generally translucent on the edges. Yields a mountain-green, inclining to a greenish-grey coloured streak. When breathed on or moistened, even when brought from a colder to a warmer place, it yields what is called a bitter smell. Rather brittle, and rather difficultly frangible.

Chemical Characters.—Melts before the blowpipe, with violent ebullition, into greyish-black coloured glass.

Constituent Parts.—

	Common Hornblende from Nora in Westmannland.
Silica,	42.00
Alumina,	12.00
Magnesia,	2.25
Lime,	11.00
Oxide of Iron,	30.00
Ferruginous Manganese,	0.25
Water,	0.75
Trace of Potash.	
	98.25 *Klaproth.*

Geognostic Situation.—Occurs in great abundance in primitive rocks, and also in some rocks of the secondary class.

Geographic Situation.—Occurs very abundantly in Scotland, in greenstone and syenite: and imbedded in limestone, gneiss, and mica-slate. Is found in similar rocks in England; and plentifully in the primitive rocks of Ireland.

Second Kind.

Hornblende-Slate.

Hornblende Schiefer, *Werner.*

External Characters.—Colour green. Occurs massive, and in delicate promiscuous prismatic concretions. Internally glistening, passing into shining, and pearly. Fracture straight slaty. Opaque. Yields a greenish-grey coloured streak.

Geognostic Situation.—Occurs in beds, in granite, gneiss, mica-slate, quartz-rock, sometimes also in clay-slate, and frequently along with beds of primitive limestone.

Geographic Situation.—In Scotland, occurs in gneiss, in the districts of Braemar and Aberdeen, in Aberdeenshire;

in Banffshire, as near Portsoy; in Argyleshire, as in the islands of Coll, Tiree, &c.; in Inverness-shire, as in the islands Rona, Lewis, &c.; and in many other parts in Scotland; and also in England and Ireland.

Third Kind.

Basaltic Hornblende.

Basaltische Hornblende, *Werner.*

External Characters.—Colours velvet or brownish black. Occurs crystallized, in six-sided prisms, sometimes acuminated on both extremities with three planes set on the lateral edges; or acuminated on one end with three planes, and on the other bevelled; and sometimes the one extremity acuminated with four planes, and the opposite bevelled. Lustre of the cleavage splendent, and vitreous, approaching to pearly; that of the cross-fracture glistening. Distinct cleavage. Fracture small-grained uneven, approaching to conchoidal. Opaque. Rather harder than common hornblende. Rather brittle. Affords a dark greyish white streak.

Geognostic and Geographic Situation.—Occurs imbedded in trap-rocks in Scotland, and other countries.

FOURTH SUBSPECIES.

Actynolite.

Strahlstein, *Werner.*—Actinote, *Haüy.*

This subspecies is divided into three kinds, viz. Asbestous, Common, and Glassy.

First Kind.

Asbestous Actynolite.

Asbestartiger Strahlstein, *Werner.*

External Characters.—Colours grey, green, and brown. Occurs massive, in distinct concretions, which are fibrous, and sometimes collected into others, which are wedge-shaped and granular. Rarely crystallized, in delicate capillary, rigid, moss-like, superimposed crystals. Internally the lustre is glistening and pearly. It is opaque, or slightly translucent on the edges. Fibres or concretions in groups are soft, but individually are equally hard with the other varicties of actynolite.

Geognostic Situation.—Occurs in beds in gneiss, mica-slate, and granular limestone.

Geographic Situation.—In Scotland, also in Norway, Sweden, &c.

Second Kind.

Common Actynolite.

Gemeiner Strahlstein, *Werner.*

External Characters.—Colours leek, olive, grass, and blackish green. Occurs massive and disseminated; also in wedge-shaped prismatic concretions, which are scopiform, stellular, and promiscuous; these sometimes pass into angulo-granular concretions. Frequently the prismatic concretions are collected into large granular concretions. Internally shining, inclining to glistening, and lustre pearly inclining to vitreous. Fracture uneven and conchoidal. Generally translucent on the edges. More brittle than hornblende.

Geognostic Situation.—Occurs in beds in gneiss, mica-slate, and talc-slate.

Geographic Situation.—Occurs at Eilan Reach in Glenelg, in Inverness-shire; near Fortrose in Cromarty; in the parish of Sleat, in the Isle of Skye; different places in the Isle of Lewis, &c.

Third Kind.

Glassy Actynolite.

Glasartiger Strahlstein, *Werner.*

External Characters.—Principal colour mountain-green; less frequently grass, leek, blackish green, and greenish-grey. Occurs massive; also in prismatic distinct concretions, which are fibrous, or radiated, arranged in a scopiform, and rarely in a promiscuous manner; and these are again collected into wedge-shaped prismatic or granular concretions. Internally shining, sometimes splendent, and intermediate between vitreous and pearly. Translucent or semi-transparent. Brittle. Uncommonly easily frangible. Traversed by numerous parallel rents.

Geognostic and Geographic Situations.—Occurs in primitive rocks in the Isle of Skye, and other parts of Scotland.

FIFTH SUBSPECIES.

Tremolite.

Tremolith, *Werner*.—Grammatite, *Haüy*.

This subspecies is divided into three kinds, viz. Asbestous, Common, and Glassy.

First Kind.

Asbestous Tremolite.

Asbestartiger Tremolith, *Werner*.

External Characters.—Most common colour greyish-white; sometimes also yellowish-white, greenish-white, rarely reddish-white, and pale violet-blue. Occurs massive; also in fibrous or very thin prismatic distinct concretions. Internally shining, approaching to glistening, and pearly. Translucent on the edges. Rather easily frangible.

Geognostic Situation.—Occurs most frequently in granular foliated limestone, or in dolomite; sometimes in chlorite; and more rarely in secondary trap-rocks.

Geographic Situation.—Occurs in foliated granular limestone in Glen-Tilt, in Perthshire, and in Glen Elg in Inverness-shire; in dolomite in Aberdeenshire and in Icolmkill; in the Shetland Islands, and in other parts of the mainland and islands of Scotland.

Second Kind.

Common Tremolite.

Gemeiner Tremolith, *Werner*.

External Characters.—Most frequent colour white, seldom grey, pale asparagus-green, and blue. Occurs massive; also in distinct concretions, which are prismatic, and these are collected into longish granular concretions. Sometimes crystallized in oblique four-sided prisms. Lustre shining, and intermediate between vitreous and pearly. Fracture uneven or conchoidal. Translucent or semi-transparent. Rather brittle. Easily frangible. Powder rough to the feel.

Geognostic Situation.—Like the asbestous subspecies, occurs principally in granular limestone, or dolomite, and in metalliferous beds.

Geographic Situation.—Occurs in Glen Tilt, Glen Elg, and in the Shetland Islands; also at Clicker Tor in Cornwall.

Third Kind.

Glassy Tremolite.

Glasartiger Trémolith, *Werner.*

External Characters.—Colour white. Occurs massive; also in distinct concretions, which are straight and scopiform prismatic, with numerous cross rents, and these are again grouped into thick and wedge-shaped concretions. Frequently crystallized in long acicular crystals. Lustre shining, but in a lower degree than the preceding kind, and intermediate between vitreous and pearly. Translucent.

Geognostic Situation.—Is the same as that of the preceding kind, occurring principally along with granular limestone.

Geographic Situation.—In Scotland it occurs along with the other kinds.

SIXTH SUBSPECIES.

Asbestus.

Asbest, *Werner.*

This subspecies is divided into four kinds, viz. Rock-Cork, Flexible Asbestus, Rigid Asbestus, and Rock-Wood.

First Kind.

Rock-Cork. is composed of very [illegible]

Bergcork, *Werner.* crystals of White [illegible]

External Characters.—Colours white, grey, and yellow. Occurs massive, in plates that vary in thickness, corroded, and with impressions; and these forms are composed of delicate and promiscuous fibrous concretions. Internally feebly glimmering or dull. Fracture fine-grained uneven, inclining to slaty in the large. Opaque. Very soft. Becomes shining in the streak. Sectile, almost like common cork. Slightly elastic-flexible. Difficultly frangible. Adheres slightly to the tongue. Emits a grating sound when we handle it. Feels meagre. So light as to swim on water. Sp. gr. 0.679, 0.991, *Brisson.*—0.991, *Haüy.*

Chemical Character.—Melts with great difficulty before the blowpipe into a milk-white nearly translucent glass.

2

Geognostic Situation.—Occurs in cotemporaneous veins in serpentine, and in red sandstone; also in metalliferous veins in primitive and transition rocks; and occasionally in mineral beds.

Geographic Situation.—Occurs in veins in the serpentine of Portsoy, and in the red sandstone of Kincardineshire; in plates, in the lead-veins at Lead-Hills in Lanarkshire and Wanlockhead in Dumfriesshire; and in small quantities at Kildrummie in Aberdeenshire.

Second Kind.

Flexible Asbestus, or Amianthus.

Amiant, *Werner.*

External Characters.—Colours white, grey, blue, and green. Sometimes blood-red, particularly when it occurs in veins in serpentine. Occurs in fibrous distinct concretions. Internally lustre shining and pearly. Translucent on the edges, or opaque. Very soft. Perfectly flexible.

Geognostic Situation.—Occurs frequently along with common asbestus, in cotemporaneous veins in serpentine.

Geographic Situation.—Occurs in serpentine in the islands of Mainland, Unst, and Fetlar in Shetland; and in the same rock at Portsoy, in Lewis, Harris, and other parts of Scotland.

Uses.—This mineral, on account of its flexibility, and its resisting the action of considerable degrees of heat, was woven into those incombustible cloths in which the ancients sometimes wrapped the bodies of persons of distinction, before they were placed on the funeral-pile, that their ashes might be collected free from admixture.

Third Kind.

Rigid or Common Asbestus.

Gemeiner Asbest, *Werner.*

External Characters.—Colours dark leek-green, and mountain-green; also greenish-grey and yellowish-grey. Occurs massive; and in fibrous distinct concretions. Internally glistening and pearly. Fracture not visible. Translucent, or only translucent on the edges. Soft, approaching to very soft. Rigid or inflexible. Rather brittle. Difficultly frangible. Feels rather greasy. Sp. gr. 2.000, *Karsten.*—2.542, *Kirwan.*—2.591, *Breithaupt.*

Geognostic Situation.—Like amianthus, it occurs in veins in serpentine, and in primitive greenstone.

Geographic Situation.—Occurs in the serpentine of Shetland, Long Island, Portsoy, Cortachie, Anglesea, Cornwall.

Fourth Kind.

Rock-Wood, or Ligneous Asbestus.

Bergholz, *Werner.*

External Characters.—Colour wood-brown, of various degrees of intensity. Occurs massive, and in plates; also in delicate and promiscuous fibrous concretions. Internally lustre glimmering. Fracture curved slaty. Becomes shining in the streak. Soft, passing into very soft. Opaque. Sectile. Sp. gr. before immersion, 1.534; after immersion, 2.225, *Breithaupt.*

Chemical Characters.—Infusible before the blowpipe.

Geognostic and Geographic Situations.—Occurs at Sterzing in the Tyrol, in primitive rocks.

3. Prismatoidal Augite.

Prismatoidischer Augit-Spath, *Mohs.*

Specific Character.—Hemiprismatic. Pyramid unknown. Cleavage, two faces, of which one is more distinct than the other. Incidence = 114° 37′. Hardness = 6.0,—7.0. Sp. gr. = 3.2,—3.5.

This species contains two subspecies, viz. Epidote and Zoisite.

FIRST SUBSPECIES.

Epidote or Pistacite.

Epidote, *Haüy.*—Pistazit, *Werner.*

External Characters.—Colours green and black. Occurs massive; also in distinct concretions, which are granular and fibrous, which latter are collected into wedge-shaped prismatic concretions. Frequently crystallized in oblique four-sided, and also in six-sided prisms. Externally the lustre alternates from splendent to glistening, and is vitreous; internally shining or glistening, and is resinous, inclining to pearly. Fracture conchoidal, sometimes uneven, sometimes even or splintery. Alternates from translucent to translucent on the edges, and to nearly transparent. Brittle, and easily frangible.

Chemical Characters.—Before the blowpipe is converted into a brown-coloured scoria, which blackens by continuance of the heat.

		Epidote from the Valais.
Constituent Parts.—	Silica, - - -	37.0
	Alumina, - - -	26.0
	Lime, - - -	20.0
	Oxide of Iron, - -	13.0
	Oxide of Manganese, -	0.6
	Water, - - -	1.8
	Loss, - - - -	1.0
		100.0 *Laugier.*

Geognostic Situation.—Occurs in beds and veins, and sometimes as an accidental constituent part of rocks.

Geographic Situation.—In Arran it occurs in syenite and clay-slate; in Mainland in Shetland in syenite; in gneiss in Sutherland; in trap-rocks in Mull and Skye; in quartz in Islands of Rona and Iona; in porphyry in Glencoe, and in other districts in Scotland.

SECOND SUBSPECIES.

Zoisite.

This subspecies is divided into two kinds, viz. Common, and Friable.

First Kind.

Common Zoisite.

Zoisit, *Werner.*

External Characters.—Colour yellowish, bluish, and smoke grey. Occurs massive; also in large prismatic distinct concretions. Internally shining on the cleavage, and glistening on the fracture-surface, and the lustre resino-pearly. Fracture small-grained uneven. Feebly translucent, or only translucent on the edges.

Geognostic and Geographic Situations.—It was first observed in the Saualp in Carinthia; and we have it from Glen Elg in Inverness-shire, Shetland, and the banks of Lochlomond.

Second Kind.

Friable Zoisite.

Mürber Zoisit, *Karsten.*

External Characters.—Colour reddish-white, spotted with pale peach-blossom-red. Massive, and in very fine loosely aggregated granular concretions. Very feebly glimmering. Fracture intermediate between earthy and splintery. Translucent on the edges.

Geognostic and Geographic Situations.—Occurs imbedded in green talc at Radelgraben in Carinthia.

4. Prismatic Augite, or Tabular-Spar.

Prismatischer Augitspath, *Mohs.*—Schaalstein, *Werner.*—Tafelspath, *Karsten.*—Spath en Tables, *Haüy.*

Specific Character.—Prismatic. Pyramid unknown. Cleavage, $P + \infty = 105°$ (nearly). $\breve{P}r + \infty$. $\bar{P}r + \infty$. Sp. gr. $= 2.7, —2.9$.

External Characters.—Colour white. Occurs massive, and coarsely disseminated; also in granular and lamellar distinct concretions. Internally the lustre varies from shining to glistening, and is pearly inclining to vitreous. Cleavage, rather distinct. Fracture splintery. Translucent. Brittle, and easily frangible.

Constituent Parts.—Silica,	50	
Lime,	45	
Water,	5	
	100	*Klaproth.*

Geognostic and Geographic Situations.—Occurs in primitive rocks at Orawicza in the Bannat of Temeswar, where it is associated with brown garnets, blue-coloured calcareous-spar, tremolite, actynolite, and variegated copper-ore. It has been lately discovered in the Island of Ceylon, associated with cinnamon-stone, in gneiss.

Genus IX. Azure-Spar.

Lazur-Spath, *Mohs.*

Prismatic. Blue. Hardness $= 5.0, —6.0$. Sp. gr. $= 3.0, —3.1$.

1. Prismatic Azure-Spar.

Prismatischer Lazur-Spath, *Mohs*.—Lazulit, *Werner*.—Lazulit, *Haüy*.

Specific Character.—Prismatic. Pyramid unknown. Cleavage, $P + \infty$. Colour lively. Hardness $= 5.0,—5.5$.

External Characters.—Colour blue. Occurs in small massive portions, disseminated, and crystallized in very oblique four-sided prisms, which are rather flatly acuminated on the extremities with four planes, which are set on the lateral edges. Cleavage, distinct. Fracture uneven. Opaque, or very feebly translucent on the edges. Easily frangible.

Geognostic Situation.—Occurs imbedded in quartz: also in fissures in clay-slate, along with sparry iron, heavy-spar, and quartz.

Geographic Situation.—Occurs principally in the district of Vorau in Stiria.

2. Prismatoidal Azure-Spar, or Blue Spar.

Prismatoidischer Lazur-Spath, *Mohs*.—Blauspath, *Werner*,—Feldspath bleu, *Haüy*.

Specific Character.—Prismatic. Pyramid unknown. Cleavage prismatoidal. Colour pale. Hardness $= 5.5,—6.0$.

External Characters.—Colour pale smalt-blue, which sometimes passes into sky-blue, and occasionally into milk-white. Occurs massive and disseminated. Internally glistening, approaching to shining. Cleavage, distinct. Fracture splintery. Translucent in a low degree. Yields a greyish-white coloured streak.

Chemical Characters.—Before the blowpipe it becomes white and opaque; and affords a black-coloured glass with borax.

Constituent Parts.—

Silica, - - -	14.00
Alumina, - -	71.00
Magnesia, - -	5.00
Lime, - -	3.00
Potash, - - -	0.25
Oxide of Iron, - -	0.75
Water, - - -	5.00
	99.00 *Klaproth.*

Geognostic and Geographic Situations.—Occurs, along with quartz, mica, and garnets, in the valley of Murz, near Krieglach in Stiria.

Lapis Lazuli. App: IV. I. 317.

ORDER *VII. GEM.*

No metallic lustre. Streak white or grey.

Hardness = 5.5,—10.0. If 6.0 and less, the Sp. gr. = 2.4 and less; and no traces of form or cleavage.

Sp. gr. = 1.9,—4.7. If under 3.8, there is no pearly lustre.

GENUS I. ANDALUSITE.

Com. Andalusite in Stir.

Prismatic. Cleavage, not prismatoidal. Hardness = 7.5. Sp. gr. = 3.0,—3.2.

1. Prismatic Andalusite.

Prismatischer Andalusit, *Mohs.*

Specific Character.—Prismatic. Pyramid unknown. Cleavage, $P + \infty.\ \breve{P}r + \infty.\ \bar{P}r + \infty.$

It is divided into two subspecies, viz. Common Andalusite and Saussurite.

FIRST SUBSPECIES.

Common Andalusite.

Andalusit, *Werner.*—Feldspath apyre, *Haüy.*

External Characters.—Colour flesh-red, which sometimes inclines to pearl-grey. Occurs massive, and crystallized in slightly oblique four-sided prisms, in which the terminal angles and lateral edges are sometimes truncated. Principal fracture shining in a low degree; cross fracture glistening, and lustre vitreous. Cleavage, sometimes distinct. Fracture uneven. Feebly translucent.

Chemical Characters.—Becomes white before the blowpipe, but does not melt.

Constituent Parts.—	Silica,	32
	Alumina,	52
	Potash,	8
	Oxide of Iron,	2
		94 *Vauquelin.*

Geognostic Situation.—Occurs in gneiss, mica-slate, and clay-slate.

Geographic Situation.—Occurs in primitive rocks in Banffshire, Aberdeenshire, and Shetland Islands; Devonshire; and counties of Wicklow and Dublin in Ireland.

SECOND SUBSPECIES.

Saussurite.

External Characters.—Colours white, grey, and green. Occurs massive, disseminated, and in rolled pieces. Internally dull, or feebly glimmering. Cleavage, imperfect. Fracture splintery. Faintly translucent on the edges.

Chemical Characters.—Before the blowpipe it melts on the edges and angles, but is not entirely melted.

Geognostic and Geographic Situations.—Occurs associated with serpentine, hyperstene, &c. between Ballantree and Girvan, in Ayrshire; also in Switzerland and other countries.

GENUS II. CORUNDUM.

Tessular, rhomboidal, prismatic. If prismatic, the Sp. gr. = 3.7 and more, and hardness = 8.5. If colour red, and Sp. gr. = 3.7 and more, the hardness = 9.0. Hardness = 8.0, —9.0. Sp. gr. = 3.5, 4.3.

1. Dodecahedral Corundum.

Dodecaedrischer Corund, *Mohs.*—Spinel and Zeilanit, *Werner.*—Spinelle, *Haüy.*—Octahedral Corundum, *Jameson,* 3d edit.

Specific Character.—Tessular. Cleavage, octahedral, but imperfect. Hardness = 8.0. Sp. gr. = 3.5,—3.8.

This species is divided into two subspecies, viz. Ceylanite and Spinel.

FIRST SUBSPECIES.

Ceylanite.

Zeilanit, *Werner.*—Pleonast, *Haüy.*

External Characters.—Colours green and greyish-black. Occurs crystallized in octahedrons and rhomboidal dodecahedrons. Internally splendent, and lustre vitreous, inclining to semi-metallic. Fracture perfect, and very flat conchoidal. Translucent on the edges. Rather easily frangible.

Geognostic and Geographic Situations.—This mineral was first found in the Island of Ceylon, where it occurs in the sand of rivers, along with tourmaline, zircon, sapphire, and iron-sand. It also occurs in the ejected unaltered rocks at Monte Somma, and in other quarters.

SECOND SUBSPECIES.

Spinel.

Spinell, *Werner & Haüy.*

External Characters.—Principal colour red; from which there is a transition on the one side into blue, and almost into green; on the other side into yellow and brown, and even into white. The following are its crystallizations: 1. Octahedron. 2. Tetrahedron. 3. Rhomboidal dodecahedron. 4. Various twin-crystals.

Externally and internally splendent, and lustre vitreous. Fracture flat conchoidal. Alternates from translucent to transparent, and refracts single.

Chemical Characters.—Infusible before the blowpipe without addition; but is fusible with borax.

Constituent Parts.—

Alumina,	82.47	
Magnesia,	8.78	
Chromic Acid,	6.18	
Loss,	2.57	
	100	*Vauquelin.*

Colouring matter

Geognostic and Geographic Situations.—It is found in the gneiss district of Acker in Sudermannland, in a white foliated granular primitive limestone; and in drusy cavities, along with vesuvian and ceylanite, in the ejected foliated granular limestone of Vesuvius.

Asia.—Occurs in the kingdom of Pegu, and at Cannanor in the Mysore country. In the Island of Ceylon, so prolific in gems, it is found not only in the sand of rivers, but also imbedded in gneiss.

Uses.—It is an esteemed precious stone, but has neither the hardness nor fire of the red sapphire or oriental ruby.

2. Octahedral Corundum or Automalite.

Octaedrischer Corund, *Mohs.*—Automolith, *Werner.*—Spinelle Zincifere, *Haüy.*

Specific Character.—Tessular. Cleavage octahedral and perfect. Hardness = 8. Sp. gr. = 4.1,—4.3.

External Characters.—Colour green. Crystallized, in octahedrons, tetrahedrons, and in twin-crystals. Externally glistening, and lustre pearly, inclining to semi-metallic. Internally shining on the cleavage, but glistening on the fracture, and the lustre resinous. Cleavage visible. Fracture flat conchoidal. Opaque, or faintly translucent on the edges. Brittle.

Chemical Character.—Infusible before the blowpipe.

Constituent Parts.—

Alumina,	42
Silica,	4
Oxide of Zinc,	28
Iron,	5
Sulphur,	17
Undecomposed,	4
	100 *Vauquelin.*

Geognostic and Geographic Situations.—Occurs imbedded in talc-slate, along with galena, and has been hitherto found only at Fahlun in Sweden.

3. Rhomboidal Corundum.

Rhomboedrischer Corund, *Mohs.*

Specific Character.—Rhomboidal. Rhomboid = 86° 6′ Cleavage R — ∞. More distinct R. Hardness = 9.0. Sp. gr. = 3.8,—4.3.

It is divided into three subspecies, viz. Sapphire, Emery and Corundum.

FIRST SUBSPECIES.

Sapphire. is highly

Sapphir, *Werner.*—Telesie, *Haüy.*

External Characters.—Blue and red are its principal colours; occurs also grey, white, green, and yellow. Its crystallizations are six-sided pyramids and six-sided prisms.

Internally lustre splendent and vitreous, sometimes inclining to adamantine. Cleavage pretty distinct in the red varieties. Fracture conchoidal. Alternates from transparent to translucent; and the translucent varieties frequently exhibit a six-rayed opalescence. Refracts double. Brittle, and easily frangible.

Constituent Parts.—	Blue Sapphire.	Red Sapphire, or Oriental Ruby.
Alumina,	92.00	90.0
Lime,	5.25	7.0
Oxide of Iron,	1.00	1.2
Loss,	1.75	1.8
	100	100
	Chevenix.	*Chevenix.*

Chemical Characters.—Infusible before the blowpipe.

Physical Characters.—Becomes electrical by rnbbing, and retains its electricity for several hours; but does not become electrical by heating.

Geognostic Situation.—Occurs in alluvial soil, in the vicinity of rocks belonging to the secondary or flœtz-trap formation, and imbedded in gneiss.

Geographic Situation.—Occurs in alluvial soil, in different countries of Europe, but most abundantly in the East, as Ceylon, Pegu, &c.

Uses.—This mineral is, next to diamond, the most valuable of the precious stones. The most highly prized varieties are the crimson and carmine red; these are the *Oriental Ruby* of the jeweller, and next to the diamond are the most valuable gems hitherto discovered. The blue varieties, the *Sapphire* of the jeweller, are next in value to the red. The yellow varieties, the *Oriental Topaz* of the jeweller, arc of less value than the blue or true sapphire.

must be distinguished from the Spinel

SECOND SUBSPECIES.

Emery. is an uncrystallized Sapphire

Schmiergel, *Werner.*—Corindon granulaire, *Haüy.*

External Characters.—Colour intermediate between greyish-black and bluish-grey. Occurs massive and disseminated; and the massive is sometimes intermixed with other minerals. Lustre glistening, passing into glimmering, and adamantine. Fracture fine and small-grained uneven; sometimes splintery. Slightly translucent on the edges. Rather difficultly frangible. Chiefly composed of Alumina

Geognostic and Geographic Situations.—It is found in talc-slate at Ochsenkopf near Schwartzenberg, and at Eibenstock in Saxony, and abundantly in the Island of Naxos.

Use.—It is used for polishing hard minerals and metals, and hence is an important article in the arts.

THIRD SUBSPECIES.

Corundum. may be supposed

Korund & Demant-Spath, *Werner.*—Corindon harmophane opaque, *Haüy.*

External Characters.—Colours white, grey, green, blue, red, and brown. The green, blue, and red colours are generally muddy, and inclining to grey. When cut in a semicircular form, it often presents an opalescent star of six rays. Its principal crystallizations are six-sided prisms and six-sided pyramids. Externally they are dull and rough. Lustre of the cleavage and fracture shining and glistening, and either vitreous inclining to resinous, or pearly inclining to adamantine. Cleavage distinct. Fracture conchoidal, and sometimes uneven. Alternates from strongly translucent to translucent on the edges.

Geognostic and Geographic Situations.—Occurs in dolomite in St Gothard; also in the Carnatic, on the coast of Malabar; and abundantly in the neighbourhood of Canton in China.

Use.—In its powdered state, it has long been used by the artists of India and China for cutting and polishing precious stones.

4. Prismatic Corundum or Chrysoberyl.

Prismatischer Corund, *Mohs.*—Krysoberyll, *Werner.*—Cymophane, *Haüy.*

Specific Character.—Prismatic. Pyramid $= 139° \ 53'$; $86° \ 16'$; $107° \ 29'$. $P + \infty = 128° \ 35'$. Cleavage $= P \breve{r} + \infty$. Hardness $= 8.5$. Sp. gr. $= 3.7, - 3.8$.

External Characters.—Chief colour asparagus green. Often exhibits a milk-white opalescence, which appears in general to float in the interior of the mineral. Occurs in blunt angular rolled pieces, that sometimes approach to the cubic form, and crystallized in six-sided prisms. Internally splendent, and lustre intermediate between resinous and vitreous, but more inclining to the first. Cleavage, imperfect. Fracture perfect conchoidal. Semi-transparent, sometimes inclining to transparent, and refracts double. Brittle, and rather easily frangible.

Constituent Parts.—

Alumina,	71.5
Silica,	18.0
Lime,	6.0
Oxide of Iron,	1.5
Loss,	3.0
	100 *Klaproth.*

Geognostic and Geographic Situations.—Occurs in Brazil, in alluvial soil with topaz, or in sandstone with diamond; and at Haddam, on Connecticut River, in the United States, in granite, along with garnet, beryl and tourmaline.

It is found in the Island of Ceylon, in the beds of rivers, along with sapphires, rubies and tourmalines.

Uses.—This fine gem was formerly much less prized than it is at present. When cut and polished, it is not inferior in brilliancy and beauty to other gems of the same colour.

Genus III. Diamond.

Tessular. Hardness = 10. Sp. gr. = 3.4,—3.6.

1. Octahedral Diamond.

Octaedrischer Demant, *Mohs.*—Demant, *Werner.*—Diamant, *Haüy.*

Specific Character.—Tessular. Cleavage, octahedral.

External Characters.—Most common colours of the diamond are white and grey. Besides these two colours, it occurs blue, red, brown, black, yellow, and green. Occurs in rolled pieces, in indeterminate angular and spherical grains, and crystallized in octahedrons, tetrahedrons, rhomboidal dodecahedrons, and in various twin-crystals. Internally

[illegible] will
be found to be a vegetable [illegible]

always splendent, often specular splendent, and the lustre perfectly adamantine. Seldom completely transparent; more generally it rather inclines to semitransparent; but the black variety is nearly opaque. Refracts single. Rather easily frangible.

Constituent Parts.—It is said to be nearly pure carbon.

Geognostic Situation.—Occurs imbedded in grains and crystals, in alluvial soil, sandstone, and, probably, in secondary trap-rocks.

Geographic Situation.—Occurs in Brazil, Peninsula of India, and the Island of Borneo.

Uses.—The diamond, on account of the splendour of its lustre, its beautiful play of colour, its hardness, and lastly, its rarity, is considered as the most precious substance in the mineral kingdom, and is particularly valued by jewellers. The diamonds purchased by jewellers are generally in grains, or crystals, and sometimes coarsely polished.

Genus IV. Topaz.

Prismatic. Cleavage, axotomous. Hardness = 8. Sp. gr. = 3.4,—3.6.

1. Prismatic Topaz.

Prismatischer Topaz, *Mohs.*

Specific Character.—Prismatic. Pyramid = 141° 7′; 101° 52′; 90° 55′. $P + \infty$ = 124° 19′. Cleavage, $P - \infty$.

This species contains three subspecies, viz. Common Topaz, Schorlite, and Physalite or Pyrophysalite.

FIRST SUBSPECIES.

Common Topaz.

Topaz, *Werner.*

External Characters.—Colours yellow, green, blue, and red. Frequently crystallized, and generally in prisms which are variously bevelled and acuminated. The lateral planes of the crystals are longitudinally streaked; but the acuminating and bevelling planes are smooth; the terminal planes are rough. Externally splendent; internally, splendent and vitreous. Distinct axotomous cleavage. Fracture small and perfectly conchoidal. Alternates from transparent to semi-transparent; and refracts double. Easily frangible.

Chemical Characters.—Saxon topaz in a gentle heat becomes white, but a strong heat deprives it of lustre and transparency: the Brazilian, on the contrary, by exposure to a high temperature, burns rose-red, and in a still higher violet-blue.

Physical Characters.—When heated, exhibits at one extremity positive, and at the other negative electricity. Also becomes electrical by friction, and retains this property for a considerable time, sometimes more than twenty-four hours.

		Brazilian Topaz.	
Constituent Parts.—	Alumina,	58.38	
	Silica,	34.01	
	+ Fluoric Acid,	7.79	
		100.18	*Berzelius.*

Geognostic Situation.—Occurs in various primitive rocks, such as topaz-rock, gneiss, and clay-slate.

Geographic Situation.—Occurs in large crystals, and rolled masses, in an alluvial soil, in the granite and gneiss districts of Mar and Cairngorm, in the upper parts of Aberdeenshire; and in veins, along with tinstone, in clay-slate, at St Anne's, in Cornwall; also in St Michael's Mount, and at Trevaunance, in the same county. The finest topazes are those found in Brazil.

Uses.—This gem is much prized by jewellers, and is considered one of the more beautiful ornamental stones.

SECOND SUBSPECIES.

Schorlite, or Schorlous Topaz.

Schorlartiger Berill, or Piknit, *Werner.*—Pycnite, *Haüy.*

External Characters.—Colours yellow, white, and grey Occurs massive, and in parallel, thin, and straight prismatic distinct concretions, which are longitudinally streaked; also crystallized in long six-sided prisms, which are sometimes truncated on the terminal edges and angles, and are generally imbedded. Externally and internally its lustre is shining, approaching to glistening, and is resinous. Cleavage, indi-

+ Said by some to have been ...

stinct. Fracture small and imperfect conchoidal, or fine-grained uneven. More or less translucent on the edges. Brittle. Uncommonly easily frangible.

Geognostic and Geographic Situations.—Occurs in Aberdeenshire; also at Altenberg in Saxony, in a rock of quartz and mica, which forms an imbedded mass, included in porphyry.

THIRD SUBSPECIES.

Physalite, or Pyrophysalite.

Pyrophysalith, *Hisinger.*—Physalith, *Werner.*

External Characters.—Colours greenish-white and mountain-green. Occurs massive, in coarse granular distinct concretions; and crystallized in prisms. Lustre of the cleavage splendent, of the cross fracture glistening or dull. Cleavage, perfect. Fracture uneven or conchoidal. Translucent on the edges.

Geographic Situation.—Is found imbedded in granite at Finbo, near Fahlun, in Sweden.

Genus V. Emerald.

Rhomboidal. Prismatic. Cleavage prismato-rhomboidal, or prismatoidal; the first more distinct perpendicular to the axis. Hardness = 7.5, 8.0 Sp. gr. = 2.6, 3.2.

1. Prismatic Emerald, or Euclase.

Euclas, *Werner.*—Prismatischer Smaragd, *Mohs.*—Euclase, *Haüy.*

Specific Character.—Hemi-prismatic. Pyramid unknown. $\frac{\bar{P}}{2} . P + \infty = 133° 26'$. Cleavage, $P\breve{r} + \infty$, perfect. Hardness = 7.5. Sp. gr. = 2.9,—3.2.

External Characters.—Colours white, green, and blue. Crystallized in oblique four-sided prisms variously modified by truncations, bevelments, and acuminations. Internally splendent. Fracture small conchoidal. Alternates from transparent to translucent, and refracts double. Very easily frangible.

Chemical Characters.—Before the blowpipe, it first loses its transparency, and then melts into a white enamel.

Constituent Parts.—

Silica,	35	
Alumina,	18	
Glucine,	14	
Iron,	2	
Loss,	31	
	100	*Vauquelin.*

Geognostic and Geographic Situations.—This rare and beautiful mineral occurs in Peru and Brazil.

2. Rhomboidal Emerald.

Rhomboedrischer Smaragd, *Mohs.*—Emeraude, *Haüy.*

Specific Character.—Di-rhomboidal. $2\,R = 138° 35' : 90$. Cleavage, $R - \infty$. Less perfect $P + \infty$. Hardness $= 7.5, -8.0$. Sp. gr. $= 2.6, -2.8$.

Is divided into two subspecies, viz. Emerald and Beryl.

FIRST SUBSPECIES.

Emerald.

Schmaragd, *Werner.*

External Characters.—Colour emerald-green. Generally crystallized in equiangular six-sided prisms. Lateral planes smooth; terminal planes rough. Internally lustre intermediate between shining and splendent, and vitreous. Cleavage, indistinct. Fracture small and imperfect conchoidal. Alternates from transparent to translucent, and refracts double in a moderate degree.

Constituent Parts.—

Silica,	64.50	
Alumina,	16.00	
Glucina,	13.00	
Oxide of Chrome,	3.25	
Lime,	1.60	
Water,	2.00	
	100.35	*Vauquelin.*

Geognostic Situation.—Occurs in drusy cavities, in veins in clay-slate, and also imbedded in mica-slate; and loose in the sand of rivers, and in other alluvial deposites.

Geographic Situation.—The most beautiful emeralds are

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at present brought from Peru; others of less value are found in Salzburg; and formerly they were dug in Egypt.

Use.—It is rare to find the colour of this gem pure and of good strength; hence such specimens are very highly valued, and are employed in the most expensive kinds of jewellery. Is valued next to the ruby; and when of a good colour, is set without a foil, and upon a black ground, like brilliant diamonds.

SECOND SUBSPECIES.

Beryl.

Edler Beril, *Werner*.

External Characters.—Colours green, blue, and yellow. Occurs massive, and this variety sometimes appears arranged in straight and thin prismatic distinct concretions. Often crystallized in long equiangular six-sided prisms, either perfect, or truncated on the lateral and terminal edges or angles, also sometimes acuminated. Lateral planes deeply longitudinally streaked, but the terminal, acuminating, and truncating planes are smooth. Externally, lustre shining and glistening; internally shining, which sometimes passes into glistening and splendent, and vitreous. Cleavage, more distinct than in emerald. Fracture small, and more or less perfect conchoidal. Commonly transparent, and refracts double, but in a feeble degree. Easily frangible.

Constituent Parts.—

Silica,	69.50	
Alumina,	14.00	
Glucina,	14.00	
Oxide of Iron,	1.00	
	98.50	*Rose.*

Geognostic Situation.—Occurs in veins that traverse granite and gneiss, also imbedded in granite, and dispersed through alluvial soil.

Geographic Situation.—Occurs in alluvial soil along with rock-crystal and topaz, in the upper parts of Aberdeenshire. In Ireland, imbedded in granite, near Lough Bray, in the county of Wicklow, and near Cronebane in the same county.

Uses.—When pure, it is cut into ring-stones, seal-stones, brooches, intaglios, and necklaces, but is not so highly valued as emerald.

GENUS VI. QUARTZ.

Rhomboidal. Cleavage not perpendicular to the axis. Hardness = 5.5,—7.5. Sp. gr. = 1.9,—2.7.

1. Prismato-Rhomboidal Quartz, or Iolite.

Prismato-rhomboedrischer Quarz, *Mohs.*—Iolith Peliom, *Werner.*—Iolithe, *Haüy.*—Prismato-rhomboidal Iolite, *Jameson,* 3d Ed.

Specific Character.—Dirhomboidal. Rhomboid unknown. Cleavage, R + ∞. P + ∞. Hardness = 7,—7.5. Sp. gr. = 2.5,—2.6.

External Characters.—Colour intermediate between violet-blue and blackish-blue. When viewed in the direction of the axis of the crystals, the colour is dark indigo-blue; but perpendicular to the axis of the crystals, pale brownish-yellow. Occurs massive, disseminated, and rarely crystallized in six-sided prisms. Internally shining, and lustre vitreous. Cleavage imperfect. Fracture small-grained, uneven, and sometimes conchoidal. Translucent in the direction of the axis of the crystal, and transparent at right angles to it. Refracts double. Easily frangible.

Constituent Parts.—

Silica,	43.6	
Alumina,	37.6	
Magnesia,	9.7	
Potash,	1.0	
Oxide of Iron,	4.5	
Oxide of Manganese a trace.		
	99.5	*Gmelin.*

Geognostic and Geographic Situations.—Occurs in primitive rocks at Orijarvi, near Abo in Finland; at Bodenmais in Bavaria; in the county of Salzburg; and in other parts of Europe and America.

Use.—It is cut, polished, and worn as a gem.

2. Rhomboidal Quartz.

Quartz, *Werner.*—Rhomboedrischer Quarz, *Mohs.*

Specific Character.—Rhomboidal. Rhomboid = 75° 47'.

Cleavage, P = 133° 38′; 103° 53′. P + ∞. Hardness = 7.0. Sp. gr. = 2.5,—2.7.

This species contains fifteen subspecies, viz. 1. Amethyst, 2. Rock-Crystal, 3. Milk-Quartz, 4. Common-Quartz, 5. Prase, 6. Fibrous Quartz, 7. Cat's-eye, 8. Iron Flint, 9. Hornstone, 10. Flinty Slate, 11. Flint, 12. Calcedony, 13. Heliotrope, 14. Jasper, 15. Floatstone, * Agate.

FIRST SUBSPECIES.

Amethyst.

Amethyst, *Werner*.—Quartz-hyalin Violet, *Haüy*.

Is divided into two kinds, viz. Common, and Thick Fibrous.

First Kind.

Common Amethyst.

External Characters.—Colours blue, grey, white, brown, and rarely green. Occurs massive, in prismatic and lamellar concretions. Its most frequent crystallization is the acute six-sided pyramid; a less frequent form is the six-sided prism with a six-planed acumination. Alternates from translucent to transparent. Internally splendent, or shining, and lustre vitreous. Fracture conchoidal. Brittle, and easily frangible.

Geognostic Situation.—Occurs in agate-balls in amygdaloid, greenstone, and porphyry, and in veins in other primitive and secondary rocks.

Geographic Situation.—Occurs in veins and drusy cavities in secondary greenstone and amygdaloid, in many parts of Scotland. Near Cork in Ireland. In many places on the Continents of Europe, Asia, Africa, and America.

Uses.—The most highly valued amethysts are those brought from the Continent of India, and the Island of Ceylon. The next in esteem are the Brazilian. When the colour is good, it is cut and polished, and is considered a gem of considerable beauty.

Second Kind.

Thick Fibrous Amethyst.

Dickfasriger Amethyst, *Werner.*

External Characters.—Colours violet-blue, pearl-grey, and white. Occurs massive, and in thick fibrous concretions, collected into others, which are angulo-granular. Lustre glistening and vitreous. Fracture imperfect conchoidal, or uneven. Fragments wedge-shaped. Translucent, sometimes inclining to semi-transparent.

Geognostic and Geographic Situation.—Occurs in agate-veins, and generally associated with common amethyst.

SECOND SUBSPECIES.

Rock or Mountain Crystal.

Berg-Crystal, *Werner.*—Quartz-hyalin, *Haüy.*

External Characters.—Colours white, brown, yellow, and red. Generally occurs in crystals, which are usually six-sided prisms, acuminated with six planes set on the lateral planes, and rarely in large granular concretions. Externally the crystals are generally splendent or shining. Internally, splendent and vitreous. Fracture almost always perfect conchoidal. Fragments indeterminate angular, and very sharp-edged. Generally transparent. Brittle, and easily frangible.

Chemical Characters. — Completely infusible before the blowpipe.

Constituent Parts.—Silica,	$99\frac{5}{8}$	
Trace of ferruginous Alumina.		
	100	*Bucholz.*

Geognostic Situation.—Although rock-crystal occurs more frequently, and in more numerous geognostic relations than amethyst, yet it is not the most common subspecies of quartz. It appears most frequently, and in the largest and most transparent crystals, in primitive rocks, where it occurs in beds, veins, and large drusy cavities. very rare in Scotland [illegible]

Geographic Situation.—Crystals of great size and beauty are found in different parts of Scotland; the rock-crystals of the Island of Arran, which occur in drusy cavities in granite,

* in Specimen from Dauphiny have one very large [illegible]

[illegible]

are well known; but the largest and most valuable are found in the district of Cairngorm, in the upper part of Aberdeenshire, where they occur in granite, or in alluvial soil, along with beryl and topaz. On the Continent of Europe it is very widely, and often abundantly distributed, and the same is the case in Asia and America.

Uses.—Rock-crystal is cut and polished as an inferior kind of gem or ornamental stone. The Cairngorm stones of Scotland are varieties of rock-crystal.

THIRD SUBSPECIES.

Rose or Milk Quartz.

Milch-Quartz, *Werner*.—Quartz-hyalin rosé, *Haüy*.

External Characters.—Colours rose-red and milk-white. Occurs massive, and sometimes in lamellar concretions. Internally shining, sometimes passing to splendent, and vitreous, inclining to resinous. Fracture more or less perfect conchoidal. More or less translucent. The other characters are the same as those of rock-crystal.

Geognostic Situation.—Occurs in masses, included in beds of quartz subordinate to granite and gneiss, and in veins of manganese in granite.

Geographic Situation.—Occurs in primitive rocks in Scotland and Germany, and in various districts in Asia and America.

Uses.—Is employed in jewellery, and the larger masses are cut into vases. Silica coloured by Manganese

FOURTH SUBSPECIES.

Common Quartz.

Gemeiner Quartz, *Werner*.—Quartz-amorphe, *Haüy*.

External Characters.—Colours white, grey, yellow, brown, red, green, blue, and black. Occurs massive, disseminated, in plates, stalactitic, reniform, botryoidal, globular, specular, corroded, vesicular, ramose, amorphous, cellular, with impressions, in supposititious crystals from calcareous-spar, fluor and heavy spar; also crystallized in six-sided pyramids, and less frequently in six-sided prisms, with an acumination of six planes. Internally lustre shining, which sometimes borders on glistening, and sometimes approaches to glimmering, and is vitreous. Fracture coarse splintery, and conchoidal. Generally translucent. The other characters the same as those of rock-crystal.

Geognostic Situation.—Is one of the most abundant minerals in nature, and appears in many different geognostic situations. Occurs in primitive, transition, secondary, alluvial and volcanic rocks, and either as a constituent part of these rocks, or associated with them in the form of imbedded grains or masses, or in beds and veins.

Geographic Situation.—Abounds in all the primitive, transition, secondary, and alluvial districts in Scotland, England, and Ireland; is abundantly distributed throughout the Continents of Europe, Asia, Africa, and America.

Uses.—Is employed in the manufacture of glass and artificial gems; also in the preparation of smalt, and as an ingredient in porcelain and different kinds of pottery. The vesicular and corroded variety forms a most excellent millstone, known in commerce under the name of *Buhr-stone.*

FIFTH SUBSPECIES.

Prase.

Prasem, *Werner.*—Quartz-hyalin vert obscur, *Haüy.*

External Characters.—Colour leek-green. Generally massive, and in prismatic and granular concretions. Sometimes crystallized in same forms as common quartz. Surface of the concretions rough and transversely streaked. Lustre shining, approaching to glistening, and resino-vitreous. Fracture conchoidal, passing into splintery. Translucent. Brittle, and easily frangible.

Geognostic and Geographic Situations.—Occurs in beds in primitive rocks in Scotland, Germany, and other countries. These beds are probably connected with primitive trap.

Uses.—Is sometimes cut and polished as an ornamental stone, but is not highly esteemed.

SIXTH SUBSPECIES.

Fibrous Quartz.

Faser Kiesel, *Hoffmann.*

External Characters.—Colours greenish and yellowish white. Massive, and in rolled pieces; also in curved fibrous concretions, which sometimes cross each promiscuously. Internally, glistening or glimmering, and pearly. Fracture curved slaty. Fragments indeterminate angular, wedge-shaped, and splintery. Translucent on the edges, passing into translucent. When cut in a convex form, shews a feeble opalescence, resembling that of cat's-eye quartz.

Geognostic and Geographic Situations.—Occurs on the banks of the Moldau in Bohemia.

SEVENTH SUBSPECIES.

Cat's-Eye.

Katzenauge, *Werner.*—Quartz agathe chatoyant, *Haüy.*

External Characters.—Principal colours grey, red, and brown, and sometimes also green. Exhibits a beautiful opalescence, particularly when cut in a convex form. Massive. Internally shining, and vitreo-resinous. Fracture conchoidal. Translucent, or translucent on the edges. Brittle, and easily frangible.

Geognostic and Geographic Situations.—Occurs imbedded in gneiss in Ceylon.

Uses.—Is generally cut into ring-stones; and the most advantageous form for displaying its peculiar lustre is the oval, with a convex surface.

EIGHTH SUBSPECIES.

Iron-Flint.

Eisenkiesel, *Werner.*—Quartz rubigineux, *Haüy.*

External Characters.—Colours brown and red. Massive and crystallized like common quartz. Usually in granular distinct concretions. Externally lustre shining, approaching to glistening; internally glistening, and vitreo-resinous. Fracture conchoidal. Opaque. Brittle, and rather difficultly frangible.

Geognostic Situation.—Occurs in veins of ironstone, and also in trap-rocks.

Geographic Situation.—In rocks near Bristol; in trap-rocks that lie over white limestone, Island of Rathlin, off the coast of Ireland; and in trap-rocks near Dunbar in Scotland.

NINTH SUBSPECIES.

Hornstone.

Hornstein, *Werner.*

There are three kinds, viz. Splintery Hornstone, Conchoidal Hornstone, and Woodstone.

First Kind.

Splintery Hornstone.

Splittriger Hornstein, *Werner.*—Quartz agathe grossier, *Haüy.*

External Characters.—Colours grey, red, and green. Massive. Internally dull. Fracture splintery. More or less translucent on the edges. Brittle, and rather difficultly frangible.

Geognostic Situation.—Occurs in veins in primitive and secondary rocks.

Geographic Situation.—Occurs in primitive districts in Scotland and England, and in various quarters on the Continents of Europe, Asia, and America.

Second Kind.

Conchoidal Hornstone.

Muschlicher Hornstein, *Werner.*—Hornstein conchoide, *Brochant.*

External Characters.—Colours grey, white, and red. Massive. Internally glimmering, sometimes approaching to glistening, and lustre vitreous. Fracture conchoidal. Translucent, but in a lower degree than splintery hornstone. Brittle, and rather difficultly frangible.

Geognostic Situation.—Occurs in metalliferous veins and agate veins; also, in imbedded portions, in pitchstone porphyry, in striped jasper, and along with claystone porphyry.

Geographic Situation.—Is found along with claystone in the Pentland Hills near Edinburgh; also in Saxony and Bohemia.

Third Kind.

Woodstone.

Holztein, *Werner.*—Quartz-agathe xyloide, *Haüy.*

External Characters.—Colours grey, red, brown, black and yellow. Occurs in rolled pieces, and in the shape of trunks, branches, and roots. External surface uneven and rough. Internally dull, sometimes glimmering and glistening, according as it is more or less of the nature of the two preceding subspecies. Cross fracture imperfect conchoidal; the longitudinal fracture splintery and fibrous. Generally translucent on the edges; sometimes feebly translucent. Brittle, and rather difficultly frangible.

Geognostic Situation.—Occurs imbedded in sandy loam in alluvial soil; and also in a kind of sandstone-conglomerate, and in clay-stone.

Geographic Situation.–Occurs at Loch Neagh in Ireland: at Chemnitz and Hilbersdorf in Upper Saxony, and in many other places.

TENTH SUBSPECIES.

Flinty-Slate.

There are two kinds, viz. Common Flinty-Slate, and Lydian Stone.

First Kind.

Common Flinty-Slate.

Gemeiner Kieselchiefer, *Werner.*—Jaspe schisteux, *Brongniart.*

External Characters.—Colours grey, red, and black. Often traversed by quartz veins. Occurs massive. Internally faintly glimmering, or nearly dull. Fracture in the great slaty, and in the small splintery. More or less translucent, and passes into translucent on the edges. Brittle, but very difficultly frangible.

Geognostic Situation.—Occurs in beds and imbedded masses in clay-slate and grey-wacke; and in roundish and angular masses in sandstone.

Geographic Situation.—Occurs in different parts of the great tract of clay-slate and grey-wacke, which extends from St Abb's Head to Port Patrick; also in the Pentland Hills near Edinburgh.

Second Kind.

Lydian Stone.

Lidischerstein, *Werner*.—Jaspe schisteux, *Brongniart*.

External Characters.—Colour greyish-black, which passes into velvet-black. Occurs massive. Traversed by quartz veins. Internally glimmering. Fracture generally even, and approaches sometimes to flat conchoidal. Opaque. Brittle, and rather difficultly frangible. is often traversed by veins of white

Geognostic and Geographic Situations.—Occurs in primitive, transition, and secondary rocks in Scotland, England, and other countries.

Use.—This mineral is sometimes used as a touchstone for ascertaining the purity of gold and silver.

ELEVENTH SUBSPECIES.

Flint.

Feurstein, *Werner*.—Quartz-agathe pyromaque, *Haüy*.

External Characters.—Colours grey, yellow, brown, and red. Besides massive, in plates, in angular grains and pieces, it occurs also globular, elliptical, in the form of sand, tuberose, perforated, and in various extraneous external shapes. Sometimes occurs in lamellar concretions, which are either straight or concentrically curved. Internally lustre glimmering. Fracture perfect and large, and rather flat conchoidal. Translucent; the blackish varieties are seldom more than translucent on the edges. Brittle, and easily frangible.

Constituent Parts.—	Silica,	98.00
	Lime,	0.50
	Alumina,	0.25
	Oxide of Iron	0.25
	Loss,	1.00
		100 *Vauquelin.*

Geognostic and Geographic Situations.—Occurs most abundantly in the chalk formation; less frequently in veins, and imbedded masses in primitive, transition, and various flœtz formations; also in the form of grains and rolled masses in alluvial districts. Occurs in many districts in Europe.

Uses.—The principal use of this mineral is for gun-flints, for which purpose it is excellently fitted, on account of its hardness, the abundance of sparks it affords with steel, and the sharp fragments it gives in breaking.

TWELFTH SUBSPECIES.

Calcedony.

Kalzedon, *Werner.*

There are four kinds, viz. Common Calcedony, Chrysoprase, Plasma, and Carnelian.

First Kind.

Common Calcedony.

Gemeiner Kalzedon, *Werner.*—Quartz-agathe calcedoine, *Haüy.*

External Characters.—Colours grey, yellow, brown, blue, green, and black. Occurs in lamellar, and also in fibrous distinct concretions. Internally dull; the splintery varieties exhibit a faint degree of lustre. Fracture even, which sometimes passes into imperfect conchoidal, and splintery. Generally semi-transparent; but the black and white varieties are only translucent. Brittle, and easily frangible.

Geognostic Situation.—Occurs in primitive, secondary, and alluvial rocks, in balls, kidneys, angular pieces, short and thick beds, veins, and rolled pieces.

Geographic Situation.—Is frequent in most of the trap-districts in Scotland, and also in similar tracts on the continents of Europe, Asia, Africa, and America.

Uses.—As it is hard, susceptible of a fine polish, and exhibits beautiful colours, and considerable transparency, it is employed as an article of jewellery.

Fir mentioned by Pliny as a different mineral

Second Kind.

Chrysoprase.

Krisopras, *Werner.*—Quartz-agathe prase, *Haüy.*

External Characters.—Characteristic colours apple-green, and greenish-grey. Occurs generally massive, and sometimes in plates. Internally dull, seldom glimmering. Fracture even. Translucent, inclining to semi-transparent. Brittle, and rather difficultly frangible.

Geognostic and Geographic Situations.—Occurs in plates and cotemporaneous veins, in primitive serpentine in Silesia.

Uses.—Is considered as a gem, and is cut into ring-stones, necklaces, bracelets, ear-drops, and brooches.

Third Kind.

Plasma.

Plasma, *Werner.*

External Characters.—Colour grass-green. Internally glistening, inclining to glimmering. Fracture imperfect, and rather flat conchoidal. Translucent, inclining to semi-transparent. Brittle, and easily frangible.

Geognostic and Geographic Situations.—Occurs in beds, associated with common calcedony. Most of the specimens in cabinets have been collected among the ruins of Rome.

Uses.—It was considered by the Romans as a gem, and cut into ornaments; and frequently figures were engraved upon it.

Fourth Kind.

Carnelian. from its colour

Carneol, *Werner.*—Quartz-agathe cornaline, *Haüy.*

External Characters.—Colours red, brown, yellow, green, and white. Occurs massive, reniform, and in fibrous and lamellar concretions. Fracture perfect conchoidal, or splintery in the reniform varieties. Lustre glistening, sometimes passing into shining, and vitreous. Generally semi-transparent; seldom translucent. Brittle, and easily frangible.

Geognostic and Geographic Situations.—It frequently occurs as a constituent part of agate, and in general has the same geognostic situation as common calcedony. The secondary trap-rocks so abundant in Scotland often contain carnelian, either alone or in agate. The most beautiful carnelians are brought to this country from Arabia, India, Surinam, Siberia, and Sardinia.

Uses.—Is cut into seal-stones, ring-stones, bracelets, necklaces, brooches, and crosses; and figures are often engraved on it.

THIRTEENTH SUBSPECIES.

Heliotrope.

Heliotrop, *Werner*.—Quartz-agathe ponctué, *Haüy*.

External Characters.—Colour green, with red and yellow spots of jasper. Occurs massive. Internally glistening, and resinous. Fracture conchoidal. Generally translucent on the edges; some varieties translucent. Brittle, and easily frangible.

Gognostic and Geographic Situations.—Occurs in rocks belonging to the secondary trap-formation, in Siberia, Tartary, Iceland, and even in Scotland.

Use.—Is cut and polished, and worn as an ornamental stone.

FOURTEENTH SUBSPECIES.

Jasper. origin of name disputed

There are five kinds, viz. Egyptian, Striped, Porcelain, Common, and Agate.

First Kind.

Egyptian Jasper.

This kind is divided into Red and Brown.

a. Red Egyptian Jasper.

Rother Egyptischer Jaspis, *Werner.*

External Characters.—Colours red and yellow; and sometimes exhibits ring-shaped delineations. Occurs in roundish blunt-edged rolled pieces. Externally rough, or uneven, and dull. Internally dull, or very feebly glimmering. Fracture flat conchoidal. Fragments indeterminate angular, and sharp-edged. Feebly translucent on the edges. Brittle, and easily frangible.

Geognostic and Geographic Situations.—Occurs imbedded in red clay iron-ore in Baden.

b. Brown Egyptian Jasper.

Brauner Egyptischer Jaspis, *Werner.*—Quartz-agathe opaque, *Haüy.*

External Characters.—Colours brown, yellow, and grey, frequently disposed in concentric stripes, alternating with black stripes. In the brown colour there sometimes occur black spots, and similar coloured dendritic delineations. Internally partly glistening, partly glimmering. Fracture conchoidal. Very feebly translucent on the edges, or almost opaque.

Geognostic and Geographic Situations.—Occurs loose in the sands of the African deserts, and in conglomerate rocks in Egypt.

Uses.—Is cut and worn as an ornamental stone.

Second Kind.

Striped Jasper.

Band Jaspis, *Werner.*—Quartz-jaspe onyx, *Haüy.*

External Characters.—Colours grey, green, yellow, and red, and seldom blue. There are always several colour together, and these are arranged in striped, flamed, and sometimes in spotted delineations. Occurs massive. Internally dull. Fracture conchoidal. Opaque, or very feebly translucent on the edges. Brittle, and rather easily frangible.

Geognostic and Geographic Situations.—Occurs in secondary clay-porphyry in the Pentland Hills near Edinburgh; but the most beautiful varieties are found in Siberia.

Uses.—This mineral receives an excellent polish, and hence is used like agate for ornamental purposes.

Third Kind.

Porcelain-Jasper.

Porzellan-Jaspis, *Werner.*—Thermantide porcellanite, *Haüy.*

External Characters.—Colours grey, blue, yellow, and seldom black and red. Occurs most commonly massive, and is frequently cracked in all directions. Internally glistening, sometimes approaching to shining, sometimes to glimmering, and even to dull; and the lustre vitreo-resinous. Fracture conchoidal. Opaque. Brittle, and easily frangible.

Geognostic and Geographic Situations.—Occurs along with pseudo-volcanic rocks in Fifeshire; near Dudley in Warwickshire, and in many other parts of Europe and America.

Fourth Kind.

Common Jasper.

Gemeiner Jaspis, *Werner.*—Quartz-jaspe, *Haüy.*

External Characters.—Colours red, brown, and black. Occurs massive. Internally varies from shining to dull; and lustre resino-vitreous. Fracture of some varieties is more or less perfect and flat conchoidal, with a shining or glistening lustre; in others the fracture is even, with a glimmering lustre, or it is fine earthy and dull. Opaque, or very faintly translucent on the edges. Brittle, and rather easily frangible.

Geognostic and Geognostic Situations.—Occurs in veins and imbedded masses in primitive, transition, and secondary rocks in Scotland, England and Ireland. Is not unfrequent on the continents of Europe, Asia, Africa, and America.

Uses.—When it occurs in sufficiently large masses, it is cut into various ornamental articles, as vases, snuff-boxes, pedestals, &c.

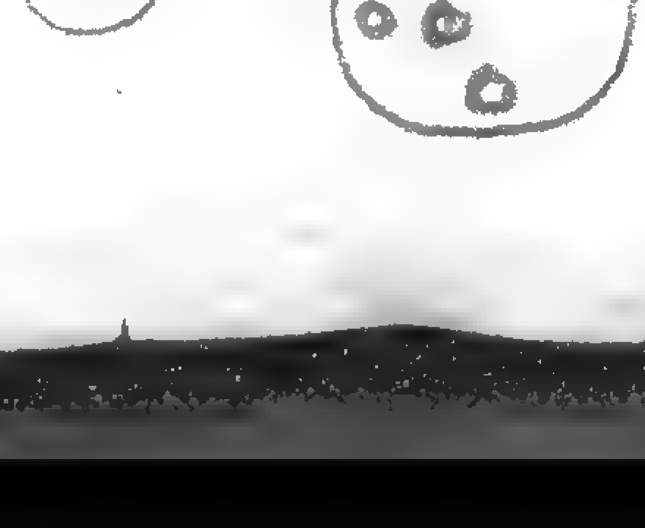
Fifth Kind.

Agate-Jasper.

Agat-Jaspis, *Werner.*

External Characters.—Colours white, yellow, and red. Several colours generally occur together, and these are ar-

—Some varieties are called Eye Stones



ranged either in clouded, flamed, or striped delineations; of these the striped are either disposed in a circular manner, or fortification-wise. Occurs massive. Frequently occurs in distinct concretions, which are either fortification-wise bent, or concentric lamellar. Internally dull. Fracture small and flat conchoidal, approaching to even. Brittle and easily frangible.

Geognostic Situation.—Occurs principally in layers, in agate-balls, in amygdaloid; likewise in agate-balls and veins in porphyry.

Geographic Situation.—Occurs in the agates of the middle district of Scotland, &c.

FIFTEENTH SUBSPECIES.

Floatstone, or Spongiform Quartz.

Schwimmstein, *Werner*.—Quartz nectique, *Haüy*.

External Characters.—Colours white and grey. Occurs in porous, massive, and tuberose forms. Internally dull. Fracture coarse earthy. Feebly translucent on the edges. Soft, but its particles are as hard as quartz. Brittle, and easily frangible. It is so porous as to float on water, but only until the air contained in its numerous cavities has been displaced by the water.

Geognostic and Geographic Situations.—Occurs incrusting flint, or in imbedded masses in a secondary limestone, at St Ouen, near Paris; also in the tin and copper mines of Cornwall.

* Agate.

Agate is not, as some mineralogists maintain, a simple mineral, but is composed of various kinds of the quartz genus, intimately joined together, and the whole mass is so compact and hard, that it receives a high polish. Agate is principally composed of calcedony, with flint, hornstone, carnelian, jasper, cacholong, amethyst, and quartz. Of these minerals, sometimes only two, in other instances more than three occur in the same agate; and these are either massive, disseminated, or in layers.

3. Uncleavable Quartz.

Untheilbarer Quartz, *Mohs*.

Specific Character.—Uncleavable. Hardness = 5.5,—6.5. Sp. gr. = 1.9,—2.2.

This species contains four subspecies, viz. 1. Quartzy Sinter; 2. Hyalite; 3. Opal; and, 4. Menilite.

FIRST SUBSPECIES.

Quartzy or Siliceous Sinter, or Pearl Sinter.

Kieselsinter, *Werner*.—Quartz-agathe concretionné thermogené, *Haüy*.

This subspecies is divided into three kinds, viz. Common, Opaline, and Pearly.

First Kind.

Common Quartzy or Siliceous Sinter.

Gemeiner Kieselsinter, *Karsten*.

External Characters.—Colour white, and grey, diversified with light red and hair-brown spots and stripes. Occurs massive, stalactitic, coralloidal, fruticose, botryoidal, porous; and occasionally contains parts of plants: also in distinct concretions, which are granular, fibrous, or curved lamellar. Externally dull; internally, when porous, dull, in other forms glistening and pearly. Fracture conchoidal or uneven. More or less translucent on the edges. Brittle, and easily frangible.

Chemical Characters.—Infusible without addition before the blowpipe.

Constituent Parts.—	Silica, - - -	98.0
	Alumina, - - -	1.5
	Iron, - - -	0.5
		100.0 *Klaproth.*

Geognostic and Geographic Situations.—Occurs around the hot-springs in Iceland.

Second Kind.

Opaline Quartzy or Siliceous Sinter.

Opalartiger Kieselsinter, *Weber*.

External Characters.—Colour white, with blackish or bluish spots, or dendritic delineations. Occurs massive, and in granular and lamellar concretions. Lustre glistening; and fracture conchoidal. Translucent on the edges. Brittle, and easily frangible.

Geognostic and Geographic Situations.—Around the hot-springs of Iceland.

Third Kind.

Pearl-Sinter, or Fiorite.

Fiorite, *Thomson.*

External Characters.—Colours white and grey. Occurs coralloidal, stalactitic, tubular, cylindrical, fruticose, botryoidal, reniform, and small globular; also in granular and lamellar concretions. Externally generally smooth and shining, and lustre pearly: sometimes rough and dull; internally dull, glistening, or shining, and lustre resino-pearly. Fracture uneven, conchoidal, or splintery. Fragments indeterminate angular and sharp-edged. Translucent, or only translucent on the edges. Brittle, and easily frangible.

Chemical Characters.—Like the other kinds, infusible before the blowpipe.

Constituent Parts.—	Silica,	94	
	Alumina	2	
	Lime,	4	
		100	*Santi.*

Geognostic and Geographic Situations.—Was discovered by Santi, an Italian naturalist, in Montamiato, and has been since found in the Vicentine, and in other quarters.

SECOND SUBSPECIES.

Hyalite.

Hyalith, *Werner.*

External Characters.—Colours white, grey, and green. Generally reniform, botryoidal, and sometimes stalactitic, and in crusts. Internally shining and splendent: and lustre vitreous, slightly inclining to resinous. Fracture conchoidal. Translucent, approaching to semi-transparent. Brittle, and easily frangible.

Chemical Characters.—Infusible without addition before the blowpipe.

Geognostic and Geographic Situations.—Has been hitherto found principally near Frankfort on the Mayne, where it occurs in fissures in vesicular basalt and basaltic greenstone.

[minute portions have been found in [illegible]

THIRD SUBSPECIES.

Opal.

Opal, *Werner.*

This subspecies is divided into seven kinds, viz. Precious, Common, Fire, Mother-of-Pearl or Cacholong, Semi, Jasper, and Wood.

First Kind.

Precious Opal.

Edler Opal, *Werner.*

External Characters.—Most common colour milk-white, which at the same time displays a fine play of beautiful colours. Occurs massive and disseminated. Internally splendent, and vitreous. Fracture conchoidal. Alternates from translucent to transparent. Brittle. Uncommonly easily frangible.

Chemical Characters.—Infusible without addition before the blowpipe.

Constituent Parts.—

	Opal of Czscherwenitza.
Silica, - - -	90
Water, - - -	10
	100 *Klaproth.*

Geognostic and Geographic Situations.—Occurs in small veins in clay-porphyry, and in secondary trap-rocks, generally accompanied with semi-opal, in Hungary; also in Iceland, and other countries. has lately been found in Mexico & Faroe Islands

Uses.—Few gems are more beautiful than precious opal. The elegant play of the richest, purest, and most beautiful colours, have procured for it a high rank among the precious stones. It is worked into ring-stones, necklaces, ear-drops, and other ornaments.

Second Kind.

Common Opal.

Gemeiner Opal, *Werner.*

External Characters.—Colours white, grey, yellow, red, and green. Occurs massive, and disseminated. Internally splendent, passing into shining, and vitreous. Fracture conchoidal. Most commonly semi-transparent. Brittle, and easily frangible.

		Of Telkobanya.	
Constituent Parts.—	Silica, - - -	93.50	
	Oxide of Iron, - -	1.00	
	Water, - - -	5.00	
		99.50	*Klaproth.*

Geognostic and Geographic Situations.—Occurs in veins, along with precious opal, in clay-porphyry, in Hungary and other countries.

Third Kind.

Fire Opal.

Feur Opal, *Karsten.*

External Characters.—Principal colour hyacinth-red, which passes through honey-yellow into wine-yellow; and upon lighter places shews a carmine-red and apple-green iridescence. In its interior, dendritic delineations are sometimes to be observed. Internally splendent, and lustre vitreous. Occurs in lamellar and granular distinct concretions. Fracture conchoidal. Completely transparent. Brittle, and uncommonly easily frangible.

Geognostic and Geographic Situations.—Has hitherto been found only in America, at Zimapan in Mexico, where it was first observed by Sonnenschmid and Humboldt, imbedded in porphyry.

Fourth Kind.

Mother-of-Pearl Opal, or Cacholong.

Perlmutter Opal, *Karsten.*

External Characters.—Colour milk-white; sometimes dendritic. Occurs massive, disseminated, and in granular concretions. Externally dull: internally alternates from dull to glistening and shining, and is pearly. Fracture flat conchoidal, but becomes earthy by the action of the atmosphere. Opaque. Brittle, and easily frangible.

Geognostic and Geographic Situations.—Occurs along with calcedony, in trap-rocks in the island of Iceland; in the Faroe islands; also in Greenland; and in Bucharia.

Fifth Kind.

Semi-Opal.

Halb-Opal, *Werner.*

External Characters.—Most common colours white, grey, and brown. Occurs not only massive and disseminated, but also tuberose, small reniform, small botryoidal, and stalactitic. Externally glistening; internally generally glistening, and vitreous, inclining to resinous. Fracture conchoidal. More or less translucent, and sometimes passes to translucent on the edges. Brittle, and rather easily frangible.

Geognostic and Geographic Situations.—Occurs in porphyry and amygdaloid, in Scotland, Iceland, France, Germany, &c.

Sixth Kind.

Jasper-Opal, or Ferruginous Opal.

Opal-Jaspis, *Werner.* distinguished from [illegible] lustre

External Characters.—Colours red, yellow, and grey. Occurs massive. Internally lustre shining, approaching to splendent, and intermediate between vitreous and resinous. Fracture perfect conchoidal, and sometimes rather flat conchoidal. Opaque, and sometimes feebly translucent on the edges.

Geognostic and Geographic Situations.—Is found in large and small pieces in porphyry, near Telkobanya and Tokay in Hungary, and in other parts of Europe.

Seventh Kind.

Wood-Opal.

Holz-Opal, *Werner.*

External Characters.—Colours white, grey, or brown, and sometimes also black. Occurs in pieces which have the shape of branches and stems. Internally lustre shining, and sometimes splendent, and glistening, or glimmering. Cross fracture conchoidal; longitudinal fracture sometimes modified by the remaining fibrous woody texture. More or less translucent; sometimes only translucent on the edges. Brittle, and easily frangible.

Geognostic and Geographic Situations.—Is found in alluvial land in Zastravia in Hungary; and is said to occur in secondary trap-rocks in Transylvania. In New-Holland

Uses.—Is cut into plates, and is then used for snuff-boxes, and other ornamental articles.

FOURTH SUBSPECIES.

Menilite.

This subspecies is divided into two kinds, viz. Brown and Grey.

First Kind.

Brown Menilite. from Menil, a hill near Paris

Brauner Menilith, *Hoffmann.*

External Characters.—Colour chesnut-brown. On the surface sometimes of a bluish colour. Occurs always tuberose. External surface rough and dull; internally faintly glistening, and lustre intermediate between resinous and vitreous. Fracture very flat conchoidal. Translucent on the edges. Brittle, and easily frangible.

Constituent Parts.—

Silica, - - -	85.5
Alumina, - - -	1.0
Lime - - -	0.5
Oxide of Iron, - -	0.5
Water and Carbonaceous Matter,	11.0
	98.5 *Klaproth.*

Geognostic and Geographic Situations.—Has hitherto been found only at Menil Montant, near Paris, where it occurs imbedded in adhesive-slate, in the same manner as flint is in chalk.

Second Kind.

Grey Menilite.

Grauer Menelit, *Hoffmann.*

External Characters.—Colour yellowish-grey, sometimes inclining to wood-brown. Occurs tuberose. Internally glimmering or dull. Fracture very flat conchoidal. Fragments indeterminate angular and sharp-edged. Translucent in the edges, or opaque. Easily frangible and brittle.

Geognostic and Geographic Situations.—Occurs imbedded in clayey-marl at Argenteuil, near Paris.

4. Fusible Quartz *.

Empyrodox Quartz, *Mohs.*

Specific Character.—Uncleavable. Hardness = 6.0,—7.0 Sp. gr. = 2.2,—2.4.

This species contains four subspecies, viz. Obsidian, Pitchstone, Pearl-stone and Pumice.

FIRST SUBSPECIES.

Obsidian.

Obsidian, *Werner.*—Lave vitreuse obsidienne, *Haüy.*

This subspecies is divided into two kinds, viz. Translucent, and Transparent.

First Kind.

Translucent Obsidian. from Obsidian a German

Durchscheinender Obsidian, *Hoffmann.*

External Characters.—Colours black, grey, and green. Occurs massive. Internally splendent, seldom shining, and lustre vitreous. Fracture conchoidal. Alternates from translucent to translucent on the edges. Very brittle. Easily frangible. Streak grey.

Chemical Characters.—The black obsidian of Iceland, according to Da Camara, on charcoal, before the blowpipe, melts into a pale ash-grey imperfect vesicular glass.

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* This species is nearly allied to felspar.

Constituent Parts.—

	American.
Silica,	72.0
Alumina,	12.5
Natron and Potash,	10.0
Lime,	0.0
Oxide of Iron and Manganese,	2.0
	96.5 *Collet-Descotils.*

Geognostic Situation.—This mineral occurs in beds, imbedded masses and veins, in porphyry, and in various secondary trap-rocks. Said also to occur in streams *(coule)*, in undoubted volcanic districts.

Geographic Situation.—Occurs in various parts of Europe, Asia, Africa, and America.

Uses.—It is cut into ornamental articles of different kinds.

Second Kind.

Transparent Obsidian.

Durchsichtiger Obsidian, *Hoffmann.*

External Characters.—Colours blue, brown, and white. Internally splendent and vitreous. Fracture conchoidal. Perfectly transparent.

Geognostic and Geographic Situations.—Occurs imbedded in pearlstone-porphyry, at Marekan in Siberia.

SECOND SUBSPECIES.

Pitchstone.

Pechstein, *Werner.*—Petrosilex resiniforme, *Haüy.*

External Characters.—Colours green, grey, blue, yellow, brown, and black. Occurs massive, and in prismatic, globular, and lamellar concretions. Internally shining and glistening, and lustre vitreo-resinous. Feebly translucent on the edges. Fracture conchoidal, coarse-grained uneven, and coarse splintery. Brittle, and easily frangible.

Constituent Parts.—

Silica,	73.00
Alumina,	14.50
Lime,	1.00
Oxide of Iron,	1.00
Oxide of Manganese,	0.10
Natron,	1,75
Water,	8.50
	99.85 *Klaproth.*

Geognostic and Geographic Situations.—Occurs in primitive, transition and secondary rocks, in Scotland, Ireland, Saxony, &c. in Amer

THIRD SUBSPECIES.

Pearl-Stone.

Perlstein, *Werner.*—Obsidienne perlé, *Haüy.*

External Characters.—Colours grey, black, and red. Occurs massive, disseminated; also in roundish granular, and curved lamellar concretions. Lustre shining and pearly. Translucent on the edges, or translucent. Very easily frangible.

Constituent Parts.—

Silica,	77.0
Alumina,	13.00
Oxide of Iron and Manganese,	2.00
Potash,	*2.00
Lime,	1.50
Natron,	0.70
Water,	4.00
	100.02 *Vauquelin.*

Geognostic and Geographic Situations.—Occurs in porphyry, in Hungary, Spain, North of Ireland, Iceland, and Mexico.

FOURTH SUBSPECIES.

Pumice.

Bimstein, *Werner.*—Lave vitreuse pumicée, *Haüy.*

This subspecies is divided into three kinds, viz. Glassy, Common, and Porphyritic.

First Kind.

Glassy Pumice.

Glasiger Bimstein, *Werner.*

External Characters.—Colour grey, and sometimes white. Occurs vesicular, and capillary in the vesicular cavities. Internally, principal fracture is glistening and pearly; cross fracture shining, and nearly vitreous. Principal fracture is promiscuous fibrous; the cross fracture conchoidal, sometimes inclining to uneven. Fragments indeterminate angular and blunt edged. Translucent, or translucent on the edges. Brittle, and rather easily frangible. Feels very rough, sharp, and meagre.

Geognostic and Geographic Situations.—Occurs in beds along with common pumice and obsidian, in the Lipari Islands, &c.

Second Kind.

Common Pumice.

Gemeiner Bimstein, *Werner.*

External Characters.—Colours white and grey. Occurs vesicular, and in the interior of the vesicles capillary fibres. Internally glistening or glimmering and pearly. Principal fracture fibrous; cross fracture uneven. Fragments blunt, angular, and sometimes splintery. Translucent on the edges. Brittle and easily frangible. Feels meagre and rough.

Chemical Characters.—At 60° Wedgwood, melts into a grey coloured slag.

Constituent Parts.—

Silica,	77.50
Alumina,	17.50
Natron and Potash,	3.00
Iron and Manganese,	1.75
	99.75 *Klaproth.*

Geognostic and Geographic Situations.—Occurs in beds along with glassy pumice and obsidian, in the Island of Lipari; also in Iceland, Teneriff, and other parts.

Uses.—It is used for polishing glass and soft stones; also by parchment-makers, curriers and hat-makers, and hence forms a considerable article of trade, and is exported from the Lipari Islands in great quantities, to the different countries of Europe.

Third Kind.

Porphyritic Pumice.

Porphyrartiger Bimstein, *Werner.*

External Characters.—Colours white and grey; rarely brown. Occurs massive and porous. Internally glistening or glimmering, and pearly. Fracture imperfect, curved fibrous, which sometimes passes into splintery or uneven. Feebly translucent on the edges. Brittle, and easily frangible.

Geognostic and Geographic Situations.—It contains crystals of felspar, quartz and mica, and is associated with trachyte-porphyry, obsidian, pearlstone and pitchstone, in Hungary and other countries.

Genus VII. Axinite.

the crystals are [illegible]

Prismatic. Perfect vitreous lustre. Hardness = 6.5,—7.0. Specific gravity = 3.0,—3.3.

the head of an axe

1. Prismatic Axinite.

Prismatischer Axinit, *Mohs.*—Thumerstein, *Werner.*—Axinite, *Haüy.*

Specific Character.—Tetarto-prismatic. Pyramid unknown. Cleavage, two faces, the one more distinct than the other. Incidence = 101° 30′.

External Characters.—Colours clove-brown, plumb-blue, grey, and black. Seldom massive, most frequently crystallized in very oblique four-sided prisms. Massive varieties occur in curved lamellar distinct concretions. Externally, lustre splendent; internally, alternates from glistening to shining, and is vitreous, slightly inclining to resinous. Fracture fine-grained uneven, or conchoidal. Alternates from perfectly transparent to feebly translucent. Brittle, and very easily frangible.

Chemical Characters.—Easily fusible with ebullition into a bottle-green glass, which, by continuance of the heat, becomes nearly black.

Constituent Parts.—

Silica,	50.50
Alumina,	16.00
Lime,	17.00
Oxide of Iron,	9.50
—— of Manganese,	5.25
Potash,	0.25
	98.50 *Klaproth.*

Geognostic Situation.—Occurs in primitive mountains, in rocks of gneiss, mica-slate, clay-slate, and hornblende-rock, Is found in Cornwall, and in various districts on the Continent of Europe.

Genus VIII. Chrysolite.

Prismatic. Perfect vitreous lustre. Hardness = 6.5,—7.0. Sp. gr. = 3.3,—3.5

1. Prismatic Chrysolite.

Prismatischer Krisolith, *Mohs.*—Peridot, *Haüy.*

Specific Character.—Prismatic. Pyramid = 107° 46′; 101° 31′; 190° 41′. $P + \infty = 94° 3′$. Cleavage, $P\breve{r} + \infty$. Less distinct $P\bar{r} + \infty$.

Of this species there are two subspecies, viz. Chrysolite, and Olivine.

FIRST SUBSPECIES.

Chrysolite.

Krisolith, *Werner.*

External Characters.—Colours pistachio-green, and also asparagus, and pale grass green. Occurs in angular pieces, roundish pieces, and often crystallized in a four and six sided prisms, variously acuminated, and bevelled, and truncated on the lateral edges. Internally, lustre splendent and vitreous. Fracture conchoidal. Transparent, and refracts double. Brittle, and easily frangible.

Chemical Characters.—Infusible, without addition, before the blowpipe; but with borax melts into a transparent green glass.

Constituent Parts.—	Silica,	39.00	
	Magnesia,	43.50	
	Iron,	19.00	
		101.50	*Klaproth.*

Geognostic and Geographic Situations.—Is found in alluvial soil in Upper Egypt, and on the shores of the Red Sea.

Uses.—It is cut and polished, and made into necklaces, hair ornaments and ring-stones.

SECOND SUBSPECIES.

* Olivine.

Olivin, *Werner.*

External Characters.—Colours olive-green, and yellow.

* Is Chrysolite in a less perfect form -

Occurs massive, in grains, in roundish pieces, and in angulo-granular concretions. When crystallized, which is rarely the case, it is in the form of rectangular four-sided prisms, and these are always imbedded. Internally, lustre shining and glistening, and vitreo-resinous. Fracture small-grained uneven, sometimes passing into imperfect small conchoidal. Translucent, passing into semi-transparent, but seldom transparent.

Geognostic and Geographic Situations.—Occurs imbedded in basalt, greenstone, porphyry, and lava, generally accompanied with augite, in Scotland, Germany, Italy, and other countries. (near Edinburgh.

GENUS IX. BORACITE. Borate of Magnesia

Tessular. Hardness = 7. Sp. gr. = 2.8,—3.0.

1. Octahedral Boracite.

Octaedrischer Borazit, *Mohs.*—Borazit, *Werner.*—Magnesie Boratée, *Haüy.*

Specific Character.—Tessular. Cleavage, imperfect octahedral.

External Characters.—Colours white and grey. Occurs crystallized in the following figures: 1. Cube, either perfect or variously truncated on the edges and angles. 2. Tetrahedron, truncated on all the edges, and acuminated on all the angles with three planes, which are set on the lateral planes. 3. Rhomboidal dodecahedron. Internally shining and adamantine. Fracture conchoidal, sometimes passing into uneven. Translucent, or transparent. Brittle and easily frangible.

Physical Characters.—Pyro-electric on all the angles, and this electricity very easily excited.

Chemical Characters.—Fusible before the blowpipe into a yellowish enamel.

Constituent Parts.—

Magnesia,	16.6
Boracic Acid,	83.4
	100.0 *Vauquelin.*

Geognostic and Geographic Situations.—Occurs imbedded always in gypsum and anhydrite; and hitherto only in two places, viz. at the Kalkberg at Lüneberg in Hanover, and the Segeberg, near Kiel, in Holstein.

Genus X. Tourmaline.

Rhomboidal. Hardness = 7.0,—7.5. Sp. gr. = 3.0,—3.2.

1. Rhomboidal Tourmaline.

Rhomboedrischer Turmalin, *Mohs.*—Tourmaline, *Haüy.*

Specific Character.—Rhomboidal. Rhomboid = 133° 26′. Cleavage, R. P + ∞.

It is divided into two subspecies, viz. Tourmaline and Schorl.

FIRST SUBSPECIES.

Tourmaline.

Turmalin, *Werner.*

External Characters.—Colours green, brown, red, blue, yellow, and white. In some crystals the centre is red, but the exterior green. Occurs very seldom massive, or in prismatic concretions; scarcely ever disseminated; oftener in rolled pieces; but most frequently crystallized, in three, four, six, and nine sided prisms, variously acuminated. The lateral faces are generally cylindrical convex, and deeply longitudinally streaked; the acuminating planes are mostly smooth and shining: sometimes the planes on one extremity are smooth, but on the other rough. Internally lustre splendent and vitreous. Fracture nearly perfect, and small conchoidal. Alternates from nearly opaque to completely transparent. Refracts double in a middling degree. When viewed perpendicular to the axis of the crystal, it is more or less transparent, but in the direction of the axis, even when the length of the prism is less than the thickness, it is opaque. Brittle, and easily frangible.

Physical Characters.—By friction, it exhibits signs of vitreous electricity; by heating, vitreous electricity at one extremity, and resinous electricity at the other.

(Boracic acid is found in Salisbury Craigs)

Chemical Characters.—Before the blowpipe it melts into a greyish-white vesicular enamel; but the red coloured Siberian tourmaline is infusible.

Constituent Parts.—

	Green Tourmaline from Brazil.
Silica,	40.00
Alumina,	39.00
Lime,	3.84
Oxide of Iron,	12.50
Oxide of Manganese,	2.00
Loss,	2.66
	100.00 *Vauquelin.*

occasionally contains a little Boracic Acid

Geognostic and Geographic Situations.—Tourmaline occurs in primitive rocks in Scotland, England, Germany, Norway, Italy, and many other countries.

Uses.—The green, blue, red, and brown varieties are sometimes cut and polished, and worn as ornamental stones.

SECOND SUBSPECIES.

Common Schorl.

from a village in Saxony

Gemeiner Schorl, *Werner*.—Schorl opaque et noire, *Haüy*.

External Characters.—Colour velvet-black, of various degrees of intensity. Occurs massive, disseminated, in granular and prismatic concretions, and frequently crystallized, in three, six, and nine sided prisms, that present various acuminations, truncations and bevelments. Internally lustre intermediate, between shining and glistening, and vitreous. Fracture intermediate between conchoidal and uneven. Opaque. Affords a grey streak. Brittle, and easily frangible.

Constituent Parts.—

	Common Schorl from Eibenstock.
Silica,	36.75
Alumina,	34.50
Magnesia,	0.25
Oxide of Iron,	21.00
Potash,	6.00
	98.50 *Klaproth.*

Physical Characters.—Exhibits the same electrical properties as tourmaline.

Geognostic and Geographic Situations.—Occurs in primitive mountains in every extensive alpine district in Europe; and also in Asia, Africa, and America.

GENUS XI. GARNET.

Tessular, pyramidal, prismatic. If colour red, the Sp. gr. = 3.7 and more. If black, Sp. gr. = 3.9 and less. Lustre not pure vitreous. Hardness ranges from 6.0 to 7.5. If 7.5 the colour is red or brown. Sp. gr. = 3.1,—4.3.

1. Pyramidal Garnet, or Vĕsuvian.

Pyramidaler Granat, *Mohs.*—Vesuvian, & Egeran, *Werner.*—Idocrase, *Haüy.*

Specific Character.—Pyramidal. Pyramid = 129° 29′; 74° 14′. Cleavage, $P - \infty$. $P + \infty$. $[P + \infty]$. Hardness = 6.5. Sp. gr. = 3.3—3.4.

External Characters.—Colours green and brown. Occurs massive, disseminated, and in granular concretions; but more frequently crystallized in rectangular four-sided prisms, variously acuminated, truncated, and bevelled. Lateral planes of the prism are longitudinally streaked; but the truncating and terminal planes are smooth. Externally the crystals are splendent; internally glistening, approaching to shining, and the lustre vitreo-resinous. Fracture small-grained uneven. Alternates from translucent to translucent on the edges, and refracts double. Brittle, and easily frangible.

Chemical Characters.—Before the blowpipe it melts without addition into a yellowish and faintly translucent glass.

		Vesuvian of Vesuvius.
Constituent Parts.—	Silica,	35.05
	Lime,	33.00
	Alumina,	22.25
	Oxide of Iron,	7.05
	Oxide of Manganese,	0.25
	Loss,	1.05
		100.00 *Klaproth.*

Geognostic and Geographic Situations.—Occurs in primitive rocks in Ireland, Italy, Norway, Switzerland, &c.

Uses.—At Naples it is cut into ring-stones, and is sold under various names: the green-coloured varieties are denominated Volcanic Chrysolite; and the brown, Volcanic Hyacinth.

2. Tetrahedral Garnet, or Helvine.

Helvin, *Werner.*—Helvine, *Jameson,* 3d edit.

Specific Character.—Tessular. Cleavage, octahedral, but indistinct. Hardness = 6.0,—6.5. Sp. gr. = 3.1,—3.3.

External Characters.—Colours wax-yellow, and pale oil and siskin green. Occurs disseminated, in granular concretions; and crystallized in tetrahedrons, which are perfect or truncated on the angles. Internally glimmering or shining: externally vitreous, and internally vitreo-resinous. Fracture small-grained uneven. Crystals strongly translucent. Brittle, and easily frangible.

Chemical Characters.—Melts before the blowpipe into a blackish-brown glass.

Geognostic and Geographic Situations.—Occurs along with slate-spar, brown-blende, fluor, and chlorite, in beds subordinate to gneiss, near Schwarzenberg in Saxony.

3. Dodecahedral Garnet.

Specific Character.—Tessular. Cleavage dodecahedral. Hardness = 6.5,—7.5. Sp. gr. = 3.5,—4.3.

This species contains seven subspecies, viz. 1. Grossulare; 2. Pyreneite; 3. Melanite; 4. Allochroite; 5. Colophonite; 6. Garnet; and 7. Pyrope.

FIRST SUBSPECIES.

Grossulare.

Grossular, *Werner.*

External Characters.—Colour asparagus-green. Crystallized in acute double eight-sided pyramids, flatly acuminated on both extremities by four planes; the acuminating planes set on the alternate edges of the double eight-sided pyramid. Planes of the crystals smooth. Externally shining; internally shining, and lustre resinous. Fracture intermediate between conchoidal and uneven. Translucent. Brittle, and rather easily frangible.

Geognostic and Geographic Situations.—Occurs imbedded in small crystals, along with vesuvian, in a pale greenish-grey claystone, near the river Wilui in Siberia; also in the Bannat of Temeswar.

SECOND SUBSPECIES.

Pyreneite.

Pyreneit, *Werner.*

External Characters.—Colour greyish-black. Occurs massive, and crystallized in rhomboidal dodecahedrons. Externally glistening, inclining to shining, and metallic-like. Internally glistening and vitreous. Fracture small-grained uneven. Opaque.

Geognostic and Geographic Situation.—Occurs in primitive limestone in the Pic of Eres-Lids, near Bareges, in the French Pyrenees.

THIRD SUBSPECIES.

Melanite. from [illegible]

Melanit, *Werner.*

External Characters.—Colour velvet-black. Generally crystallized in rhomboidal dodecahedrons, truncated on the edges. Internally shining, inclining to glistening, and resino-vitreous. Fracture conchoidal. Opaque. Rather easily frangible.

Constituent Parts.—

Silica,	35.50
Alumina,	6.00
Lime,	32.05
Oxide of Iron,	25.25
Oxide of Manganese,	0.04
Loss,	0.35
	100 *Klaproth.*

Geognostic and Geographic Situations.—Occurs in primitive and secondary rocks in Italy, Germany, and Norway.

FOURTH SUBSPECIES.

Allochroite.

Allochroit, *Werner.*

External Characters.—Colours, grey, brown, and green. Occurs massive. Internally glimmering, rarely glistening, and lustre resinous. Fracture uneven, sometimes even passing to conchoidal. Feebly translucent on the flat edges. Rather easily frangible.

Geognostic and Geographic Situations.—It has hitherto been found only in Viuls iron-mine near Drammen in Norway, where it is associated with calcareous-spar, reddish-brown garnet, and magnetic iron-ore.

FIFTH SUBSPECIES.

Colophonite, or Resinous Garnet.

External Characters.—Colours brown, red, and green. Occurs massive, in angulo-granular concretions; and crystallized in rhomboidal dodecahedrons, either perfect, or truncated on the edges. Appears as if melted. Internally shining; externally splendent. Lustre resino-adamantine. Fracture imperfect conchoidal. Translucent, or only translucent on the edges.

Geognostic and Geographic Situations.—Occurs in beds of magnetic iron-ore, which are subordinate to gneiss, at Arendal in Norway; in talc-slate at Salvagnengo in Piedmont; and in gneiss in the Island of Ceylon.

SIXTH SUBSPECIES.

Garnet.

This subspecies is divided into two kinds, viz. Precious and Common Garnet.

First Kind.

Precious Garnet.

Edler Granat, *Werner.*

External Characters.—All the colours of this gem are [illegible] of the ancients [illegible]: the origin of their name signifying [illegible] shining in the dark is erroneous, this [illegible] sapphire

dark-red, which generally fall into blue. Occurs in roundish grains, and in lamellar concretions, also crystallized in rhomboidal dodecahedrons, and in the form of the leucite. Internally it is shining, bordering on splendent; and vitreous, inclining slightly to resinous. Fracture conchoidal. Alternates from completely transparent to translucent. Brittle, and rather difficultly frangible.

Chemical Characters.—Before the blowpipe it melts pretty easily into a black scoria or enamel.

Constituent Parts.—

Silica,	39.66
Alumina,	19.66
Black Oxide of Iron,	39.68
Oxide of Manganese,	1.80
	100.80 *Berzelius.*

Geognostic and Geographic Situations.—Occurs imbedded in primitive rocks, in Scotland, England, Ireland, Germany, Norway, Sweden, and many other countries.

Use.—This beautiful gem is not so highly valued at present as it was a century ago. The larger kinds are used as ring-stones, and, after cutting and polishing, are set either *au jour*, or are provided with a silver or violet-blue foil.

Second Kind.

Common Garnet.

Gemeiner Granat, *Werner.*

External Characters.—Colours brown, green, yellow, red and black. Occurs most commonly massive, in angulo-granular distinct concretions, sometimes crystallized, and possesses all the figures of the precious garnet. External lustre shining, or glistening, very rarely splendent. Internal lustre glistening, seldom shining, and intermediate between resinous and vitreous. Fracture fine-grained uneven, sometimes slightly inclining to imperfect conchoidal, or to splintery. More or less translucent; the streak nearly opaque. Softer than precious garnet.

Geognostic and Geographic Situations.—Occurs massive or crystallized in primitive rocks in Scotland, England, Ireland, Norway, Sweden, Germany, Italy, and many other countries.

Use.—On account of its easy fusibility, it is sometimes employed as a flux in smelting iron-ores.

SEVENTH SUBSPECIES.

Pyrope.

from its beautiful red colour

Pyrope, *Werner.*

External Characters.—Colour dark blood-red. Occurs in roundish and angular grains. Lustre splendent, and vitreo-resinous. Fracture conchoidal. Transparent, and refracts double. Rather harder than precious garnet.

Constituent Parts.—

Silica,	40.00
Alumina,	28.50
Magnesia,	10.00
Lime,	3.50
Oxide of Iron,	16.50
—— Manganese,	0.25
Acid of Chrome,	2.00
Loss,	1.25
	100.75 *Klaproth.*

Geognostic and Geographic Situation.—Occurs in serpentine and trap, in Bohemia.

Use.—This beautiful gem is employed in almost every kind of jewellery, and is generally set with a gold foil.

(is called the Bohemian Garnet

4. Prismatic Garnet, or Cinnamon-Stone.

Prismatischer Garnet, *Mohs.*—Kaneelstein, *Werner.*—Essonite, *Haüy.*

Specific Character.—Prismatic. Pyramid unknown. Cleavage, $P + \infty = 102° 40'$, indistinct. Hardness $= 7.0,—7.5$. Sp. gr. 3.5,—3.7.

External Characters.—Principal colour intermediate between hyacinth-red and orange-yellow. Occurs massive, and in granular distinct concretions. Internally shining, approaching to glistening; and lustre resino-vitreous. Fracture in every direction rather imperfect, and flat conchoidal. Transparent and semitransparent; generally so impure and full of cracks, that faultless specimens rarely occur. Refracts single. Brittle, and rather difficultly frangible.

Geognostic and Geographic Situation.—Occurs in gneiss near Kincardine in Ross-shire; in alluvial deposites, and also associated with quartz, tabular-spar, and iron-ore, in gneiss, in the island of Ceylon.

Use.—Is cut as a precious stone, and, when free of flaws, is of considerable value.

5. Prismatoidal Garnet, or Grenatite.

Prismatoidischer Granat, *Mohs.*—Granatit, *Werner.*—Staurotide, *Haüy.*

Specific Character.—Prismatic. Pyramid $= 131° 54'$; $80° 43'$; $124° 48'$. $P + \infty = 129° 30'$. Cleavage, $\breve{P}r + \infty$, perfect. Hardness $= 7.0, — 7.5$. Sp. gr. $= 3.3, — 3.9$.

External Characters.—Colour dark reddish-brown. Occurs only crystallized, and in the following figures: 1. Very oblique four-sided prism, truncated on the acute lateral edges. 2. Preceding figure acutely bevelled on the extremities, the bevelling planes cut on the obtuse lateral edges. 3. Various twin crystals. Internally the cleavage is shining and splendent; fracture glistening and glimmering, with a resino-vitreous lustre. Fracture small-grained uneven, which sometimes approaches to small conchoidal. Often opaque, sometimes translucent, and very rarely semitransparent. Brittle, and easily frangible.

		St Gothard.
Constituent Parts.—	Alumina,	41.00
	Silica,	37.05
	Oxide of Iron,	18.25
	Oxide of Manganese,	0.05
	Loss,	2.75
		100 *Klaproth.*

Geognostic and Geographic Situations.—The geognostic relations of this mineral are nearly the same with those of precious garnet. Occurs in Aberdeenshire, the Shetland Islands, county of Wicklow in Ireland, &c.

Genus XII. Zircon.

Pyramidal. Hardness = 7.5. Sp. gr. = 4.5,—4.7.

1. Pyramidal Zircon.

Pyramidaler Zircon, *Mohs.*

Specific Character.—Pyramidal. Pyramid = 123° 19′; 84° 20′. Cleavage, P . P + ∞.

This species is divided into two subspecies, Common Zircon, and Hyacinth.

FIRST SUBSPECIES.

Common Zircon.

Zirkon, *Werner* & *Haüy.*

External Characters.—Colour grey, also white, green, and brown; and rarely yellow, blue, and red. Occurs crystallized in rectangular fonr-sided prisms acuminated with four or eight planes. Internally splendent, passing into shining, and lustre intermediate between adamantine and resinous. Imperfect cleavage. Fracture perfect and flat conchoidal. Alternates from transparent to opaque. Refracts double in a high degree.

Chemical Characters.—Infusible without addition before the blowpipe.

Constituent Parts.—	Zircon of Ceylon.	
Zirconia,	69.00	
Silica,	26.50	
Oxide of Iron,	0.50	
	96.00	*Klaproth.*

SECOND SUBSPECIES.

Hyacinth.

Hiacinth, *Werner.*

External Characters.—Colours red, brown, yellow, grey, green, and white. Occurs crystallized, in rectangular four-sided prisms, acuminated with four planes set on the lateral edges. Internally specular-splendent, and lustre intermediate between resinous and vitreous. Perfect cleavage. Fracture perfect and small conchoidal. Alternates from transparent to semitransparent. Refracts double.

Geognostic and Geographic Situations of the Zircon Species, including Common Zircon and Hyacinth.—Occurs in grains and crystals, imbedded in gneiss and sienite: also imbedded in basalt and lava, and dispersed through alluvial soil. It is met with in the Shetland Islands, Sutherlandshire, Inverness-shire, Galloway, &c. The finest specimens are brought from the East, principally from Ceylon.

Genus XIII. Gadolinite.

Prismatic. Black. Hardness $=6.5,—7.0$. Sp. gr. $4.0,—4.3$.

1. Prismatic Gadolinite.

Prismatischer Gadolinit, *Mohs.*—Gadolinit, *Karsten.*

Specific Character.—Hemiprismatic. Pyramid unknown. $P + \infty = 110°$ (nearly).

External Characters.—Colour velvet-black; sometimes greenish-black; very rarely hyacinth-red. Occurs massive and disseminated; the massive varieties sometimes composed of granular or prismatic concrtions, the surfaces of which have frequently a whitish or bluish aspect, and vary from glistening to dull. It very rarely occurs crystallized, in six-sided prisms. Internally shining; lustre resinous, inclining to vitreous. Fracture generally conchoidal; seldom uneven. Brittle, and difficultly frangible.

Constituent Parts.—

Silica,	25.80
Yttria,	45.00
Oxide of Cerium,	16.69
Oxide of Iron,	10.26
Volatile Matter,	0.60
	98.35 *Berzelius.*

Geognostic and Geographic Situations.—Occurs in beds of felspar in mica-slate, at Ytterby near Waxholm in Roslagen, and in granite at Finbo near Fahlun, in Sweden.

ORDER VIII. ORE.

If the lustre is metallic, the colour is black. If the lustre is not metallic, it is adamantine or imperfect, or semi-metallic lustre.

If the streak is yellow or red, the Hardness = 3.5, and more; and the Sp. gr. = 4.8, and more. If the streak is brown or black, the hardness = 5.0, and is more, or perfectly prismatoidal.

Hardness = 2.5,—7.0. If 4.5 and less, the streak is red, yellow, or black. If 6.5 and more, the streak is white or grey, and the Sp. gr. = 6.5 and more.

Sp. gr. = 3.4,—7.4.

GENUS I. TITANIUM-ORE.

Pyramidal, prismatic. Hardness = 5.0,—6.5. Sp. gr. = 3.4,—4.4. If less than 4.2, the streak is white or grey.

1. Prismatic Titanium-Ore, or Sphene.

Prismatisches Titan-erz, *Mohs.*

Specific Character.—Hemiprismatic. Pyramid = 111° 12′; 88° 47′; 131° 16′. $\frac{P}{2}$ = 111° 12′. P + ∞ = 103° 20′. $P\bar{r}$ = 60°. $(P\bar{r} + \infty)^3$ = 136° 50′. Cleavage, $\frac{\bar{P}}{2}$. Streak white or grey. Hardness = 5.0,—5.5. Sp. gr. 3.4,—3.6.

This species is divided into two subspecies, viz. Common and Foliated.

FIRST SUBSPECIES.

* Common Sphene.

Braun Manakerz, *Werner.*—Titane siliceo-calcaire, *Haüy.*

External Characters.—Colours brown, green, grey, and white. Occurs in granular distinct concretions; and crystallized in the following forms: 1. Oblique four-sided prism, be-

* not unlike H[illegible] distinguish[illegible] from yellowing [illegible] the [illegible]

velled on the extremities, the bevelling planes set on the obtuse lateral edges. 2. Broad six-sided prism, acuminated with four planes. 3. Rectangular four-sided prism, which is either bevelled on the extremities, or acuminated with four planes, which are set on the lateral planes. 4. Oblique four-sided pyramid, in which the apices are bevelled. 5. Sometimes the preceding figure is so flat that it has a lenticular form. Internally shining or glistening; lustre adamantine, sometimes inclining to resinous, sometimes to vitreous. Fracture imperfect conchoidal, which inclines to uneven. Alternates from opaque to translucent. Brittle, and easily frangible.

Chemical Characters.—Without addition, is difficultly fusible before the blowpipe. With borax, yields a grey slag; and with phosphate of soda a green globule.

		St Gothard.
Constituent Parts.—	Oxide of Titanium,	33.3
	Silica,	28.0
	Lime,	32.2
	Water,	0.0
		93.5 *Cordier.*

Geognostic and Geographic Situations.—Occurs imbedded in the syenite of Criffle, and other hills in Galloway; in the syenite of Inverary; and in various other quarters in Scotland.

SECOND SUBSPECIES.

Foliated Sphene.

Gelb Manakerz, *Werner.*—Titane siliceo-calcaire, *Haüy.*

External Characters.—Colours yellow, brown, and grey. Occurs massive, in straight lamellar concretions, and crystallized in the same figures as the preceding subspecies. Lustre on the cleavage splendent or shining; on the imperfect conchoidal and uneven fractures only shining or glistening, and resinous. Fracture imperfect conchoidal, inclining to uneven. Translucent, or only translucent on the edges.

Geognostic and Geographic Situations.—Occurs in primitive rocks in Italy, Bohemia, Norway, and other countries.

2. Prismato-Pyramidal Titanium-Ore.

Prismato-Pyramidales Titan-erz, *Mohs.*

Specific Character.—Pyramidal. Pyramid = 117° 2′; 95° 13′. Cleavage, P + ∞. [P + ∞]. Streak brown. Hardness = 6.0,—6.5. Sp. gr. = 4.2,—4.4.

This species is divided into two subspecies, viz. Rutile and Nigrine.

FIRST SUBSPECIES.

Rutile. pure oxide of titanium

Rutil, *Werner.*—Titane oxydé, *Haüy.*

External Characters.—Colours brown, red, and yellow. Occurs massive, disseminated, in membranes, and in four and six-sided prisms. Internally the lustre is intermediate between adamantine and imperfect metallic, and is splendent on the surface of the cleavage, but only shining or glistening in the conchoidal or uneven fractures. Fracture uneven and conchoidal. Streak brown. Transparent, or only translucent on the edges.

Constituent Parts.—Is nearly pure Oxide of Titanium.

Geognostic Situation.—It is found imbedded in veins and in drusy cavities in granite, syenite, gneiss, mica-slate, quartz-rock, limestone, chlorite-slate, and hornblende-slate.

Geographic Situation.—In Scotland, in the granite of Cairngorm; at Craig Cailleach, near Killin, imbedded in quartz; in quartz-rock in Ben-Gloe: in Wales, near Beddgelert in Caernarvonshire; and in quartz in Snowdon.

SECOND SUBSPECIES.

Nigrine.

Nigrin, *Werner.*

External Characters.—Colours dark brownish-black, inclining to velvet-black. Occurs in angular grains, and in rolled pieces. Internally cleavage shining; cross fracture moderately glistening, and lustre metallo-adamantine. Cleavage distinct. Fracture conchoidal. Opaque. Brittle, and easily frangible.

Physical Characters.—Not attracted by the magnet.

Constituent Parts.—		
	Oxide of Titanium, - -	84
	Oxide of Iron, - -	14
	Oxide of Manganese, - -	2
		100 *Klaproth.*

Geognostic and Geographic Situations.—Occurs in primitive and alluvial districts. Is frequently associated with iron-sand, hyacinth, zircon, &c. and is found in Transylvania, Bohemia, Ceylon, and other countries.

3. Pyramidal Titanium-Ore, or Octahedrite.

Pyramidales Titan-erz, *Mohs.*—Octaedrit, *Werner.*—Titane, Anatase, *Haüy.*

Specific Character.—Pyramidal. Pyramid $= 97° 38'$; $137° 10'$. Cleavage, $P - \infty$. P. Streak white. Hardness $= 5.5$,—6.0. Sp. gr. $= 3.8$,—3.9.

External Characters.—Colours blue and brown. Occurs crystallized in double four-sided pyramids, variously modified by acuminations and truncations. Internally splendent, and lustre adamantine, inclining to semi-metallic. Is strongly translucent or transparent. Brittle, and easily frangible.

Constituent Part.—Is Oxide of Titanium.

Geognostic and Geographic Situations.—Occurs at Bourg d'Oisans at Dauphiny, in primitive rocks, and in transition limestone in Norway.

Genus II. Zinc-Ore.

Prismatic. Hardness $= 4.0$, 4.5. Sp. gr. $= 6.2$,—6.3.

1. Prismatic Zinc-Ore.

Red Zinc, or Red Oxide of Zinc, *Jameson,* 3d edit.; Red Zinc-Ore, *Jameson,* 2d edit.

Specific Character.—Prismatic. Pyramid unknown. Cleavage, $P + \infty = 125°$ (nearly). Traces of $\breve{P}r + \infty$. Streak orange-yellow.

External Characters.—Colours blood-red, and aurora-red. Occurs massive, and disseminated. Internally, fresh fracture shining; after long exposure to the air becomes dull, and even covered with a pearly crust. Fracture conchoidal. Translucent on the edges, or opaque. Brittle.

Constituent Parts.—

Zinc, - - -	76
Oxygen, - - -	16
Oxides of Manganese and Iron,	8
	100 *Bruce.*

Geognostic and Geographic Situations.—This mineral occurs in several iron-mines in Sussex county, and New Jersey, in North America: in some instances it is imbedded in foliated granular limestone; while in others, it serves as a basis in which magnetic ironstone occurs, either in crystals or grains. At Franklin Mines, it also assumes a micaceous form, and is imbedded in a white oxide of zinc, which is often, in the same specimen, found adhering to the black oxide of iron.

Uses.—It occurs abundantly in the United States of America, and, according to Dr Bruce, promises to be a valuable discovery to that country, as it is excellently adapted for the making of brass, and also for the production of sulphate of zinc or the white vitriol of commerce.

Genus III. Red Copper-Ore.

Tessular. Hardness = 3.5,—4.0. Sp. gr. = 5.6,—6.0.

1. Octahedral Red Copper-Ore.

Octaedrisches Kupfererz, *Mohs.*—Roth Kupfererz, *Werner.*—Cuivre oxydulé, *Haüy.*

Specific Character.—Tessular. Cleavage octahedral. Streak red.

This species is divided into four subspecies, viz. Foliated, Compact, Capillary, and Tile-ore.

FIRST SUBSPECIES.

Foliated Red Copper-Ore.

Blättriches Rothkupfererz, *Werner.*

External Characters.—Colour dark cochineal-red. Occurs massive, disseminated, in membranes, corroded; also in granular concretions, and crystallized in octahedrons, variously modified by truncations, bevelments and acuminations. Internally alternates from shining to glistening; lustre adamantine, inclining to semi-metallic. Fracture coarse and small-grained uneven. Ranges from opaque to translucent. Brittle, and easily frangible.

SECOND SUBSPECIES.

Compact Red Copper-Ore.

Dichtes Roth Kupfererz, *Werner.*

External Characters.—Colour intermediate between lead-grey and cochineal-red. Occurs massive, disseminated, and in a kind of reniform shape. Internally glimmering, inclining to glistening, and lustre semi-metallic. Fracture even, inclining to flat conchoidal. Opaque. Brittle, and easily frangible.

THIRD SUBSPECIES.

Capillary Red Copper-Ore.

Haarförmiges Roth Kupfererz, *Werner.*

External Characters.—Colour carmine-red. Occurs in small capillary crystals, also in thin tables, which are sometimes aggregated into amorphous and scopiform flakes. Shining. Lustre adamantine. Translucent.

		Cornwall.
Constituent Parts.—Copper,	- - -	88.5
Oxygen,	- - -	11.5
		100.0 *Chenevix.*

Geognostic and Geographic Situations.—Occurs in veins in primitive, transition and secondary rocks. Occurs in the mines of Cornwall, and in others on the continents of Europe, Asia, and America.

FOURTH SUBSPECIES.

Tile-Ore.

Ziegelerz, *Werner.*

This subspecies is divided into two kinds, viz. Earthy, and Indurated.

First Kind.

Earthy Tile-Ore.

Erdiches Ziegelerz, *Werner.*

External Characters.—Colours red and brown. Occurs massive, disseminated, and incrusting copper-pyrites. Composed of dull dusty particles, which are more or less cohering. Soils slightly. Feels meagre.

Geognostic and Geographic Situations.—Occurs in veins in the Hartz, Tyrol, &c.

Second Kind.

Indurated Tile-Ore.

Festes Ziegelerz, *Werner.*

External Characters.—Colours red, brown, grey, and black. Occurs massive, disseminated; also in curved lamellar and fibrous concretions. Internally glimmering or glistening, and resinous. Fracture conchoidal. Streak feebly shining.

Constituent Parts.—Werner considers it to be an intimate combination of Red Copper-ore and Brown Iron-ochre. It contains from 10 to 50 *per cent.* of copper.

Geognostic and Geographic Situations.—Occurs in veins in Cornwall, and other countries.

Genus IV. Tin-Ore.

Zinnerz, *Mohs.*

Pyramidal. Streak not black. Hardness = 6.0,—7.0. Sp. gr. = 6.3,—7.0.

1. Pyramidal Tin-Ore.

Pyramidales Zinnerz, *Mohs.*

Specific Character.—Pyramidal. Pyramid = 133° 36′; 67° 42′. Cleavage, $P + \infty$. $[P + \infty.]$ Streak, white, grey, and brown.

This species is divided into two subspecies, viz. Common Tin-Ore or Tinstone, and Cornish Tin-Ore.

FIRST SUBSPECIES.

Common Tin-Ore or Tinstone. Oxide of Tin

Zinnstein, *Werner.*—Etain oxydé, *Haüy.*

External Characters.—Colours brown, black, green, white, yellow, and red. Occurs most frequently crystallized; and

and the following are some of the secondary forms: 1. Rectangular four-sided prism, acuminated with four planes, which are set on the lateral planes. 2. Rectangular four-sided prism, acuminated with four planes set on the lateral edges. 3. Long rectangular four-sided prism, acutely acuminated on both extremities with eight planes, and again flatly acuminated with four planes, which are set on the obtuse edges of the first acumination. 4. Twin-crystals of various description; but of these the most frequent is that formed by the junction of two crystals of the variety N° 1. Surface of the crystals is usually smooth, seldom streaked, and is commonly splendent. Internally alternates from splendent to glistening. Lustre adamantine, inclining to resinous. Fracture uneven, inclining to conchoidal. Alternates from semi-transparent to opaque. Yields a greyish-white streak. Easily frangible, and brittle.

Chemical Characters.—Decrepitates before the blowpipe, and becomes paler; when finely pounded, it is reducible on charcoal by the continued action of the blowpipe to the metallic state.

		From Alternon.
Constituent Parts.—	Tin,	77.50
	Iron,	0.25
	Oxygen,	21.50
	Silica,	0.75
		100.00 *Klaproth.*

Geognostic and Geographic Situations.—Occurs disseminated in granite, gneiss, mica-slate, clay-slate, porphyry, and in an alluvial form, in what are in Cornwall named *Stream Works.* Cornwall contains the greatest European tin-mines, and Banca in India the most extensive beyond Europe.

SECOND SUBSPECIES.

Cornish Tin-Ore, or Wood-Tin.

Kornisch Zinnerz, *Werner.*

External Characters.—Colours hair-brown, wood-brown, and reddish-brown. Occurs reniform, botryoidal, globular, and in fibrous distinct concretions. Internally feebly glistening or glimmering, and lustre adamantine, inclining to resinous. Opaque. Streak grey inclining to brown.

Constituent Parts.—Oxide of Tin,	- -	91
Oxide of Iron,	- -	9
		100 *Vauquelin.*

Geognostic and Geographic Situations.—Occurs loose, and in small quantities, along with stream-tin, in alluvial deposites (stream-works) in Cornwall; but in Mexico is contained in veins in trap-porphyry.

Genus V. Wolfram-Ore.

Scheel-erz, *Mohs.*

Prismatic. Hardness = 5.0,—5.5. Sp. gr. = 7.1,—7.4.

1. Prismatic Wolfram.

Prismatisches Scheel-erz, *Mohs.*—Wolfram, *Werner.*—Scheelin ferruginé, *Haüy.*

Specific Character.—Hemiprismatic. Pyramid = 115° 23′; 98° 12′; 115° 23′. $\frac{P}{2}$ = 115° 23′. P + ∞ = 98° 12′. Cleavage, $\overset{o}{Pr}$ + ∞ perfect. Streak dark reddish-brown.

External Characters.—Colour between greyish and brownish black, and rarely a temper-steel tarnish. Occurs massive, and crystallized in oblique four-sided prisms, variously modified by truncations, bevelments, and acuminations. Cleavage shining or splendent; fracture glistening; lustre adamantine, inclining to resinous. Fracture coarse and small grained uneven. Opaque. Brittle, and easily frangible.

Chemical Characters.—Decrepitates before the blowpipe, and is infusible without addition. Colours glass of borax reddish, when exposed to the exterior flame of the blowpipe.

Constituent Parts.—Tungstic Acid,	- -	67.00
Oxide of Manganese,	- -	6.25
Oxide of Iron,	- -	18.10
Silica,	- - -	1.50
		92.75 *Vauquelin.*

Geognostic and Geographic Situations.—Occurs in primitive rocks, in the island of Rona, one of the Hebrides; also in Cornwall, and in other countries.

Genus VI. Tantalum-Ore.

Tantal-erz, *Mohs.*

Prismatic. Streak brownish-black. Hardness = 6.0. Sp. gr. 6.0,—6.3.

1. Prismatic Tantalum-Ore.

Prismatisches Tantal-erz, *Mohs.*

Specific Character.—Prismatic. Pyramid unknown.

External Characters.—Colours greyish and brownish black. Occurs massive, disseminated, and crystallized in oblique four-sided prisms, truncated on the lateral edges, and bevelled on the terminal planes. Externally and internally shining or glistening, and lustre semi-metallic-adamantine. Fracture uneven, or conchoidal. Opaque. Brittle, and difficultly frangible.

		Finland.
Constituent Parts.—	Oxide of Tantalum,	83
	Oxide of Iron,	12
	Oxide of Manganese,	8
		103 *Vauquelin.*

Geognostic and Geographic Situations.—Occurs disseminated in a coarse red granite, in the parish of Kemito in Finland; and near Bodenmais in Germany.

Genus VII. Uranium-Ore.

Uran-erz, *Mohs.*

Form unknown. Streak black. Hardness = 5.5. Sp. gr. = 6.4,—6.6.

1. Uncleavable Uranium-Ore.

Uran-erz, *Mohs.*—Uranpecherz, *Werner.*—Uran Oxydulé, *Haüy.*

Specific Character.—Uncleavable. Reniform, and massive.

External Characters.—Colour black. Generally occurs massive, seldom disseminated, sometimes reniform; also in granular, lamellar, and prismatic concretions. Internally shining, lustre adamantine, inclining to semi-metallic. Fracture conchoidal, which passes into coarse-grained uneven. Opaque. Brittle, and easily frangible.

Constituent Parts.—

	Joachimsthal.
Oxide of Uranium, -	86.5
Black Oxide of Iron, -	2.5
Galena or Lead-glance, -	6.0
Silica, - - - - -	5.0
	100.0 *Klaproth.*

Geognostic and Geographic Situations.—Occurs principally in veins in primitive rocks, in Cornwall, and other countries.

Genus VIII. Cerium-Ore.

Cerer-erz, *Mohs.*

Form unknown. Streak white. Hardness = 5.5. Sp. gr. = 4.6,—5.0.

1. Uncleavable Cerium-Ore.

Untheilbares Cerer-erz, *Mohs.*—Cerer-erz, *Werner.*—Cerium oxydé silicifère, *Haüy.*

Specific Character.—Uncleavable. Massive.

External Characters.—Colour red and brown. Occurs massive, and disseminated. Internally glimmering, and adamantine inclining to resinous. Fracture fine splintery. Opaque. Streak greyish-white.

Chemical Characters.—Infusible without addition before the blowpipe.

Constituent Parts.—

Oxide of Cerium, -	54.50
Silica, - - - -	34.50
Oxide of Iron, - -	3.50
Lime, - - - - -	1.25
Water, - - -	5.00
	98.75 *Klaproth.*

Geognostic and Geographic Situations.—Occurs in a bed of copper-pyrites in Westmannland in Sweden.

Genus IX. Chrome-Ore.

Chrom-erz, *Mohs.*

Prismatic. Streak brown. Hardness = 5.5. Sp. gr. = 4.4,—4.5

Streak yellow

1. Prismatic Chrome-Ore, or Chromat of Iron.

Prismatisches Chrom-erz, *Mohs.*—Chrom-Eisenstein, *Werner.*—Fer Chromaté, *Haüy.*

Specific Character.—Prismatic. Pyramid unknown. Cleavage prismatoidal.

External Characters.—Colours between steel-grey and iron-black, and sometimes passes into brownish-black. Occurs massive, disseminated, and in granular distinct concretions; also crystallized in oblique four-sided prisms, acuminated with four planes. Internally shining or glistening, and lustre imperfect metallic. Fracture small and fine-grained uneven, sometimes passing into small and imperfect conchoidal. Opaque.

Physical Characters.—Some varieties are magnetical, others are not.

Chemical Characters.—It is infusible before the blowpipe. Melted with borax, it forms a beautiful green-coloured mass, very different from the dark green-coloured glass formed when borax and magnetic iron-ore are melted.

		Stiria.	
Constituent Parts.—	Oxide of Iron, - - - -	33.00	
	Oxide of Chrome, - -	55.50	
	Alumina, - - -	6.00	
	Silica, - - -	2.00	
	Loss by heating, - -	2.00	
		98.50	*Klaproth.*

Geognostic and Geographic Situations.—Occurs in serpentine and talc in the Shetland Islands, and in various quarters in the Continents of Europe, Asia, and America.

Uses.—When the chromic acid, which this ore contains, is combined with lead, it forms an uncommonly beautiful yellow pigment.

(Streak a distinguishing character)

Genus X. Iron-Ore.

Eisen-erz, *Mohs.*

Tessular, rhomboidal, prismatic. Hardness=5.0,—6.5. Sp. gr.=3.8,—5.2. If the streak is brown, the Sp. gr. is

Occurs in Magnesian rocks, such as Talc & Serpentine below 4.2, or above 4.8. If the streak is black, the Sp. gr. is above 4.8.

1. Octahedral Iron-Ore.

Octaedrisches Eisenerz, *Mohs.*—Fer oxydule, *Haüy.*

Specific Character.—Tessular. Cleavage octahedral. Streak black. Hardness = 5.5,—6.5. Sp. gr. = 4.8,—5.2.

This species is divided into two subspecies, viz. Common, and Granular.

FIRST SUBSPECIES.

Common Magnetic Iron-Ore.

Gemeiner Magneteisenstein, *Werner.*

External Characters.—Colour iron-black. Occurs massive, disseminated, in granular distinct concretions, and crystallized in octahedrons and rhomboidal dodecahedrons. Externally shining, glistening, or splendent. Internally intermediate between shining and glistening, and lustre metallic. Fracture uneven, sometimes approaching to even, and rarely to imperfect conchoidal. Opaque. Brittle, and sometimes easily, sometimes difficultly frangible.

Physical Characters.—Highly magnetic, with polarity.

Chemical Characters.—Before the blowpipe becomes brown, but does not melt; communicates to glass of borax a dark green colour.

Constituent Parts.—Peroxide of Iron,	-	69
Protoxide of Iron,	- -	31
		100 *Berzelius.*

Geognostic and Geographic Situations.—Occurs principally in beds, in primitive mountains, in Norway, Sweden, Lapland, and other countries.

Uses.—When pure, it affords excellent iron.

when pure, affords 70 per cent: of Iron

SECOND SUBSPECIES.

Granular Magnetic Iron-Ore, or Iron-Sand.

Eisensand, *Werner.*

External Characters,—Colour very dark iron-black. Occurs in grains, and also in octahedral crystals. The grains have a feeble glimmering, and rough surface. Internally intermediate between shining and splendent, and lustre metallic. Fracture conchoidal. Opaque. Brittle.

Constituent Parts.—	Oxide of Iron,	85.50
	Oxide of Titanium,	14.00
	Manganese,	0.50
		100 *Klaproth.*

Geognostic and Geographic Situations.—Occurs imbedded in trap-rocks in different parts of Scotland, and in many countries on the Continent of Europe. in Salisbury Craigs

2. Rhomboidal Iron-Ore.

Rhomboedrisches Eisen-erz, *Mohs.*—Fer oligiste, *Haüy.*

Specific Character.—Rhomboidal. Rhomboid = 85° 58′. Cleavage, R. Sometimes R — ∞. Streak red,...reddish-brown. Hardness = 5.5,—6.5. Sp. gr. = 4.8,—5.2.

This species is divided into three subspecies, viz. 1. Specular Iron-ore, or Iron-glance. 2. Red Iron-ore. 3. Red Clay Iron-ore.

FIRST SUBSPECIES.

Specular Iron-Ore.

This subspecies is divided into two kinds, viz. Common and Micaceous.

First Kind.

Common Specular Iron-Ore.

Gemeiner Eisenglanz, *Werner.*

External Characters.—Colour dark steel-grey, which frequently borders on iron-black, and sometimes inclines to brownish-red. Occurs very frequently tarnished on the external surface. Occurs massive, disseminated, in granular and lamellar concretions, and also crystallized in rhomboids, six-sided prisms, six-sided tables, and six-sided pyramids. Internally glistening, but sometimes passes into shining and splendent, and lustre metallic. Cleavage distinct. Fracture conchoidal. Fragments indeterminate angular, and rather sharp-edged, and sometimes rhomboidal. Brittle, and rather difficultly frangible.

The Magnetic Iron Ore occurs in greater plenty in the North, the Specular in the South

Physical Characters.—When pulverized, it is feebly magnetic, but does not attract iron-filings.

Chemical Characters.—Infusible without addition before the blowpipe.

Constituent Parts.—

	From Grengesberget.
Reddish-brown Oxide of Iron,	94.38
Phosphate of Lime, -	2.75
Magnesia, - -	0.16
Mineral Oil ? - -	1.25
Loss by heating, - -	0.50
	98.94 *Hisinger.*

Geognostic and Geographic Situations.—Generally occurs in beds, in primitive and secondary rocks Occurs in Scotland and England; and the famous iron-ore of Elba belongs to this species.

Uses.—When it occurs in quantity, it is smelted as an ore of iron, and affords excellent malleable iron.

Occurs in plates in the crevices of Volcanic Rock. as Vesuvius

Second Kind.

Micaceous Specular Iron-Ore.

Eisenglimmer, *Werner.*—Iron-Mica, *Jameson,* 3d edit.

External Characters.—Colour iron-black. Occurs most commonly massive and disseminated; sometimes in granular concretions, and in six-sided tables. Internally splendent, which in some varieties passes into shining, and lustre metallic. Slightly translucent on the edges; but translucent in thin plates, and then appears blood-red. Brittle, and uncommonly easily frangible.

Geognostic and Geographic Situations.—Generally occurs in primitive rocks. It is met with in clay-slate near Dunkeld; in mica-slate on Ben More; in Fitful Head, in Shetland; Tavistock in Devonshire, Eskdale in Cumberland; near Bristol, and in Caernarvonshire Also in Norway, Germany, &c.

Uses.—It melts better than common specular iron-ore, but requires a greater addition of limestone. The iron which it affords is sometimes cold-short, but is well fitted for cast-ware.

It distinguished from Mica by the rigidity of the Plates

SECOND SUBSPECIES.

Red Iron-Ore.

Rotheisenstein, *Werner.*

This subspecies is divided into four kinds, viz. Scaly, Ochry, Compact, and Fibrous.

First Kind.

Scaly Red Iron-Ore.

Rother Eisenrahm, *Werner.*—Fer oligiste luisant, *Haüy.*

External Characters.—Colour intermediate between dark steel-grey and brownish-red. It is friable, and consists of semi-metallic shining scaly parts, which are sometimes translucent, and soil strongly. Particles more or less cohering, and feel greasy.

Constituent Parts.—

Iron,	66.00
Oxygen,	28.50
Silica,	4.25
Alumina,	1.25
	100 *Henry.*

Geognostic and Geographic Situations.—Occurs in veins in primitive rocks, sometimes also in transition and secondary rocks. It is met with at Ulverstone, and several other places on the borders of Lancashire.

Second Kind.

Ochry Red Iron-Ore.

Ochriger Rotheisenstein, *Werner.*—Fer oxidé rouge grossier, *Haüy.*

External Characters.—Colour brownish-red, which passes into blood-red. Usually friable, but in some varieties is solid; also disseminated, and sometimes massive. Consists of dusty particles, which are dull or feebly glimmering. Soils strongly. Feels more meagre than greasy.

Geognostic and Geographic Situations.—Occurs in same situations as the other kinds.

Third Kind.

Compact Red Iron-Ore.

Dichter Rotheisenstein, *Werner.*—Fer oligiste compacte, *Haüy.*

External Characters.—Colour intermediate between dark steel-grey and blood-red. Occurs most commonly massive, sometimes also disseminated, specular, with impressions; and in supposititious crystals. Specular varieties are splendent and metallic; others alternate from strongly glimmering to dull, and lustre semi-metallic. Fracture usually even, or flat conchoidal. Opaque. Easily frangible.

Constituent Parts.—Iron,	70.50	
Oxygen,	29.50	
	100.00	*Bucholz.*

Geognostic and Geographic Situations.—Occurs in beds and veins in gneiss, clay-slate, grey-wacke, and in various secondary rocks in England, Norway, Sweden, Germany, &c.

Uses.—Affords good cast and bar iron.

Fourth Kind.

Fibrous Red Iron-Ore, or Red Hematite.

Rother Glaskopf, *Werner.*—Fer oligiste concretionné, *Haüy.*

External Characters.—Colour intermediate between brownish-red and dark steel-grey. Some varieties incline to blood-red. Occurs most frequently massive, reniform, botryoidal, stalactitic, and globular; also in fibrous and lamellar distinct concretions. Internally glistening or glimmering, and lustre semi-metallic. Fracture wedge-shaped, or splintery. Opaque. Brittle, and rather easily frangible.

Constituent Parts.—Oxide of Iron,	90	
Trace of Oxide of Manganese.		
Silica,	2	
Lime,	1	
Water,	3	
	96	*Daubuisson.*

Geognostic and Geographic Situations.—In veins in sandstone, Cumberhead, Lanarkshire; veins in secondary greenstone, Salisbury Crags, near Edinburgh; Ulverstone in Lanarkshire; Cumberland; Devonshire, and near Bristol in Gloucestershire.

Uses.—Affords excellent malleable and cast iron.

THIRD SUBSPECIES.

Red Clay Iron-Ore.

This subspecies is divided into four kinds, viz. Ochry, Columnar, Lenticular and Jaspery.

First Kind.

Ochry Red Clay Iron-Ore, or Red Chalk.

Roethel, *Werner.*—Argile ocreuse graphique, *Haüy.*

External Characters.—Colour brownish-red. Occurs massive. Principal fracture glimmering; cross fracture dull. Principal fracture thick slaty; cross fracture fine earthy. Fragments sometimes tabular, and sometimes splintery. Soils and writes. Rather sectile and easily frangible.

Geognostic and Geographic Situations.—Occurs in thin beds in clay-slate and grey-wacke-slate in Hessia, Thuringia, &c.

Uses.—It is principally used for drawing. The coarser varieties are used by the carpenter, the finer by the painter.

Second Kind.

Columnar Red Clay Iron-Ore.

Stänglicher Thoneisenstein, *Werner.*—Fer oxidé rouge bacillaire, *Haüy.*

External Characters.—Colour brownish-red. Occurs massive, and in columnar distinct concretions. Soft. Brittle, and uncommonly easily frangible. Feels rough. In single pieces yields a ringing sound.

Geognostic and Geographic Situations.—It is a rare mineral, and is in general a pseudo-volcanic production. It is found in Scotland, as in Fifeshire; Germany and other countries.

Third Kind.

Lenticular Red Clay Iron-Ore.

Linsenförmiger Thoneisenstein, *Werner.*

External Characters.—Colours brownish-red and reddish-brown. Occurs massive, and in lenticular concretions. Internally strongly glimmering, and semi-metallic. Brittle, and easily frangible.

Constituent Parts.—Contains 64 *per cent.* of Oxide of Iron.

Geognostic and Geographic Situations.—Occurs principally in beds in an amygdaloid, subordinate to clay-slate and grey-wacke in Bohemia.

Uses.—Affords good malleable iron, and excellent cast-iron.

Fourth Kind.

Jaspery Red Clay Iron-Ore.

Jaspisartiger Thoneisenstein, *Werner.*

External Characters.—Colour reddish-brown. Occurs massive. Internally feebly glimmering, sometimes approaching to glistening. Fracture large and flat conchoidal. Fragments rhomboidal, cubical, or trapezoidal. Brittle, and rather easily frangible.

Geognostic and Geographic Situations.—Occurs at Fischau in Austria, where it forms considerable beds in a flœtz or secondary formation.

* 3. Prismatic Iron-Ore. Hydrate of Iron

Prismatisches Eisen-erz, *Mohs.*—Braun Eisenstein, *Werner.*

Specific Character.—Prismatic. Pyramid unknown. Cleavage prismatic. Streak yellowish-brown. Hardness = 5.5. Sp. gr. = 3.8,—4.2.

This species is divided into two subspecies, Brown Iron-Ore, and Brown Clay Iron-Ore.

FIRST SUBSPECIES.

This subspecies is divided into three kinds, viz. Ochry, Compact, and Fibrous.

First Kind.

Ochry Brown Iron-Ore.

Ochriger Brauneisenstein, *Werner.*

External Characters.—Colours light yellowish-brown. Occurs massive and disseminated. Internally dull. Fracture coarse earthy. Soils slightly. Soft. Sectile. Easily frangible.

Geognostic and Geographic Situations.—Occurs along with the compact and fibrous kinds, in England, Germany, France, &c.

* Makes better steel than the two former varieties

Use.—Affords excellent bar-iron.

Second Kind.

Compact Brown Iron-Ore.

Dichter Brauneisenstein, *Werner.*

External Characters.—Colours yellowish-brown and clove-brown. Occurs massive and disseminated; very rarely in cubical, pentagonal-dodecahedral, and pyramidal supposititious crystals. Internally dull or semi-metallic glimmering. Fracture even, sometimes also fine-grained uneven. Semi-hard, sometimes inclining to soft. Rather brittle and easily frangible.

		Bergzabern.
Constituent Parts.	Peroxide of Iron,	84
	Water,	11
	Oxide of Manganese,	1
	Silica,	2
		98 *Daubuisson.*

Geognostic and Geographic Situations.—Occurs in the same geognostic and geographic situations as the following kinds.

Use.—Affords about 50 *per cent.* of Iron. Easily fusible, and affords excellent bar-iron.

Third Kind.

Fibrous Brown Iron-Ore or Brown Hematite.

Brauner Glaskopf, *Werner.*—Fer oxidé hematite brun, *Haüy.*

External Characters.—Colour brown. Seldom occurs massive, more frequently stalactitic, coralloidal, reniform, botryoidal, tuberose; sometimes also cylindrical, fruticose, and in distinct concretions, which are fibrous, granular, and lamellar. Internally glimmering; lustre intermediate between adamantine and resinous. Opaque, or feebly translucent on the edges. Brittle, and easily frangible.

		Fibrous Borgzabern.
Constituent Parts.	Peroxide of Iron,	79
	Water,	15
	Oxide of Manganese,	2
	Silica,	3
		99 *Daubuisson.*

Geognostic and Geographic Situations.—Occurs in veins, beds, lenticular-masses, and mountain-masses, in primitive, transition, and secondary mountains in England, Germany, Italy, &c.

Uses.—Affords good iron.

SECOND SUBSPECIES.

Brown Clay Iron-Ore.

This subspecies is divided into five kinds, viz. Common, Pisiform, Reniform, Granular, and Umber.

First Kind.

Common Brown Clay Iron-Ore.

External Characters.—Colours brown and yellow. Occurs massive. Internally dull or feebly glimmering. Fracture conchoidal; also even and uneven. Opaque. Streak brown, inclining to grey. Soft, or soft, passing into semihard.

Constituent Parts.—

Oxide of Iron,	69
Oxide of Manganese,	3
Water,	13
Silica,	10
Alumina,	3
	98 *Daubuisson.*

Geognostic and Geographic Situations.—Occurs in England; also in Saxony, Bohemia, Silesia, and Westphalia, in beds in secondary rocks.

Second Kind.

Pisiform Brown Clay Iron-Ore or Pea-Ore.

Bohnerz, *Werner.*—Fer oxidé globuliforme, *Haüy.*

External Characters.—Colour yellowish-brown, which sometimes passes into blackish-brown. Occurs in small spherical round grains, which are not hollow, but composed of concentric curved lamellar concretions. Internally passes from dull to glistening. Fracture fine earthy. Soft. Easily frangible and brittle.

Constituent Parts.—Oxide of Iron,	- -	70
Alumina,	- -	7
Silica,	- -	6
Water,	- -	15
		98 *Daubuisson.*

Geognostic and Geographic Situations.—Occurs in hollows in secondary rocks. Is found at Galston in Ayrshire, and in many places on the Continent of Europe.

Third Kind.

Reniform, or Kidney-Shaped Brown Clay Iron-Ore.

Eisenniere, *Werner.*

External Characters.—Colour yellowish-brown. Occurs massive, in irregular single balls, also in reniform, lenticular and elliptical forms, which are sometimes hollow. These forms are composed of concentric lamellar concretions, which often include a loose nodule.

Geognostic and Geographic Situations.—Occurs imbedded in ironshot clay, in secondary rocks of different kinds, and also in loam and clay beds that lie over black coal.

Uses.—Is one of the best kinds of ironstone, yields an excellent iron, and is smelted in many places.

Fourth Kind.

Granular Brown Clay Iron-Ore.

External Characters.—Colours yellowish and reddish brown. Occurs massive, and in small globular cohering grains. Streak yellowish-brown. Soft. Brittle, and easily frangible.

Geognostic and Geographic Situations.—Occurs in beds between the red sandstone of the salt formation, and the lias limestone. Often contains petrifactions of shells. Is found in Bavaria, Salzburg, the Tyrol, and France.

Uses.—Affords about 40 *per cent.* of good iron.

Fifth Kind.

Umber.

External Characters.—Colours clove-brown and yellowish-brown. Occurs massive. Internally dull or glimmering.

Fracture flat conchoidal. Soft. Rather sectile. Soils strongly. Feels meagre. Adheres strongly to the tongue. Readily falls to pieces in water. Sp. gr. 2.0,—6.0.

Geognostic and Geographic Situations.—Occurs in beds in the Island of Cyprus.

Use.—Is used as a pigment.

* Bog Iron-Ore.

Raseneisenstein, *Werner.*

There are three kinds of this ore, viz. Morass, Swamp, and Meadow.

First Kind.

Morass-Ore, or Friable Bog Iron-Ore.

Morasterz, *Werner.*

External Characters.—Colour brown. Sometimes friable, sometimes nearly coherent. Coherent varieties occur massive, corroded, in grains, and sometimes tuberose. Friable varieties are composed of dull dusty particles. Coherent varieties externally and internally dull. Fracture earthy. Light.

Observations.—Is characterized by colour, dull earthy aspect, and slow specific gravity.

Second Kind.

Swamp-Ore, or Indurated Bog Iron-Ore.

Sumpferz, *Werner.*

External Characters.—Colour yellowish-brown. Occurs corroded and vesicular, also amorphous. Internally dull, but the darker varieties glimmering, and sometimes even glistening. Fracture earthy, sometimes passing into fine-grained uneven. Specific gravity, 2.944, from Sprottau, *Kirwan.*

Observations.—Is distinguished from the preceding kind, by its greater specific gravity, and greater compactness.

Third Kind.

Meadow-Ore, or Conchoidal Bog Iron-Ore.

Weisenerz, *Werner.*

External Characters.—On the fresh fracture it is blackish-brown, which sometimes passes into brownish-black. Occurs massive. Internally shining, glistening, and lustre resinous. Fracture conchoidal. Yields a light yellowish-grey streak. Brittle and easily frangible.

Constituent Parts.—

Oxide of Iron, - -	61.0
Oxide of Manganese, -	7.0
Phosphoric Acid, with a trace of Sulphur, -	2.5
Water, - - -	19.0
Silica, - - -	6.0
Alumina, - - -	2.0
	97.5 *Daubuisson.*

Geognostic and Geographic Situations of Bog-iron ore.—Is found in various places in the Highlands of Scotland, in the Hebrides, and Orkney and Shetland Islands, in alluvial soil. Also abundantly on the Continents of Europe and America.

Uses.—Affords good iron.

Genus XI. Manganese-Ore.

Mangan-erz, *Mohs.*

Prismatic. Hardness = 2.5,—6.0. Sp. gr. = 4.3,—4.8.

1. Prismatic Manganese-Ore, or Black Manganese-Ore.

Prismatisches Mangan-erz, *Mohs.*—Schwarzer Braunstein, and Schwarz-Eisenstein, *Werner.*—Manganese oxidé, *Haüy.*

Specific Character.—Prismatic. Pyramid unknown. Cleavage, unknown, imperfect. Streak black, inclining to brown. Hardness = 5.0,—6.0.

External Characters.—Colours bluish-black and steel-grey. Occurs massive, tuberose, fruticose, reniform, and botryoidal; also in fibrous and lamellar concretions. Internally glimmering, glistening, and lustre imperfect metallic. Fracture conchoidal and uneven. Opaque.

Constituent Parts.—Composed of oxides of manganese and iron.

Geognostic and Geographic Situations.—Occurs in veins in primitive, transition, and secondary rocks, in Saxony, Hanover, &c.

* Scaly Brown Manganese-Ore.

Brauner Eisenrahm, *Werner*.

External Characters.—Colour intermediate between steel-grey and clove-brown. Occurs in crusts, massive, spumous, fruticose, and irregular dendritic. Friable, or friable passing into soft. Composed of scaly particles, which are intermediate between shining and glistening, wtih metallic lustre. Soils strongly. Feels greasy.

Geognostic Situation.—Occurs in drusy cavities in fibrous brown ironstone.

Geographic Situation.—Is found near Sandlodge in Mainland, one of the Shetland islands; and in various iron-mines in different parts of Europe.

2. Prismatoidal Manganese-Ore, or Grey Manganese-Ore.

Prismatoidisches Mangan-erz, *Mohs.*—Graubraunsteinerz, *Werner.*

Specific Character.—Prismatic. Pyramid unknown. Cleavage, $P + \infty = 100°$ (nearly). More distinct $P\breve{r} + \infty$. Streak black. Hardness $= 2.8,—3.0$.

External Characters.—Colour dark steel-grey, inclining more or less to iron-black. Occurs massive, in crusts, membranes, reniform, botryoidal, dendritic, and fruticose; also in granular, fibrous, and radiated distinct concretions; and crystallized in the following secondary forms, 1. Oblique four-sided prism, truncated on the obtuse lateral edges, or on the acute lateral edges; 2. When the truncating planes increase so much as to join together, then a nearly rectangular prism is formed; 3. Sometimes the prism is bevelled on the terminal planes. or acuminated with four planes; 4. The obtuse lateral edges bevelled, then forming an eight-sided prism. Lustre shining, glimmering, and metallic. Fracture conchoidal and earthy. Streak black.

Constituent Parts.—	Black Oxide of Manganese,	90.50
	Oxygen, - -	2.25
	Water, - -	7.00
		100.00 *Klaproth.*

Geognostic and Geographic Situations.—Occurs in veins and imbedded masses in primitive, transition, and secondary mountains. Occurs near Aberdeen; near Upton Pyne in Devonshire, in the vicinity of grey-wacke; in clay-slate in the parish of Veryan, and in other quarters in Cornwall.

Uses.—Is added to glass, in small quantity, to destroy the brown colour which that material receives from intermixed inflammable substances, or in larger quantity when we wish to give it a violet-blue colour. Affords a fine brown colour, which is used for painting on porcelain. Is employed in the laboratory, as the cheapest and most convenient material from which to procure oxygen gas. All the oxymuriatic acid used in bleacheries, and for the purpose of destroying contagious matter, is prepared from manganese, and the usual materials of muriatic acid.

* Earthy Grey and Brown Manganese Ore, or Wad.

External Characters.—Colours grey and brown. Occurs massive, botryoidal, and sometimes pulverulent. Internally dull, but the grey varieties are generally glimmering. Is so soft as to yield to the nail.

Geognostic and Geographic Situations.—Occurs along with grey manganese-ore at Upton Pyne in Devonshire, and in Penandral Mine in Cornwall.

ORDER *IX.* *NATIVE METAL.*

Lustre metallic. Not black. If grey, it is malleable, and the Sp. gr. = 7.4 and more.

Hardness = 0.0,—4.0, or malleable.

Sp. gr. = 5.7,—20.0.

GENUS I. ARSENIC.

Form unknown. Tin-white, inclining to lead-grey. Hardness = 3.5. Sp. gr. = 5.7,—5.8.

1. Native Arsenic.

Gediegen Arsenik, *Werner* & *Mohs.*—Arsenic natif, *Haüy.*

Specific Character.—Reniform. Massive.

External Characters.—Colour tin-white, inclining to lead-grey, which tarnishes very speedily, becoming first grey, then greyish-black. Occurs massive, disseminated, in plates, reniform, botryoidal, reticulated, and with impressions; also in radiated, granular, and lamellar concretions. Internally on the fresh fracture usually glistening, inclining to glimmering, sometimes to shining, and the lustre metallic. Fracture small, and fine-grained uneven. Difficultly frangible. Rather sectile. Emits when struck a ringing sound, and an arsenical odour.

Chemical Characters.—Before the blowpipe it yields a white smoke, diffuses an arsenical odour, burns with a blue flame, is gradually and almost entirely volatilised, and deposits a white coating on the coal.

Constituent Parts.—It usually contains a small portion of iron, and when it occurs with gold or silver, a little gold or silver.

Geognostic and Geographic Situations.—Occurs in veins in primitive rocks, as in gneiss, mica-slate, and clay-slate; less frequently in transition and secondary rocks. It is found in Norway, Germany, France, Spain, &c.

GENUS II. TELLURIUM.

Form unknown. Tin-white. Hardness = 2.0,—2.5. Sp. gr. = 6.1,—6.2.

1. Native Tellurium.

Gediegenes Tellur, *Mohs.*— Gediegen Sylvan, *Werner.*—Tellur natif, *Haüy.*

Specific Character.—Massive.

External Characters.—Colour tin-white. Occurs massive, disseminated and in granular concretions. Internally shining, and lustre metallic. Rather brittle, and easily frangible.

Constituent Parts.—

Tellurium, - - -	92.55
Iron, - - -	7.20
Gold, - - -	0.25
	100.00 *Klaproth.*

Geognostic and Geographic Situations.—Occurs in veins in grey-wacke, in Transylvania, and also in Norway.

GENUS III. ANTIMONY.

Tessular, prismatic. Not ductile. White. Hardness = 3.0,—3.5. Sp. gr. = 6.5,—10.0.

1. Dodecahedral Antimony.

Dodecaedrisches Antimon, *Mohs.*—Gediegen Spiesglas, *Werner.* —Antimoine natif, *Haüy.*

Specific Character.—Tessular. Cleavage octahedral and dodecahedral. Hardness = 3.0,—3.5. Sp. gr. = 6.5,—6.8.

External Characters.—Colour perfect tin-white. Occurs massive, disseminated, reniform; also in granular and lamellar distinct concretions. Crystallized, in octahedrons and rhomboidal dodecahedrons. Splendent and metallic. Rather sectile, and easily frangible.

Geognostic and Geographic Situations.—Occurs in argentiferous veins in the gneiss mountain of Chalanches in Dauphiny; also in Hanover, Sweden, and Mexico.

2. Prismatic Antimony, or Antimonial Silver.

Prismatisches Antimon, *Mohs.*—Spiesglas Silber, *Werner.*—Argent antimonial, *Haüy.*

Specific Character.—Prismatic. Pyramid unknown Cleavage, $P - \infty$. $P\breve{r}$. Less distinct $P + \infty$. Hardness = 3.5. Sp. gr. = 8.9,—10.0.

External Characters.—Colour intermediate between silver-white and tin-white. Occurs massive, and crystallized, in rectangular four-sided prisms, and in unequi-angular six-sided prisms. Externally glistening or glimmering. Internally shining and splendent, with metallic lustre. Sectile, and rather easily frangible.

Constituent Parts.—	Silver,	89	
	Antimony,	11	
		100	*Selb.*

Geognostic and Geographic Situations.—Occurs in veins in primitive and transition rocks, in Germany and France.

Genus IV. Bismuth.

Tessular. Silver-white, inclining to red. Hardness = 2.0, —2.5. Specific gravity = 8.5,—9.0.

1. Octahedral Bismuth.

Octaedriches Wismuth, *Mohs.*—Gediegen Wismuth, *Werner.*—Bismuth Natif, *Haüy.*

Specific Character.—Tessular. Cleavage octahedral.

External Characters.—Colour silver-white, which inclines to red. Seldom massive, generally disseminated, dentiform, in leaves having plumosely streaked surfaces, and crystallised in octahedrons, cubes, and tetrahedrons. Internally splendent, and lustre metallic. Malleable.

Chemical Characters.—Melts even by the flame of a candle.

Geognostic and Geographic Situations.—Occurs in veins in primitive rocks in Cornwall and other countries.

Use.—Enters as an ingredient into the composition of printing types and of pewter; is used as solder, in the construction of mirrors, and for the refining of gold and silver; its oxide is used as a white pigment, as an essential ingredient in a kind of salve, which is used for giving a black colour to the hair, and as an ingredient in sympathetic ink. All the bismuth of commerce is obtained from Saxony.

Genus V. Mercury.

Tessular, liquid. Not malleable. White. Hardness = 0.0, —3.0. Specific gravity = 10.5,—15.0.

1. Liquid Native Mercury.

Flüssiges Mercur, *Mohs.*—Gediegen Quecksilber, *Werner.*—Mercur Natif, *Haüy.*

Specific Characters.—Liquid. Tin-white. Hardness = 0. Specific gravity = 12.0,—15.0.

External Characters.—Colour tin-white. Perfectly liquid. Splendent, and lustre metallic. Opaque.

Geognostic and Geographic Situations.—This mineral occurs principally in rocks of the coal formation, and either disseminated, or in veins traversing them, as in Spain and Germany.

2. Dodecahedral Mercury, or Native Amalgam.

Dodecaedrisches Mercur, *Mohs.*—Natürlich Amalgam, *Werner.*—Mercur Argental, *Haüy.*

Specific Characters.—Tessular. No cleavage. Silver-white. Hardness = 1.0,—3.0. Specific gravity = 10.5,–12.5.

External Characters.—Colour silver-white. Occurs usually in small roundish portions; and crystallized in rhomboidal dodecahedrons. Internally shining and metallic. Fracture small-grained uneven. When pressed between the fingers, or cut with a knife, it emits a creaking sound like artificial amalgam.

Constituent Parts.—Mercury	74	
Silver,	25	
	99	*Heyer.*

Geognostic and Geographic Situations.—Is generally associated with native mercury and cinnabar. Is found at Moschellandsberg in Deux-Ponts; and, it is said also at Rosenau in Hungary.

Genus VI. Silver.

Tessular. Ductile. Silver-white. Specific gravity = 10.0, —10.5.

1. Hexahedral Silver.

Hexaedrisches Silber, *Mohs.*—Argent Natif, *Haüy.*

Specific Character.—Tessular. No cleavage.

This species is divided into two subspecies, viz. Common, and Auriferous.

FIRST SUBSPECIES.

Common Native Silver.

External Characters.—Colour pure silver-white. Seldom occurs massive, more frequently disseminated, and in various particular external shapes, such as dentiform, filiform, reticulated, and in leaves; also crystallised in cubes, octahedrons, rhomboidal dodecahedrons, and tetrahedrons. Lustre splendent to glimmering. Fracture fine hackly. Flexible, and difficultly frangible.

Geognostic and Geographic Situations.—Occurs in veins in primitive, transition, and secondary rocks, in various silver-mines in Europe, Asia, Africa, and America.

Uses.—Its various uses, in coinage, and for other useful purposes, will be considered in my treatise on Economical Mineralogy.

SECOND SUBSPECIES.

Auriferous Native Silver.

Guldisches-gediegen Silber, *Werner.*

External Characters.—Colour intermediate between brass-yellow and silver-white. Occurs disseminated, in leaves, and sometimes crystallized in cubes.

Constituent Parts.—	Silver,	72.00	
	Gold,	28.00	
		100.00	*Fordyce.*

Geognostic and Geographic Situations.—Occurs in veins in primitive rocks at Kongsberg in Norway; at Rauris in Salzburg; and at Schlangenberg in Siberia.

Genus VII. Gold.

Tessular. Yellow. Specific gravity = 12.0,—20.0.

1. Hexahedral Gold.

Hexaedrisches Gediegen Gold, *Mohs.*—Gediegen Gold, *Werner.* —Or Natif, *Haüy.*

Specific Character.—Tessular. No cleavage.

This species is divided into four subspecies, viz. Gold-yellow, Brass-yellow, Greyish-yellow, and Argentiferous.

FIRST SUBSPECIES.

Gold-Yellow Gold.

Gold-gelbes Gediegen Gold, *Werner.*

External Characters.—Colour gold-yellow, which sometimes inclines to brass-yellow. Seldom occurs massive, often disseminated, in flakes, leaves, flattish pieces, and crystallized in octahedrons, cubes, rhomboidal dodecahedron, leucite form, and tetrahedrons. Internally shining and glistening, and metallic. Fracture hackly. Very difficultly frangible.

Chemical Characters.—Fusible into a globule, which does not alter by continuance of the heat.

Geognostic and Geographic Situations.—Occurs in veins in mineral beds, and disseminated in primitive and secondary rocks, and also dispersed through those of the alluvial class. Is not confined to any quarter of the globe, being found in Europe, Asia, Africa, and America. It was formerly washed for in some mountainous districts in Scotland; has been found in England; and in Ireland, it was collected a few years ago to the amount of 1000 ounces, and one piece weighed 22 ounces.

SECOND SUBSPECIES.

Brass-Yellow Gold.

Messing-gelbes Gediegen Gold, *Werner.*

External Characters.—Colour brass-yellow. Occurs disseminated, rarely massive, capillary, moss-like, reticulated, in leaves, and crystallized in octahedrons.

Constituent Parts.—		
	Gold,	96.9
	Silver,	2.0
	Iron,	1.1
		100.0 *Lampadius.*

Geognostic and Geographic Situations.—Occurs most abundantly in veins in grey-wacke and porphyry, in Hungary and other countries. Occurs in newer formation than the last —

THIRD SUBSPECIES.

Greyish-Yellow Gold.

Graugelbes Gediegen Gold, *Werner.*

External Characters.—Colour brass-yellow, verging on steel-grey. Occurs in flattish grains like those of platina.

Constituent Parts.—Said to contain platina.

Geognostic and Geographic Situations.—Occurs along with platina and magnetic iron-ore in South America.

FOURTH SUBSPECIES.

Argentiferous Gold, or Electrum.

Electrum, *Klaproth.*

External Characters.—Colour pale brass-yellow, passing into silver-white. Occurs in small plates, dentiform, and in cubes.

Constituent Parts.—Gold,	64	
Silver,	36	
	100	*Klaproth.*

Geognostic and Geographic Situations.—Occurs along with heavy-spar and hornstone at Schlangenberg in Siberia.

GENUS VIII. PLATINA.

Form unknown. Steel-grey. Sp. gr. = 16.0,—20.0.

1. Native Platina.

Gediegen Platin, *Werner, Mohs.*—Platin Natif, *Haüy.*

Specific Character.—In grains and rolled pieces.

External Characters.—Colour very light steel-grey, which approaches to silver-white. Occurs in flat grains, and in angular and roundish grains, with impressions of other minerals. Externally shining, glistening, or glimmering, and lustre metallic.

Geognostic and Geographic Situations.—Occurs principally in alluvial deposites in South America.

GENUS IX. IRON.

Tessular. Pale steel-grey. Sp. gr. = 7.4,—7.8.

1. Octahedral Iron.

Octaedrisches Eisen, *Mohs.*—Gediegen Eisen, *Werner.*—Fer Natif, *Haüy.*

Specific Character.—Tessular. No cleavage.

This species is divided into two subspecies, viz. Terrestrial and Meteoric.

FIRST SUBSPECIES.

Terrestrial Native Iron.

Tellureisen, *Werner*.

External Characters.—Colour steel-grey. Occurs massive, in plates, and in leaves. Internally glistening, and lustre metallic. Fracture hackly.

Constituent Parts.—	Iron,	92.50	
	Lead,	6.00	
	Copper,	1.50	
		100.00	*Klaproth.*

Geognostic and Geographic Situation.—Is said to have been found associated with brown iron-ore, sparry-iron, and heavy-spar, at Kamsdorf in Saxony.

SECOND SUBSPECIES.

Meteoric Native Iron.

Meteoreisen, *Karsten.*

External Characters.—Colour pale steel-grey. Occurs ramose, imperfect globular, and disseminated in meteoric stones. Internally intermediate between glimmering and glistening, and lustre metallic. Fracture hackly. Yields a splendent streak. It is flexible, but not elastic. Very difficultly frangible.

		Agram.	
Constituent Parts.—	Iron,	96.5	
	Nickel,	3.5	
		100.0	*Klaproth.*

Geographic Situation.—This subspecies of iron falls from the air in all parts of the world, and appears to be formed in the atmosphere by some process hitherto unknown to us.

Genus X. Copper.

Tessular. Copper-red. Sp. gr. $= 8.4, — 8.9$.

1. Octahedral Copper.

Octaedrisches Kupfer, *Mohs.*—Gediegen Kupfer, *Werner.*

Specific Character.—Tessular. No cleavage.

1 forms of crystals; in this mineral by cubes

External Characters.—Colour copper-red. Occurs massive, disseminated, capillary, filiform, botryoidal, dendritic, ramose, with impressions, and crystallized in cubes, octahedrons, and rhomboidal dodecahedrons. Internally glistening, and lustre metallic. Fracture hackly.

Geognostic and Geographic Situations.—Occurs in veins, and imbedded in various primitive, transition, and secondary rocks; also in large blocks in alluvial districts. In Scotland, occurs in serpentine in the island of Yell, one of the Shetlands; in sandstone in Mainland, the largest of the Shetland islands; and in many places in Cornwall.

ORDER X. PYRITES.

because when struck give out sparks

Metallic lustre.

Hardness = 3.5,—6.5 If 4.5, and less, the Specific gravity is less than 5.0.

Specific gravity = 4.1,—7.7. If 5.3 and less, the colour is yellow or red.

GENUS I. NICKEL PYRITES, OR COPPER-NICKEL.

Nickelkies, *Mohs.* Arseniuret of Nickel

Prismatic. Hardness = 5.0,—5.5. Sp. gr. = 7.5,—7.7.

1. Prismatic Nickel Pyrites.

Prismatischer Nickel-kies, *Mohs.*—Kupfer-Nickel, *Werner.*—Nickel Arsenical, *Haüy.*

Specific Character.—Prismatic. Pyramid unknown. Copper-red.

External Characters.—Colour copper-red. Occurs most frequently massive and disseminated, seldom reticulated, dendritic, fruticose, small globular, and botryoidal, rarely in granular concretions, and sometimes crystallized in oblique four-sided prisms. Internally alternates from shining to glistening, and lustre metallic. Fracture conchoidal, sometimes passing into uneven. Rather brittle, and difficultly frangible.

Constituent Parts.—Nickel,	39.94	
Cobalt,	00.16	
Arsenic,	48.80	
Antimony,	8.00	
Sulphur,	2.00	
Iron and Manganese trace.	——	
	98.90	*Berthier.*

Geognostic and Geographic Situations.—Occurs in primitive, transition, and secondary rocks. In Scotland is met with at Lead Hills and Wanlockhead, and in the coalfield of West Lothian.

* Nickel Ochre.

Nickel-Ocker, *Werner.*

External Characters.—Colour apple-green, inclining to grass-green. Generally occurs as a thin coating, seldom massive and disseminated. Dull. Fracture splintery, uneven, or earthy. Translucent on the edges, or opaque. Soft or friable. Feels meagre.

Geognostic and Geographic Situations.—Occurs in mineral veins at Lead Hills and Wanlockhead; at Alva in Stirlingshire, in Linlithgowshire, and in the copper-mines of Cornwall.

** Black Nickel.

Nickelschwärze, *Hausmann.*

External Characters.—Colour black. Occurs massive, disseminated, and in crusts. Internally dull. Fracture earthy. Opaque. Soft. Shining resinous streak. Soils slightly.

Chemical Characters.—Forms an apple-green solution with nitric acid, which lets fall a white precipitate of arsenic acid.

Constituent Parts.—Conjectured to be a compound of oxides of nickel and arsenic.

Geognostic and Geographic Situations.—Occurs in veins in bituminous *marl-slate* in the district of Riegelsdorf.

Genus II. Arsenic Pyrites.

Prismatic. If white, the Sp. gr. = 6.2 and less. If grey, the Sp. gr. above 6.8. Hardness = 5.0,—6.0. Specific gravity = 5.7,—7.4.

1. Axotomous Arsenic Pyrites.

Axentheilender Arsenikkies, *Mohs.*

Specific Character.—Prismatic. Pyramid unknown. Cleavage, $P-\infty$. Less distinct $P+\infty$. Pale steel-grey. Hardness $=5.0,-5.5$. Sp. gr. $=6.9,-7.4$.

External Characters.—Colour pale steel-grey. Occurs massive, and in oblique four-sided prisms. Lustre metallic and shining.

Observation.—I am unacquainted with the locality of this species.

2. Prismatic Arsenic Pyrites.

Prismatischer Arsenikkies, *Mohs.*—Arsenikkies, *Werner.*—Fer Arsenical, *Haüy.*—Diprismatic Arsenical Pyrites, *Jameson,* 3d edit.

Specific Character.—Prismatic. Pyramid $=154°\ 48'$; $100°\ 34'$; $84°\ 56'$. $P+\infty\ 147°\ 3'$. Cleavage, $P-\infty$. $(\breve{P}r+\infty)^3=111°\ 19'$. White. Hardness $=5.5,-6.0$. Sp. gr. $=5.7,-6.2$.

External Characters.—Colour silver-white. Occurs massive, and disseminated; also in prismatic distinct concretions, and crystallized in oblique four-sided prisms, variously modified by bevelments and truncations. Externally shining or splendent; internally shining, seldom glistening, and lustre metallic. Fracture uneven. Opaque. Brittle, and rather difficultly frangible.

Chemical Characters.—Emits copious arsenical vapours before the blowpipe, and leaves a reddish-brown oxide of iron.

Constituent Parts.—Arsenic,	- - -	48.1
Iron,	- - -	36.5
Sulphur,	- -	15.4
		100.0 *Thomson.*

Geognostic and Geographic Situations.—Occurs in primitive, transition, and secondary rocks, at Alva in Stirlingshire, and abundantly in Devonshire and Cornwall, accompanying copper and iron.

Use.—It is from this ore that the White Oxide of Arsenic is principally obtained, and artificial Orpiment is also prepared from it. A variety named *Argentiferous* contains a portion of silver.

Genus III. Cobalt-Pyrites.

Tessular. Hardness = 5.5. Sp. gr. = 6.0,—6.6.

1. Hexahedral Cobalt-Pyrites, or Silver-White Cobalt.

Hexaedrischer Kobalt-Kies, *Mohs.*—Glanz Kobold, *Werner.*—Cobalt gris, *Haüy.*

Specific Character.—Tessular. Cleavage hexahedral, and perfect. White, inclining to red. Hardness = 5.5. Sp. gr. = 6.1,—6.3.

External Characters.—Colour silver-white, slightly inclining to copper-red. Occurs commonly massive and disseminated; also reticulated, occasionally in granular concretions, and crystallized in cubes, octahedrons, pentagonal dodecahedrons, and icosahedrons. Internally shining and glistening, and lustre metallic. Fracture conchoidal. Brittle, and easily frangible.

Constituent Parts.—

Cobalt,	33.10
Arsenic,	43.46
Iron,	3.23
Sulphur,	20.08

Strohmeyer.

Geognostic and Geographic Situations.—Occurs in primitive rocks in Norway, Sweden, and Silesia.

Use.—Is one of the most common species of cobalt, and is that from which the cobalt of commerce is principally obtained.

2. Octahedral Cobalt-Pyrites, or Tin-White Cobalt.

Octaedrischer Cobalt-Kies, *Mohs.*—Weisser Speiskobald, *Werner.*—Cobalt Arsenical, *Haüy.*

Specific Character.—Tessular. Cleavage, hexahedral, octahedral, dodecahedral, but very indistinct; sometimes the hexahedral is more distinct. White, inclining to steel-grey. Hardness = 5.5. Sp. gr. = 6.0,—6.6.

External Characters.—Colour tin-white, inclining more or less to steel-grey. Occurs massive, disseminated, cylindrical, reticulated, fruticose, specular, also in lamellar, and granular concretions; and crystallized in cubes, octahedrons, and rhomboidal dodecahedrons. Externally shining and splendent; internally glistening and metallic. Fracture uneven. Brittle, and easily frangible.

Constituent Parts.—

	From Riegelsdorf.
Arsenic,	74.2174
Cobalt.	20.3135
Iron,	3.4257
Copper,	0.1586
Sulphur,	0.8860
	100 *Strohmeyer.*

Geognostic and Geographic Situations.—Occurs in veins and beds in primitive, transition, and secondary rocks; and is found in Cornwall, Germany, France, Poland, Norway, and Sweden.

* Grey Cobalt Pyrites.

Grauer Speisskobalt, *Werner.*—Cobalt Arsenical Amorphe, *Haüy.*

External Characters.—On fresh fracture pale steel-grey, which, on exposure, becomes greyish-black. Occurs massive, disseminated, tubiform and specular. Internally glimmering or glistening, and lustre metallic, but the specular variety is splendent. Fracture even, conchoidal, or uneven. Brittle. Becomes shining in the streak without change of colour. Hardness same as that of hexahedral cobalt-pyrites. Brittle, and easily frangible. Sp. gr. = 7.0,—7.3, *Mohs.*

Geognostic and Geographic Situations.—Occurs in veins in primitive rocks, and is one of the ores of cobalt met with in the mines of Cornwall.

** Cobalt-Kies, *Hausmann.*

External Characters.—Colour pale steel-grey, which, on exposure, becomes nearly copper-red. Occurs massive, disseminated, and it is said also crystallized in cubes. Lustre shining and metallic. Fracture uneven, or imperfect conchoidal. Semihard.

Constituent Parts.—

Cobalt,	43.20
Sulphur,	38.50
Copper,	14.40
Iron,	3.53

Hisinger.

Geognostic and Geographic Situations.—Occurs in a bed of copper-pyrites, and in gneiss, at Riddarhyttan, in Sweden.

* * Radiated Tin-white Cobalt Pyrites.

Strahliger Weisser Speisskobald, *Werner.*

External Characters.—Colour tin-white, passing into steel-grey. Occurs massive, disseminated, and reniform; also in scopiform and stellular, radiated, or fibrous concretions. Internally glistening and metallic. Fracture uneven. Softer than octahedral tin white cobalt-pyrites.

Constituent Parts.—

Arsenic, - - -	65.75	
Cobalt, - - -	28.00	
Oxide of Iron, - -	5.00	
Oxide of Manganese, - -	1.25	
	100	*John.*

Geognostic and Geographic Situations.—Is a rare mineral, and has hitherto been found only at Schneeberg in Saxony, and Kongsberg in Norway.

Genus IV. Iron-Pyrites.

Tessular, rhomboidal, prismatic. Yellow. Hardness = 3.5,—6.5. Sp. gr. 4.4,—5.0.

1. Hexahedral Iron-Pyrites.

Hexaedrischer Eisen-Kies, *Mohs.*—Gemeiner Schwefelkies, *Werner.*—Fer Sulphure, *Haüy.*

Specific Character.—Tessular. Cleavage hexahedral. Bronze yellow. Hardness = 6.0,—6.5. Sp. gr. = 4.7,—5.0.

This species is divided into two subspecies, viz. Common and Cellular.

First Subspecies.

Common Iron-Pyrites.

Gemeiner Schwefelkies, *Werner.*

External Characters.—Colour bronze-yellow. Occurs most commonly massive, disseminated, and globular; also in granular distinct concretions, and crystallized in cubes, octahedrons, and in the leucite-form. Internally shining and glistening, and lustre metallic. Fracture uneven, and sometimes conchoidal. Brittle, and rather easily frangible.

Chemical Characters.—Before the blowpipe it emits a strong sulphureous smell, and burns with a bluish flame.

Constituent Parts.—

Sulphur,	52.15	
Iron,	47.85	
	100	*Hatchett.*

Geognostic and Geographic Situations.—Occurs in primitive, transition, and secondary mountains, in every country.

Uses.—It is never worked as an ore of iron; it is principally valued on account of the sulphur which can be obtained from it by sublimation, and the iron-vitrol which it affords by exposure to the air, either with or without previous roasting.

SECOND SUBSPECIES.

Cellular Pyrites.

Zellkies, *Werner.*

External Characters.—Colours bronze-yellow, which inclines very much to steel-grey, and slightly to green. Occurs massive, and but most frequently cellular. Of this form it exhibits the hexagonal, polygonal, and indeterminate varieties. Internally strongly glimmering, or glistening, and metallic. Fracture conchoidal.

Geognostic and Geographic Situations.—Occurs in metalliferous veins in Saxony.

2. Prismatic Iron-Pyrites.

Prismatischer Eisenkies, *Mohs.*—Fer Sulphure Blanc, *Haüy.*

Specific Character.—Prismatic. Pyramid $= 115° 53'$; $89° 12'$; $125° 16'$. Cleavage, $P + \infty = 116° 36'$. Bronze-yellow. Hardness $= 6.0,—6.5$. Sp. gr. $= 4.7,—5.0$.

This species is divided into four subspecies, viz. Radiated, Hepatic, Spear, and Cockscomb.

+ decays more rapidly than the other varieties

FIRST SUBSPECIES.

+ Radiated Pyrites.

Strahlkies, *Werner.*

External Characters.—Colour bronze-yellow. Occurs massive, dendritic, reniform, stalactitic, globular, botryoidal, fruticose, tuberose, with impressions; also in diverging prismatic, or radiated concretions, which are collected into others, having the granular form, and these are traversed by curved lamellar concretions. Frequently crystallized in oblique four-sided prisms, variously modified by bevelling and truncating planes. Lustre varies from glistering to glimmering and is metallic. Fracture uneven. Fragments wedge-shaped. Brittle, and very easily frangible.

Constituent Parts.—Sulphur, - - 53.60
Iron, - - - 46.40
100 *Hatchett.*

Geognostic and Geographic Situations.—Occurs in primitive, transition, secondary, and alluvial formations; and the different principal varieties are met with in England, Scotland, Germany, Spain, and other countries.

SECOND SUBSPECIES.

Hepatic Pyrites.

Leberkies, *Werner.*

External Character.—Colour pale brass-yellow, which inclines to steel-grey. On exposure acquires a brown or columbine tarnish. Occurs massive, disseminated, globular, tuberose, reniform, stalactitic, and with impressions. Internally glimmering and metallic. Fracture even, uneven, and sometimes flat conchoidal.

Geognostic and Geographic Situations.—Occurs in veins in primitive rocks, and is met with in many mines on the Continent of Europe, and also in North America.

THIRD SUBSPECIES.

Spear-Pyrites.

Sparkies, *Werner.*

External Characters.—Colour intermediate between bronze-yellow and steel-grey. Occurs massive, and crystallized in twin and triple crystals, which are aggregated in a spear-form. Externally shining; internally glistening, and lustre metallic. Fracture uneven, or imperfect conchoidal.

Geognostic and Geographic Situations.—Occurs in veins in primitive rocks, but more frequently in rocks of a newer date, associated with brown-wad, and is found in Bohemia and Saxony.

FOURTH SUBSPECIES.

Cockscomb-Pyrites.

Kamkies, *Werner.*

External Characters.—Colour bronze-yellow, inclining to pale steel-grey. Occurs massive, and crystallized in flat double four-sided pyramids, which are so aggregated as to resemble the comb of a cock. Internally shining, glistening and metallic. Fracture uneven.

Geognostic and Geographic Situations.—Occurs in veins in Derbyshire, and in some mines in Saxony.

3. Rhomboidal Iron-Pyrites, or Magnetic Pyrites.

Rhomboedrischer Eisenkies, *Mohs.*—Magnetkies, *Werner.*—Fer sulphuré ferrifère, *Haüy.*

Specific Character—Dirhomboidal. Rhomboid unknown. Cleavage, $R - \infty$. Less distinct $P + \infty$. Hardness $= 3.5$, —4.5. Sp. gr. $= 4.4$,—4.7.

External Characters.—Colour intermediate between bronze-yellow and copper-red. Occurs massive, disseminated, in coarse granular concretions; and very rarely crystallized in six-sided prisms and six-sided pyramids. Internally splendent, inclining to glistening, and lustre metallic. Fracture conchoidal, or uneven. Brittle, and easily frangible.

Constituent Parts.—	Iron,	59.85
	Sulphur,	40.15
		100.00 *Berzelius.*

Geognostic and Geographic Situations.—Occurs in beds, and imbedded, in primitive and transition mountains, along with common iron-pyrites, magnetic iron-ore, and blende. Occurs in the Criffle, Windy-Shoulder, and other hills in Galloway; at the base of the mountain called Moel-Elion, in Caernarvonshire, and in Saxony and Bohemia.

does not afford sparks with steel

GENUS V. COPPER-PYRITES.

Pyramidal. Hardness = 3.0,—4.0. Sp. gr. = 4.1,—4.3.

1. Pyramidal Copper-Pyrites, or Yellow Copper-Pyrites.

Pyramidaler Kupferkies, *Mohs.*—Kupferkies, *Werner.*—Cuivre pyriteux, *Haüy.*

Specific Character.—Pyramidal. Pyramid = 109° 53′; 108° 40′. Cleavage, $P+\infty$ = 101° 49′; 126° 11′. Brass-yellow.

External Characters.—Colour brass-yellow. Occurs massive, disseminated, in membranes, also dendritic, reniform, botryoidal, stalactitic, specular; and crystallized in various pyramidal forms. Internally shining, which in some varieties passes into glimmering. Lustre metallic. Fracture commonly uneven, sometimes even or conchoidal. Brittle, and easily frangible.

Constituent Parts.—		Cornwall.
	Copper,	30
	Iron	53
	Sulphur,	12
		95 *Chenevix.*

Geognostic and Geographic Situations.—Is one of the most abundant metalliferous minerals; occurs in almost every kind of repository, in all the great classes of rocks, and has a very extensive geographical range. Occurs near Tyndrum in Perthshire; in Mainland, the largest of the Shetlands; at the mines of Ecton, on the borders of Derbyshire and Staffordshire; at Pary's Mount in Anglesea; in several lead-mines in Derbyshire; abundantly in the copper-mines of Cornwall; in considerable quantity in the copper-mines of Cronebane and Ballymurtagh, in county of Wicklow.

Uses.—Much of the copper of commerce is obtained from this mineral. In Cornwall alone, the annual quantity of copper-ore raised is sometimes 73,700 tons, of which the principal ore is yellow copper-pyrites. This quantity of copper affords 6,425 tons of pure copper, and sells for £410,936.

Order XI. GLANCE.

Lustre metallic. Grey, black.

Hardness = 1.0,—4.0.

Sp. gr. = 4.0,—7.6. If under 5.0, and single perfect cleavage, the colour is lead-grey. If above 7.4, the colour is lead-grey.

Genus I. Copper-Glance.

Kupfer-Glanz, *Mohs.*

Tessular, prismatic. Hardness = 2.5,—4.0. Sp. gr. = 4.4,—5.8. If above 5.0, the colour is blackish lead-grey. If under 5.0, it is steel-grey or black.

1. Tetrahedral Copper-Glance.

Tetraedrischer Kupfer-glanz, *Mohs.*

Specific Character.—Tessular. Cleavage octahedral. Steel-grey....iron-black. Hardness = 3.0,—4.0. Sp. gr. = 4.4, —4.9.

This species is divided into two subspecies, viz. Grey and Black.

FIRST SUBSPECIES.

Grey Tetrahedral Copper-Glance, or Grey Copper.

Fahlerz, *Werner.*—Cuivre gris arsenifère, *Haüy.*—Grey Copper-Ore, *Jameson,* 2d edit.

External Characters.—Colour steel-grey. Occurs massive, disseminated, and crystallized in tetrahedrons variously modified. Surface shining or splendent. Internally glistening, or shining, and metallic lustre. Fracture uneven, sometimes conchoidal. Brittle, and easily frangible.

Constituent Parts.—

	Freyberg.	
Copper,	42.50	
Iron,	27.60	
Sulphur,	10.00	
Arsenic,	15.60	
Silver,	0.90	
Antimony,	1.50	
	98.00	*Klaproth.*

Geognostic and Geographic Situations.—Occurs in beds and veins, in primitive, transition, and secondary rocks. It is associated with yellow copper at Sand-Lodge in Shetland; occurs in veins at Fassney Burn in East Lothian; at Airthrie, north-east of Stirling; also in Ayrshire; and at Tavistock in Devonshire.

Uses.—Is valued as an ore of copper; and when it contains silver, is worked as an ore of that metal.

SECOND SUBSPECIES.

Black Tetrahedral Copper-Glance, or Black Copper.

Schwarzerz, *Werner.*—Cuivre gris antimonifère, *Haüy.*—Black Copper-ore, *Jameson,* 2d edit.

External Characters.—Colour iron-black, which sometimes inclines to steel-grey. Occurs massive, disseminated, and crystallized in tetrahedrons variously modified. Internally shining and splendent. Lustre metallic. Fracture conchoidal. Brittle, and very easily frangible.

Constituent Parts.		Kapnik in Transylvania.
	Copper,	37.75
	Antimony,	22.00
	Sulphur,	28.00
	Silver,	0.25
	Iron,	3.25
	Zinc,	5.00
	Loss,	3.75
		100.00 *Klaproth.*

Some varieties contain 13 *per cent.* of silver.

Geognostic and Geographic Situations.—Occurs in veins that traverse transition rocks at Zilla, in Clausthal in the Hartz, and in other districts.

Uses.—Is worked both as an ore of copper and as an ore of silver.

2. Prismatoidal Copper-Glance.

Prismatoidischer Kupfer-glanz, *Mohs.*—Prismatic Antimony-glance, *Jameson,* 3d edit.

Specific Character.—Prismatic. Pyramid unknown. Cleavage, $\breve{P}r + \infty$. Blackish lead-grey. Brittle. Hardness = 3.0. Sp. gr. = 5.7,—5.8.

External Characters.—Colour blackish lead-grey. Crystallized in oblique four-sided prisms. Lustre shining, and metallic.

3. Prismatic Copper-Glance, or Vitreous Copper.

Prismatischer Kupfer-glanz, *Mohs.*—Kupferglas, *Werner.*—Cuivre sulphuré, *Haüy.*—Rhomboidal Copper-glance, *Jameson,* 3d ed.

Specific Character.—Prismatic. Pyramid unknown. Cleavage, $P + \infty = 120$ (nearly). $\breve{P}r + \infty$. Sectile in a high degree. Blackish lead-grey. Hardness = 2.5,—3.0. Sp. gr. = 5.5,—5.8.

External Characters.—Colour blackish lead-grey. Occurs massive, disseminated, in granular concretions, and crystallized in six-sided prisms and six-sided pyramids. Internally shining, glistening and glimmering, and metallic. Fracture uneven and conchoidal. Sectile, and rather easily frangible.

Constituent Parts.—

	Siberia.
Copper,	78.05
Iron,	2.25
Sulphur,	18.50
Silica,	0.75
	100.00 *Klaproth.*

Geognostic and Geographic Situations.—Occurs in veins and beds in primitive rocks; also in beds in bituminous marl-slate, and flœtz amygdaloid. Veins of it occur at Fassney Burn, East Lothian; in Ayrshire; Fair Isle; also at Middleton Tyas in Yorkshire; Llandidno in Caernarvonshire; and in various mines in Cornwall.

* Variegated Copper.

Buntkupfererz, *Werner.*—Cuivre pyriteux hepatique, *Haüy.*

External Characters.—Fresh colour intermediate between copper-red and pinchbeck-brown, but soon acquires a variegated tarnish. Occurs massive, disseminated, and crystallized in six-sided prisms. Internally shining or glistening, and lustre metallic. Fracture conchoidal, which sometimes inclines to uneven. Hardness = 3.0. Sp. gr. = 4.9,—5.1.

		From Rudelstadt in Silesia.
Constituent Parts.—	Copper,	58
	Sulphur,	19
	Iron,	18
	Oxygen,	5
		100 *Klaproth.*

Geognostic and Geographic Situations.—Occurs in veins in primitive, transition, and secondary rocks, in various mining countries, as Cornwall, Arendahl, Kongsberg, Thuringia, &c.

Uses.—Copper is extracted from it, but it is not so easily reduced as copper-glance. It yields from 50 to 70 *per cent.* of copper.

GENUS II. SILVER-GLANCE, or VITREOUS SILVER.

Silber-Glanz, *Mohs.*

Tessular. Blackish lead-grey. Hardness = 2.0,—2.5. Sp. gr. = 6.9,—7.2.

1. Hexahedral Silver-Glance.

Hexaedrischer Silber-glanz, *Mohs.*—Glaserz, *Werner.*—Argent sulphuré, *Haüy.*

Specific Character.—Tessular. Cleavage not discernible. Malleable.

External Characters.—Colour dark blackish lead-grey. Generally occurs massive, sometimes disseminated, in membranes, and plates, dentiform, filiform, capillary, reticulated, dendritic, and stalactitic, with impressions, and crystallized in cubes, octahedrons, rhomboidal dodecahedrons, and in the leucite form. Externally shining and glistening. Internally shining, glistening, and metallic. Fracture uneven, or conchoidal. Completely malleable. Flexible, but not elastic.

		From Himmelfürst.
Constituent Parts.—	Silver,	85
	Sulphur,	15
		100 *Klaproth.*

Geognostic and Geographic Situations.—It is one of the most frequent of the ores of silver, and there are few formations of that metal which do not contain it. It was formerly met with at Airthrie in Stirlingshire, and is still found in the mines of Cornwall.

Uses.—Is highly valued as an ore of silver.

to be formed by aqueous means

+ continue GENUS III. GALENA, OR LEAD-GLANCE.

Tessular. Pure lead-grey. Hardness = 2.5. Sp. gr. = 7.4,—7.6.

1. Hexahedral Galena, or Lead-Glance.

Hexaedrischer Bleiglanz, *Mohs.*—Bleiglanz, *Werner.*—Plomb sulphuré, *Haüy.*

Specific Character.—Tessular. Cleavage octahedral.

This species is divided into two subspecies, viz. Common, and Compact.

FIRST SUBSPECIES.

Common Galena, or Lead-Glance.

Gemeiner Bleiglanz, *Werner.*

External Characters.—Colour lead-grey. Occurs massive, disseminated, reticulated, botryoidal, corroded, fused-like; also in granular, prismatic, and lamellar concretions; and crystallized in cubes, octahedrons, and rectangular four-sided prisms, acuminated with four planes, set on the lateral planes or lateral edges. Internally alternates from specular-splendent to glistening, and lustre metallic. Fragments cubical. Perfectly sectile. Uncommonly easily frangible.

Constituent Parts.—

Durham.		Kantenbach.	
Lead,	85.13	Lead, -	64
Sulphur,	13.02	Sulphur, -	18
Iron,	0.50	Calcareous Earth and Silica, -	18
	98.65		100
	Thomson.		*Vauquelin.*

Geognostic and Geographic Situations.—Occurs in veins, beds, and imbedded masses, in primitive, transition, and secondary mountains, in many of the mining districts in Europe, Asia, and America.

Uses.—Nearly all the lead of commerce is obtained from galena.

SECOND SUBSPECIES.

Compact Galena, or Lead-Glance.

Bleischweif, *Werner.*

External Characters.—Colour lead-grey. Occurs massive, disseminated, and specular. Internally glimmering, and lustre metallic. Fracture even, which in some varieties passes into flat conchoidal.

Geognostic and Geographic Situations.—Occurs in the same formations, and in the same countries as Common Galena.

* Blue Lead.

Blau Bleierz, *Werner*.

External Characters.—Colour intermediate between dark indigo-blue and dark lead-grey. Occurs massive, and in six-sided prisms. Internally glimmering and metallic. Fracture uneven, or small conchoidal. Opaque. Streak shining and metallic. Sectile, and easily frangible.

Constituent Parts.—Conjectured to be a mixture of Lead-glance and Phosphate of Lead.

Geognostic and Geographic Situations.—Occurs in veins, along with various lead-spars, in Saxony and France.

Genus IV. Tellurium-Glance, or Black Tellurium.

Tellur-Glanz, *Mohs.*

Prismatic. Cleavage perfect, according to one direction. Hardness = 1.0,—1.5. Sp. gr. = 7.0,—7.2.

1. Prismatic Tellurium-Glance.

Prismatischer Tellur-glanz, *Mohs.*—Nagyagerz, *Werner.*—Tellure natif auro-plombifère, *Haüy.*—Prismatic Black Tellurium, *Jameson*, 3d edit.

Specific Character.—Prismatic. Pyramid unknown. Cleavage perfect in one direction. Blackish lead-grey.

External Characters.—Colour between blackish lead-grey, and iron-black. Occurs massive, disseminated, in leaves, and crystallized in oblique four-sided prisms and four-sided pyramids. Externally splendent, and lustre metallic. Internally shining, and metallic. Sectile. Thin leaves and tables which are flexible.

Constituent Parts.—

Tellurium, - -	32.2
Lead, - - -	54.0
Gold, - - -	9.0
Sulphur, - -	3.0
Copper, - - -	1.3
Silver, - -	0.5
	100.0 *Klaproth.*

Geognostic and Geographic Situations.—Occurs in veins that traverse porphyry, at Nagyag in Transylvania.

Uses.—It is worked for the gold it contains.

GENUS V. MOLYBDENA, OR MOLYBDENA GLANCE.

Molybdän-Glanz, *Mohs.*

Rhomboidal. Easily flexible. Hardness = 1.0,—1.5. Sp. gr. = 4.4,—4.6.

1. Rhomboidal Molybdena.

Rhomboedrischer Molydän, *Mohs.*—Wasserblei, *Werner.*—Molybdene sulphuré, *Haüy.*

Specific Character.—Dirhomboidal. Rhomboid unknown. Cleavage R — ∞, perfect. Pure lead-grey.

External Characters.—Colour fresh lead-grey. Occurs usually masive, disseminated, in plates, also in granular distinct concretions, and sometimes crystallized in six-sided prisms. Internally splendent or shining, and lustre metallic. It writes with a bluish-grey streak on paper, but with a greenish-grey streak on porcelain. Soils slightly. Easily frangible. Splits easily into thin flexible leaves. Sectile, approaching to malleable. Feels greasy.

Constituent Parts.—

Molybdena, - - -	60
Sulphur, - - -	40
	100 *Buchols.*

Geognostic and Geographic Situations.—Occurs disseminated in granite, gneiss, mica-slate, and chlorite-slate. At Peterhead it is imbedded in granite and syenite; in chlorite-slate in Glenelg, Inverness-shire; in granite on Corybuy, at head of Loch Creran; in various mines in Cornwall; in granite veins near the source of the Caldew, in Cumberland; and in the granite of Shap, also in Cumberland.

* Molybdena Ochre.

Molybdän Ocker, *Karsten.*

External Characters.—Colour sulphur-yellow, inclining to straw and orange yellow, and to siskin-green. Occurs disseminated, and incrusting molybdena. Friable. Dull.

Geognostic and Geographic Situations.—Is found investing and intermixed with molybdena, in the granite of Corybuy, at Loch Creran.

Genus VI. Bismuth-Glance.

Prismatic. Pure lead-grey. Hardness = 2.0,—2.5. Sp. gr. = 6.1,—6.4.

1. Prismatic Bismuth-Glance.

Prismatischer Wismuth-Glanz, *Mohs.*—Wismuth-Glanz, *Werner.* —Bismuth sulphuré, *Haüy.*

Specific Character.—Prismatic. Pyramid unknown. Cleavage, $P + \infty$. $\breve{P}r + \infty$. $\bar{P}r + \infty$.

External Characters.—Colour pale lead-grey. Occurs massive, disseminated, in granular and radiated concretions, and crystallized in oblique four-sided prisms. Internally splendent and metallic. Soils. Brittle, inclining to sectile. Easily frangible.

Chemical Characters.—Melts in the flame of a candle.

Constituent Parts.—Bismuth,	60	
Sulphur,	40	
	100	*Sage.*

Geognostic and Geographic Situations.—Occurs in veins in Cornwall, Saxony, and other countries.

* Bismuth-Ochre.

Wismuth-Ocker, *Werner.*

External Characters.—Colours yellow, grey, and sometimes green. Occurs massive, and disseminated. Internally glimmering or glistening. Fracture uneven, or earthy. Opaque. Soft, sometimes verging on friable. Brittle, and easily frangible.

Constituent Parts.—

Oxide of Bismuth,	86.3
Oxide of Iron,	5.2
Carbonic Acid,	4.1
Water,	3.4
	99.0 *Lampadius.*

Geognostic and Geographic Situations.—Occurs in veins in primitive rocks in Cornwall, Saxony, and Bohemia.

Genus VII. Antimony-Glance.

Antimon-Glanz, *Mohs.*

Prismatic. Hardness = 1.5,—2.5. Sp. gr. = 4.0,—5.8. If under 5.0, the Hardness = 2.0, and sometimes slightly flexible. If above 5.0, the colour is steel-grey.

1. Prismatic Antimony-Glance.

Prismatischer Antimon-glanz, *Mohs.*—Schrift-erz, *Werner.*—Tellure natif auro-argentifère, *Haüy.*—Graphic Tellurium, or Graphic-ore, *Jameson,* 2d edit.; Prismatic Gold-glance, *Jameson,* 3d edit.

Specific Character.—Prismatic. Pyramid unknown. Cleavage, $\breve{P}r + \infty$, perfect. Less distinct $\bar{P}r + \infty$. Pure steel-grey. Hardness = 1.5,—2.0. Sp. gr. = 5.7,—5.8.

External Characters.—Colour steel-grey. Occurs massive, disseminated, in leaves; and crystallized in oblique four-sided prisms. Frequently there are attached to the extremities of the prisms others at right angles, giving to the whole row the appearance of a line of Persepolitan characters; hence the name Graphic sometimes given to this mineral. Externally splendent, and lustre metallic. Internally glistening, and metallic. Fracture uneven. Rather brittle, and easily frangible. Soils slightly.

Constituent Parts.—

Tellurium,	60
Gold,	30
Silver,	10
	100 *Klaproth.*

Geognostic and Geographic Situations.—Occurs in veins in porphyry in Transylvania.

Uses.—Is worked as an ore of gold, and as an ore of silver.

2. Prismatoidal Antimony-Glance, or Grey Antimony.

Grau Spiesglaserz, *Werner*.—Prismatoidischer Antimon-Glanz, *Mohs*.—Antimoine sulphuré, *Haüy*.

Specific Character.—Prismatic. Pyramid unknown. Cleavage, $P\breve{r}+\infty$, perfect. Less distinct $P-\infty$. $P+\infty$. $P\bar{r}+\infty$. Lead-grey. Hardness $=2.0$. Sp. gr. $=4.0,-4.6$.

External Characters.—Colour lead-grey. Occurs massive, disseminated, in distinct concretions, which are radiated, fibrous, and granular; also crystallized in oblique four-sided prisms, and in six-sided prisms. Lustre inclining from glistening to splendent and metallic. Fracture uneven and even. Rather brittle, and easily frangible.

Chemical Characters.—Melts by the mere flame of a candle; it is almost dissipated before the blowpipe in the form of a white vapour, with a sulphureous odour.

Constituent Parts.—	Antimony, - - -	74
	Sulphur, - - -	26
		100 *Bergmann*.

Geognostic and Geographic Situations.—Occurs in veins and beds in primitive and transition rocks. In Dumfriesshire there are veins of it in grey-wacke; and in Banffshire it occurs among rocks of the primitive class, and associated with green fluor *. There are considerable deposites of it on the Continent, and also in America.

3. Axotomous Antimony-Glance, or Bournonite.

Axentheilender Antimon-glanz, *Mohs*.—Axifrangible Antimony-glance or Bournonite, *Jameson*, 3d edit.—Triple sulphuré d'Antimoine, Plomb et Cuivre; Endellione, *Bournon*.

Specific Character.—Prismatic. Pyramid unknown. Cleavage, $P-\infty$, very perfect. Steel-grey. Hardness $=2.0,-2.5$. Sp. gr. $=5.5,-5.8$.

External Characters.—Colour steel-grey. Occurs massive, and crystallized in oblique four-sided prisms, variously modified by truncations, bevelments and acuminations. External-

* The discovery in Banffshire of fluor, one of the rarest of our Scottish minerals, was made by one of my pupils, Mr James Maitland Hogg of Newliston.

ly shining and metallic: internally glistening and metallic. Fracture uneven or conchoidal. Opaque. Very brittle, and easily frangible.

Constituent Parts.—	Lead,	42.62
	Antimony,	24.23
	Copper,	18.20
	Iron,	1.20
	Sulphur,	17.00
		100.00 *Hatchett.*

Geognostic and Geographic Situations.—Occurs in veins in clay-slate in Cornwall.

Genus VIII. Melane-Glance *.

Prismatic. Black, partly inclining to lead-grey. Hardness = 2.0,—3.0. Sp. gr. = 5.9,—6.6.

1. Diprismatic Melane-Glance.

Diprismatischer Melan-glanz, *Mohs.*—Schwarz Spiesglaserz, *Werner.*—Plomb sulphuré-antimonifère, *Haüy.*

Specific Character.—Prismatic. Pyramid unknown. Cleavage, $P\bar{r} + \infty$. $P\breve{r} + \infty$, the latter somewhat more discernible, both imperfect. Iron-black, inclining to lead-grey. Hardness = 2.5,—3.0. Sp. gr. = 6.4,—6.6.

External Characters.—Iron-black, inclining more or less to blackish lead-grey. Occurs massive; and crystallized in longish rectangular four-sided tables, and in double four-sided pyramids, in which the apices and the edges of the common base are truncated. Externally generally smooth, or feebly streaked. Internally shining or splendent, and metallic. Fracture imperfect conchoidal. Rather brittle, and easily frangible.

Constituent Parts.—It is conjectured to be Sulphuret of Antimony, combined with Copper and Silver.

Geognostic and Geographic Situations.—Occurs in veins in primitive and transition rocks. In Transylvania, it is associated with grey copper, yellow blende, and quartz; and in Saxony, near Freyberg, with calcareous-spar and quartz.

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* *Melane*, from μελας, *black.*

2. Prismatic Melan-Glance.

Prismatischer Melan-glanz, *Mohs.*—Sprödglaserz, *Werner.*—Argent antimoine-sulphuré noire, *Haüy.*—Rhomboidal Silver-glance, or Brittle Silver-glance, *Jameson* 3d edit.

Specific Character.—Prismatic. Pyramid unknown. Cleavage, $P + \infty = 124°$ (nearly). $\breve{P}r + \infty$, imperfect. Iron-black. Hardness = 2.0,—2.6. Sp. gr. = 5.9,—6.4.

External Characters.—Colour intermediate between iron-black and blackish lead-grey. Generally disseminated, and sometimes crystallized in six-sided prisms and tables, and six-sided pyramids. Externally highly splendent: internally shining, inclining to glistening, and lustre metallic. Fracture alternates from small conchoidal to fine-grained uneven. Lustre not increased in the streak. Sectile? and easily frangible.

Constituent Parts.—

Silver,	66.50
Sulphur,	12.00
Antimony,	10.00
Iron,	5.00
Copper and Arsenic,	0.50
Earthy substances,	1.00
	95.00 *Klaproth.*

Geognostic and Geographic Situations.—Occurs in veins that traverse gneiss, clay-slate, and porphyry, in Saxony, Bohemia, and Hungary.

ORDER *XII. BLENDE.*

If the lustre is metallic, the colour is black. If the lustre is not metallic, it is adamantine. If the streak is brown, white, or grey, the Sp. gr. is between 4.0 and 4.2; and the form tessular. If the streak is red, the Sp. gr. = 4.5, and more; and the Hardness = 2.5, and less.

Hardness = 1.0,—4.0.

Sp. gr. = 3.9,—8.2. If 4.3 and more, the streak is red.

Genus I. Manganese-Blende.

Glanz-blende, *Mohs.*—Mangan-blende, *Werner.*—Manganese sulphuré, *Haüy.*—Braunstein-blende, *Blumenbach.*—Sulphuret of Manganese, *Jameson,* 2d edit.

Prismatic. Streak green. Hardness = 3.5,—4.0. Sp. gr. = 3.9,—4.0.

1. Prismatic Manganese-Blende.

Prismatisches Glanz-blende, *Mohs.*

Specific Character.—Prismatic. Pyramid unknown. Cleavage, prismatic. Metallic lustre.

External Characters.—Colour on the fresh fracture iron-black, but on exposure becomes tarnished of a brownish-black colour. Occurs massive, disseminated, in granular concretions, and crystallized in oblique four-sided prisms, variously modified by truncations. Lustre splendent or shining, and metallic, inclining to imperfect metallic. Opaque. Streak of a greenish colour.

Constituent Parts.—

Oxide of Manganese,	85	
Sulphur,	15	
	100	*Vauquelin.*

Geognostic and Geographic Situations.—Occurs in Cornwall, and at Nagyag in Transylvania, along with ores of tellurium, blende, copper-pyrites, compact red manganese, and brown-spar.

Genus II. Zinc-Blende, or Garnet-Blende.

Granat-Blende, *Mohs.*

Tessular. Streak not green. Hardness = 3.5,—4.0. Sp. gr. = 4.0,—4.2.

1. Dodecahedral Zinc-Blende.

Dodecaedrischer Granat-Blende, *Mohs.*—Blende, *Werner.*—Zinc sulphuré, *Haüy.*

Specific Character.—Tessular. Cleavage dodecahedral. Streak, white, grey, or reddish-brown.

This species is divided into three subspecies, viz. Yellow, Brown, and Black.

FIRST SUBSPECIES.

Yellow Zinc-Blende.

Gelb Blende, *Werner.*

External Characters.—Colours yellow, green, grey, and sometimes red. Occurs massive, disseminated, in granular concretions; and crystallized in octahedrons and rhomboidal dodecahedrons. Externally and internally lustre shining and splendent, and adamantine, inclining to resinous. Varies from translucent to transparent. Brittle, and easily frangible.

Physical Character.—Becomes phosphorescent by friction.

Chemical Characters.—Decrepitates before the blowpipe, becomes grey, but is infusible, either alone or with borax.

Geognostic and Geographic Situations.—Occurs in veins in primitive, transition, and secondary rocks. Is met with in Clifton mine, near Tyndrum in Perthshire; also in Flintshire.

SECOND SUBSPECIES.

Brown Zinc-Blende.

Braun Blende, *Werner.*

External Characters.—Colour brown. Occurs massive, disseminated, in granular, and sometimes in fibrous concretions; also crystallized in octahedrons, rhomboidal dodecahedrons, tetrahedrons, and twin-crystals. Lustre ranges from specular-splendent to glimmering, and is pearly-adamantine. Translucent, or only translucent on the edges.

Constituent Parts.—

Zinc,	58.8	
Sulphur,	23.5	
Iron,	8.4	
Silica,	7.0	
	97.7	*Thomson.*

Geognostic and Geographic Situations.—Occurs in Clifton lead-mine near Tyndrum; in small veins, with galena, in the coal-fields around Edinburgh; Cumberhead, Lanarkshire; Lead-Hills; and in all the lead-mines in England and Wales.

THIRD SUBSPECIES.

Black Zinc-Blende.

Schwarz Blende, *Werner.*

External Characters.—Colour black, and rarely blood-red. Occurs massive, and in granular concretions. Internally shining or splendent, and lustre adamantine, inclining to metallic; always opaque, excepting the blood-red variety, which is translucent on the edges.

Geognostic and Geographic Situations.—Occurs in the same geognostic situations as the other subspecies, but is much rarer. Is found in Saxony, Siberia, Hungary, &c.

Uses of Zinc Blende.—It is principally valuable as an ore of zinc.

Genus III. Antimony-Blende, or Red Antimony.

Nadel Blende, *Mohs.*

Prismatic. Hardness = 1.0,—1.5. Sp. gr. = 4.5,—4.6.

1. Prismatic Antimony-Blende, or Red Antimony.

Prismatisches Nadel-blende, *Mohs.*—Roth Spiesglas-erz, *Werner.* —Antimoine oxidé sulphuré, *Haüy.*—Purple Blende, *Mohs.*

Specific Character.—Prismatic. Pyramid unknown. Cleavage prismatoidal. Streak red.

External Characters.—Colour cherry-red, and frequently with a tempered-steel tarnish. Occurs massive, disseminated, in flakes, in distinct concretions, which are scopiform and stellular fibrous, and granular; and crystallized in oblique four-sided prisms. Externally and internally shining. Lustre nearly adamantine. Opaque, or translucent on the edges. Rather brittle, and very easily frangible.

		From the mine called Neue Hoffnung Gottes at Braünsdorf.
Constituent Parts.—	Antimony, - - -	67.50
	Oxygen, - - -	10.80
	Sulphur, - - -	19.70
		98.00 *Klaproth.*

Geognostic and Geographic Situations.—This rare mineral occurs in veins, in primitive rocks, in Saxony, France, and Hungary.

Genus IV. Ruby-Blende.

Rubin-Blende, *Mohs.*

Rhomboidal. Hardness = 2.0,—2.5. Sp. gr. = 5.2,—8.2.

1. Rhomboidal Ruby-Blende, or Red Silver.

Rhomboedrischer Rubin-Blende, *Mohs.*

Specific Character.—Rhomboidal. Rhomboid = 109° 28′. Cleavage, rhomboidal.. Streak red. Hardness = 2.5. Sp. gr. = 5.2,—5.8.

External Characters.—Colour intermediate between cochineal-red and dark lead-grey, and sometimes inclines to carmine-red. Occurs massive, disseminated, in membranes; and crystallized in six-sided prisms and six-sided pyramids. Externally alternates from shining to splendent; lustre semimetallic or adamantine. Internally alternates from shining to glimmering; lustre sometimes adamantine, sometimes semimetallic. Fracture uneven or conchoidal. Ranges from opaque to transparent. Streak cochineal-red.

Constituent Parts.—	Silver,	60.0	
	Antimony,	20.3	
	Sulphur,	14.7	
	Oxygen,	5.0	
		100.0	*Klaproth.*

Geognostic and Geographic Situations.—Occurs in veins in gneiss, mica-slate, porphyry, and grey-wacke, in various mining districts, as in Cornwall, Hartz, Hungary, Mexico, and Peru.

Uses.—It is a valuable ore of silver, and in some mines occurs in considerable quantity.

2. Prismato-Rhomboidal Ruby-Blende, or Cinnabar.

Prismato-Rhomboedrischer Rubin-Blende, *Mohs.*—Mercure sulphuré, *Haüy.*

Specific Character.—Rhomboidal. Rhomboid ahout 85°. Cleavage, R + ∞, perfect. Streak red. Hardness = 2.0, —2.5. Sp. gr. = 6.7,—8.2.

Is divided into two subspecies, viz. Common and Hepatic.

FIRST SUBSPECIES.

Common Cinnabar.

Zinnober, *Werner.*

External Characters.—Colours cochineal-red, scarlet-red. and carmine-red. Besides massive, disseminated, dendritic, and in granular concretions; it also occurs crystallized in six-sided prisms. Internally alternates from shining to glimmering; lustre adamantine, verging on semi-metallic. Fracture fine-grained uneven, even, conchoidal, and earthy. Alternates from opaque to transparent. Yields a scarlet-red shining streak. Sectile, and easily frangible.

		Japan.	
Constituent Parts.—	Mercury, - -	84.50	
	Sulphur, - -	14.75	
		99.25	*Klaproth.*

Geognostic and Geographic Situations.—Occurs most abundantly in the coal formation, and less plentifully in beds and veins in primitive rocks. There are considerable mines of this mineral at Idria in Carniola, and in other parts of Europe; also in Asia and America.

Uses.—It is from this mineral and the following, that the mercury of commerce is obtained.

SECOND SUBSPECIES.

Hepatic Cinnabar.

Quecksilber Lebererz, *Werner.*—Mercure sulphuré bituminifere, *Haüy.*

External Characters.—Colour intermediate hetween dark cochineal-red and dark lead-grey. Occurs massive, disseminated, and in globular concretions. Internally alternates from glimmering to splendent. Lustre semi-metallic. Fracture even or slaty. Opaque. Sectile, and easily frangible.

Constituent Parts.—

Mercury,	81.80
Sulphur,	13.75
Carbon,	2.30
Silica,	0.65
Alumina,	0.55
Oxide of Iron,	0.20
Copper,	0.02
Water,	0.73
	100.00 *Klaproth.*

Geognostic and Geographic Situations.—This mineral occurs in considerable masses in slate-clay and bituminous-shale, at Almaden Spain, in Deux-Ponts, and Siberia.

ORDER XIII. SULPHUR.

No metallic lustre. Colour red, yellow or brown.

Prismatic.

Hardness = 1.0,—2.5.

Sp. gr. = 1.9,—3.6. If above 2.1, the streak is yellow or red.

GENUS I. SULPHUR.

Prismatic. Hardness = 1.5,—2.5. Sp. gr. = 1.9,—3.6.

1. Prismatoidal Sulphur, or Yellow Orpiment.

Prismatoidischer Schwefel, *Mohs.*—Gelb-Rausch gelb, *Werner.*—Arsenic Sulphuré jaune, *Haüy.*

Specific Character.—Prismatic. Pyramid unknown. Cleavage, distinctly prismatoidal. Streak lemon-yellow. Hardness = 1.5,—2.0. Sp. gr. = 3.4,—3.6.

External Characters.—Colour lemon-yellow. Occurs massive, disseminated, stalactitic, reniform, botryoidal, in crusts, in granular and concentric curved lamellar concretions, and crystallized in oblique four-sided prisms, and in flat double four-sided pyramids. Splendent, and lustre intermediate between adamantine and semi-metallic. Translucent, but in thin leaves transparent. Colour not altered in the streak. Sectile. Flexible, but not elastic.

		Turkey.	
Constituent Parts.—	Arsenic, - - -	62	
	Sulphur, - -	38	
		100	*Klaproth.*

Geognostic and Geographic Situations.—Occurs in veins in secondary and primitive rocks in Germany, Hungary, China, Mexico, and United States.

2. Hemiprismatic Sulphur, or Red Orpiment.

Hemiprismatischer Schwefel, *Mohs.*—Roth-Rausch gelb, *Werner.* —Arsenic Sulphuré rouge, *Haüy.*

Specific Character.—Hemiprismatic. Pyramid unknown. Cleavage, $P + \infty = 107° 42'$. $\breve{P}r + \infty$. $P\bar{r} + \infty$. None distinct. Streak orange-yellow and aurora-red. Hardness = 1.5,—2.0. Sp. gr. = 3.3,—3.4.

External Characters.—Colour aurora-red, sometimes inclining to orange-yellow. Occurs massive, disseminated, in flakes or membranes, and crystallized in oblique four-sided prisms, variously modified by acuminations, truncations, and bevelments. Internally shining. Lustre adamantine, inclining to resinous. Fracture uneven, sometimes passing into conchoidal. Translucent; crystals semi-transparent. Brittle, and easily frangible.

		Bannat.	
Constituent Parts.—	Arsenic, - -	69	
	Sulphur, - -	31	
		100	*Klaproth.*

Geognostic and Geographic Situations.—Occurs most frequently in veins in primitive rocks, less frequently in secondary rocks. Different mining districts in Germany afford this mineral, and it is also a production of Japan, the north-west coast of America, and of volcanoes. associated with Native Orpim

Use.—Is used as a pigment.

3. Prismatic Sulphur.

Prismatischer Schwefel, *Mohs*—Natürliches Schwefel, *Werner.*—Soufre, *Haüy.*

Specific Character.—Prismatic. Pyramid = 107°, 19′; 84 24′; 143° 8′. Cleavage, P . P + ∞ = 102° 41. Streak white or sulphur-yellow. Hardness = 1.5,—2.5. Sp. gr. 1.9,—2.1.

This species is divided into two subspecies, viz. Common and Volcanic.

FIRST SUBSPECIES.

Common Sulphur.

Gemeiner Naturlicher Schwefel, *Werner.*

External Characters.—Colour yellow, brown, and grey. Occurs massive, disseminated, in granular concretions, and crystallized in acute double six-sided pyramids. Internally varies from shining to glimmering. Lustre intermediate between adamantine and resinous. Fracture uneven, sometimes inclining to splintery, or to conchoidal. Translucent. Crystals semi-transparent and transparent, and refract double. Brittle, and easily frangible.

Chemical Characters.—Is easily inflamed, and burns with a lambent bluish flame, and suffocating odour.

Geognostic and Geographic Situations.—Common sulphur occurs in considerable abundance in primitive mountains, in a state of combination with metals; but rarely pure or uncombined; while in secondary mountains, it is more abundant in the pure uncombined state than in combination with metals. Is also met with in alluvial districts, particularly near sulphureous springs. Abounds in Iceland, Spain, Italy, &c.

along with compact Gypsum

SECOND SUBSPECIES.

Volcanic Sulphur.

Vulcanischer Natürlichér Schwefel, *Werner.*

External Characters.—Colour pale sulphur-yellow. Occurs massive, stalactitic, vesicular, corroded, perforated; crystallized in pyramidal figures. Glistening, and lustre adamantine, inclining to resinous. Fracture uneven. Translucent. In other characters it agrees with the preceding subspecies.

Every time [illegible] sulphur: mostly in [illegible]
[illegible] —

Geognostic and Geographic Situations.—Occurs only in volcanic countries, where it is found more or less abundantly among lavas. Solfatara, in the vicinity of Vesuvius, is one of the most famous repositories of volcanic sulphur, and it is there collected in considerable quantities for the purposes of commerce.

Uses.—When burnt, it affords sulphuric acid; it enters into the composition of gunpowder; is used in various metallurgic processes, and in bleaching; it forms a constituent part of some cements; is employed in taking casts; and is an article in the Materia Medica.

CLASS III.

If liquid, the smell is bituminous. If solid, is tasteless. Specific gravity under 1.8.

ORDER I. *RESIN.*

Liquid. Solid. Streak white, grey, yellow, brown and black.

Hardness = 0.0,—2.5.

Specific gravity = 0.7,—1.6. If 1.2 and more, the streak is white or grey.

GENUS I. MELLILITE, or HONEY-STONE.

Melichron-Resin, *Mohs.*

Pyramidal. Hardness = 2.0,—2.5. Sp. gr. = 1.4,—1.6.

1. Pyramidal Mellilite, or Honeystone.

Pyramidales Melichron-Resin, *Mohs.*—Honigstein, *Werner.*—Mellite, *Haüy.*

Specific Character.—Pyramidal. Pyramid = 118° 4′,—93° 22′. Cleavage, pyramidal but imperfect.

External Characters.—Colour yellow, and sometimes red. Rarely massive. Generally crystallized in flat double four-sided pyramids. Lustre shining or splendent, and vitreo-resinous. Fracture conchoidal. Semi-transparent, or translucent, and refracts double. Brittle, and easily frangible.

Constituent Parts.—Alumina,	16	
Mellilitic Acid,	46	
Water of crystallization,	38	
	100	*Klaproth.*

Geognostic and Geographic Situations.—Occurs superimposed on bituminous wood and earth-coal, and is usually accompanied with sulphur. It has been hitherto found only at Artern in Thuringia.

Genus II. Mineral-Resin.

Erd-Harz, *Mohs.*

Amorphous. Hardness = 0.0,—2.5. Sp. gr. = 0.8,—1.2.

1. Yellow Mineral-Resin, or Amber.

Gelbes Erdharz, *Mohs.*—Bernstein, *Werner.*—Succin, *Haüy.*

Specific Character.—Solid. Yellow...white. Streak white, or grey. Hardness = 2.0,—2.5. Sp. gr. = 1.0,—1.1.

External Characters.—Colour yellow and white. Occurs in massive pieces, and disseminated; often incloses insects, and sometimes vegetables. Externally dull; internally splendent, shining or glistening, and lustre resinous. Fracture conchoidal. Transparent or translucent. Brittle, and easily frangible.

Chemical Characters.—Burns with a yellow-coloured flame, and fragrant odour, at the same time intumescing, but scarcely melting.

Physical Characters.—When rubbed, it gives out an agreeable smell, and becomes strongly resino-electric. This latter property was known to the ancients, who termed amber *electrum;* from whence is derived the word *electricity.*

Constituent Parts.—Is composed of carbon, hydrogen, and oxygen. An acid named *Succinic* is obtained from it by distillation.

{all the insects inclosed in amber are extinct, & different from those now alive

Geognostic and Geographic Situations.—Occurs in beds of bituminons wood and moor-coal; also in a conglomerate formed, by the aggregation of fragments on sea-shores; in sandy soil; frequently floating on the sea; and it is said to have been observed imbedded in secondary limestone. It is found on the shores of Scotland and England, of the Baltic, and in Germany, Poland, and other countries.

Uses.—On account of its beautiful colour, great transparency, and the fine polish it receives, it is considered as an ornamental stone, and is cut into necklaces, bracelets, snuff-boxes, and other articles of dress.

2. Black Mineral-Resin.

Schwarzes Erd-Harz, *Mohs.*—Bitume, *Haüy.*

Specific Character.—Solid...liquid. Black, brown, red, and grey. Streak black, brown, yellow, and grey. Hardness 0.0,—2.0 Sp. gr. = 0.8,—1.2.

This species is divided into three subspecies, viz. Naphtha, Mineral Oil or Petroleum, and Mineral-Pitch, or Bitumen.

FIRST SUBSPECIES.

Naphtha.

External Characters.—Colours yellowish-white, yellowish-grey, and wine-yellow. Perfectly liquid. Shining and resinous. Feels greasy. Exhales an agreeable bituminous smell.

Chemical Characters.—Takes fire on the approach of flame, affording a bright white light.

Constituent Parts.—Is a compound of carbon, hydrogen, and a little oxygen.

Geognostic and Geographic Situations.—This mineral is seldom found in a pure state. Is said to occur in considerable springs on the shores of the Caspian Sea, in the Caucasus, and other places.

Uses.—In Persia, Japan, and some parts of Italy, where it occurs in considerable quantity, it is used in lamps, in place of oil, for lighting streets, churches, &c.

SECOND SUBSPECIES.

Mineral-Oil, or Petroleum.

Erdöl, *Werner.*

External Characters.—Colour dark blackish-brown, which sometimes inclines to green. Liquid, but occasionally approaches more or less to the viscid state. Shining and resinous. Feels greasy. Semi-transparent, translucent, and opaque. Exhales a strong bituminous odour.

Geognostic and Geographic Situations.—Generally flows from rocks of the coal formation, and usually from the immediate vicinity of beds of coal; also from limestone rocks. Occurs in marshes, on the surface of spring water; or it flows or trickles unmixed from its mineral repository. Small quantities are occasionally found in cavities of quartz, or diffused through it, and giving it blackish-brown colour. Is found at St Catherine's Well, near Edinburgh, in the Orkney Islands, in +Shropshire in England, &c.

Uses.—In Piedmont, Persia, Japan, and other countries, it is used in lamps in place of oil, for lighting streets and churches.

Pitch ford & Coal-Brook Dale

THIRD SUBSPECIES.

Mineral-Pitch, or Bitumen.

This subspecies is divided into three kinds, viz. Earthy, Slaggy, and Elastic.

First Kind.

Earthy Mineral-Pitch.

Erdiges Erdpech, *Werner.*

External Characters.—Colour blackish-brown. Occurs massive. Faintly glimmering, inclining to dull. Fracture earthy or uneven. Streak shining and resinous. Soft. Sectile. Feels greasy.

Geognostic and Geographic Situations.—Occurs in the Iberg in the Hartz, along with slaggy mineral-pitch, in veins that traverse grey wacke; also in other places.

The walls of Babylon were cemented by this

Mineral pitch

Second Kind.

Slaggy Mineral-Pitch, or Asphaltum.

Schlackiges Erdpech, *Werner*.

External Characters.—Colour pitch-black. Occurs massive, disseminated, sometimes globular, reniform, and stalagmitic. Externally and internally splendent and shining, and lustre resinous. Fracture conchoidal. Soft. Opaque. Sectile.

Geognostic and Geographic Situations.—Occurs in veins, and in reniform and imbedded masses in secondary limestone in Fifeshire; in clay iron-stone in East Lothian; in veins at Haughmond Hill in Shropshire, and in mineral veins in Cornwall.

Uses.—The Egyptians employed it in the process of embalming bodies: The Turks quarry it in Albania, and use it, when mixed with common rosin, for paying the bottoms of ships, and for smearing the rigging.

Third Kind.

Elastic Mineral-Pitch. Mineral Caoutchouc

Elastiches Erdpech, *Werner*.

External Characters.—Colour brown. Occurs massive, reniform, and sometimes with impressions. Internally shining and glistening, and lustre resinous. Fracture curved slaty, or conchoidal. Translucent on the edges. Shining in the streak. Perfectly sectile. Elastic flexible.

Geognostic and Geographic Situations.—Is found in the cavities of a lead-glance vein, in the lead-mine called Odin, which is situated near the base of Mamtor, to the north of Castletown in Derbyshire.

ORDER II. COAL.

Solid. Streak brown and black.
Hardness = 0.1,—2.5.
Sp. gr. = 1.2,—1.5.

Genus I. Mineral-Coal.

Amorphous. Hardness = 1.0,—2.5. Sp. gr. = 1.2,—1.5.

1. Bituminous Mineral-Coal.

Harzige Stein-Kohle, *Mohs.*

Specific Character.—Colours black and brown. Resinous lustre. Bituminous smell. Hardness = 1.0,—2.5. Sp. gr. 1.2,—1.5.

This species contains two subspecies, viz. Brown and Black.

FIRST SUBSPECIES.

Brown Bituminous Coal, or Brown Coal.

Braun Kohle, *Werner.*

This subspecies is divided into five kinds, viz. Bituminous Wood, or Fibrous Brown Coal. 2. Earthy Coal, or Earthy Brown Coal. 3. Alum-Earth, or Aluminous Brown Coal. 4. Common Brown Coal, or Conchoidal Brown Coal; and, 5. Moor-Coal, or Trapezoidal Brown Coal.

the remains of ancient trees

First Kind.

Bituminous Wood, or Fibrous Brown Coal.

Bituminoses Holz, *Werner.*

External Characters.—Colour brown. External shape resembles exactly that of stems and branches of trees, but usually compressed. Principal fracture glimmering or glistening; cross fracture shining. Fracture fibrous in the small, slaty in the great. Opaque. Streak shining.

Geognostic and Geographic Situations.—Occurs in alluvial land, or in secondary rocks; and is found in Scotland, England, Ireland, &c.

Second Kind.

Earth-Coal, or Earthy Brown Coal.

Erdkohle, *Werner.*

External Characters.—Colours brown and grey. Occurs massive. Its consistence is between cohering and loose, but more inclined to the latter. Particles coarse dusty, and soil a little. Internally faintly glimmering, passing into dull. Fracture in the more cohering masses fine earthy. Streak somewhat shining.

Geognostic and Geographic Situations.—Is found, along with bituminous wood, in Thuringia, and other countries.

Uses.—It is used as fuel where no great degree of heat is required, as in heating rooms, salt, nitre, and alum-works, and in distillation. but must be mixed with some [illegible] matter

Third Kind.

Alum-Earth, or Aluminous Brown Coal.

Alaunerde, *Werner.*

External Characters.—Colour black. Occurs massive. Dull; sometimes glimmering, owing to an intermixture of mica. Fracture in the great, thick or thin slaty: in the small, earthy. Breaks into tabular pieces. Streak shining. Sectile, and uncommonly easily frangible.

Geognostic and Geographic Situations.—Occurs in alluvial districts in France, Germany, Italy, and Hungary.

Uses.—It is first exposed to the air for several months, and then lixiviated, to obtain the alum it contains; it is rarely used for fuel.

Fourth Kind.

Common Brown Coal, or Conchoidal Brown Coal.

Gemeiner Braunkohle, *Werner.*

External Characters.—Colour black. Occurs massive, and sometimes ligniform. Internally shining, sometimes glistening, and lustre resinous. Fracture conchoidal, and sometimes shews the fibrous woody texture. Colour lighter in the streak.

Constituent Parts.—200 grains of the Bovey brown coal, by distillation, yielded,

1. Water, which soon came over acid, and afterwards turbid, by the mixture of some bitumen, -	60 Grains.
3. Thick brown oily bitumen, - - -	21
3. Charcoal, - - - - - -	90
4. Mixed gass, consisting of hydrogen, carbonated hydrogen, and carbonic acid, - - -	29
	200 *Hatchett.*

Geognostic and Geographic Situations.—Occurs in alluvial land, and in secondary or flœtz-trap rocks, in England, Ireland, France, &c.

Use.—It is used as fuel.

Fifth Kind.

Moor-Coal, or Trapezoidal Brown Coal.

Moorkohle, *Werner.*

External Characters.—Colours brown and black. Occurs massive, when first dug, but soon bursts and splits into rhomboidal pieces. Lustre of the principal fracture glimmering, of the cross fracture glistening, and lustre resinous. Principal fracture imperfect slaty; cross fracture even approaching to conchoidal. Sectile. Streak shining. Uncommonly easily frangible. The most easily frangible species of coal.

Geognostic and Geographic Situations.—Occurs in great beds in alluvial lands, and in secondary trap-rocks in Bohemia, Germany, &c.

SECOND SUBSPECIES.

Black Bituminous Coal.

Schwartzkohle, *Werner.*

This subspecies is divided into four kinds, viz. Slate, Cannel, Foliated, and Coarse.

First Kind.

Slate-Coal. common Coal

Schieferkohle, *Werner.*

External Characters.—Colour black. Occurs massive. Shining or glistening, and lustre resinous. Principal fracture nearly straight, and generally thick slaty; cross fracture imperfect and flat conchoidal, and sometimes even or uneven. Lustre increased in the streak.

Geognostic and Geographic Situations.—Abounds in all the coal districts in great Britain. of most common [illegible]

Second Kind.

Cannel-Coal.

Kennelkohle, *Werner.*

External Characters.—Colour black. Occurs massive. Internally glistening or glimmering, and lustre resinous. Fracture large and flat conchoidal, or even. Fragments irregular, cubical, or trapezoidal. Brittle, and easily frangible.

Geognostic and Geographic Situations.—Occurs along with the preceding subspecies, in the coal formation in most of the coal-fields of Great Britain.

Uses.—On account of its solidity, and the good polish it is capable of receiving when pure, it is cut into drinking-vessels of various kinds, ink-holders, snuff-boxes, &c.; but its principal use is as fuel.

Third Kind.

Foliated Coal.

Blätterkohle, *Werner.*

External Characters.—Colour velvet-black. Occurs massive, and in lamellar concretions. Lustre splendent and resinous. Fracture uneven. Softer than cannel-coal. Rather brittle, and very easily frangible.

Geognostic and Geographic Situations.—Occurs in the coal formation, although not abundantly, and generally accompanied with slate-coal, in Saxony and Silesia.

Fourth Kind.

Coarse Coal.

Grobkhole, *Werner.*

External Characters.—Colour black. Occurs massive, and in granular concretions, which are intimately aggregated

Is of older formation than the [illegible] —
(was formed by [illegible] [illegible] [illegible]
but these [illegible] [illegible] shells)

together. Glistening and resinous. Principal fracture imperfect, and thick scaly; cross fracture fine-grained uneven. Rather brittle, and easily frangible.

Geognostic Situation.—Occurs in the coal formation in Germany.

2. Glance-Coal.

Harzlose Steinkhole, *Mohs.*—Anthracite, *Haüy.*

Specific Character.—Colour black. Partly imperfect metallic lustre. No bituminous smell. Hardness = 2.0,—2.5. Sp. gr. = 1.3,—1.5.

This species contains two subspecies, viz. Pitch-Coal, and Glance-Coal.

FIRST SUBSPECIES.

Pitch-Coal, or Jet.

Pechkohle, *Werner.*

External Characters.—Colour velvet-black. Occurs massive; and it is said also in plates, and sometimes in the shape of branches, with a regular woody internal structure. Internally splendent, and the lustre resinous, inclining to imperfect metallic. Fracture large and perfect conchoidal. Affords a brown coloured streak.

Chemical Characters.—It burns with a greenish flame. Its chemical constitution is still imperfectly understood.

Geognostic and Geographic Situations.—Occurs along with brown coal, in beds in flœtz-trap and limestone rocks; also in beds and in imbedded portions in bituminous shale, in Scotland, Faroe Islands, and Germany.

SECOND SUBSPECIES.

+ Glance-Coal.

Glanzkohle, *Werner.*

This subspecies contains four kinds, viz. 1. Conchoidal, 2. Slaty, 3. Columnar, 4. Fibrous.

+ little Bitumen [illegible] U [illegible]

First Kind.

Conchoidal Glance-Coal.

Muschliche Glanzkohle, *Werner.*—Anthracite Compacte, *Haüy.*

External Characters.—Colour iron-black. Massive and vesicular. Internally splendent, shining, and lustre imperfect metallic. Fracture conchoidal.

Chemical Characters.—It burns without flame or smell, and leaves a white coloured ash.

Geognostic Situation.—Occurs in beds in transition and secondary rocks.

Geographic Situation.—Occurs in beds in the coal formation of Ayrshire, as near Cumnock and Kilmarnock; in the coal districts in the river district of the Forth; and in Staffordshire in England.

Second Kind.

Slaty Glance-Coal.

Schiefrige Glanzkohle, *Werner.*—Anthracite feuilleté, *Haüy.*

External Characters.—Colour dark iron-black, seldom inclining to brown; those varieties that border on graphite, incline to steel-grey. Massive. Internally shining and glistening, and lustre imperfect metallic. Principal fracture slaty; cross fracture conchoidal or uneven.

Constituent Parts.—

Carbon,	90	72.05
Silica,	4 to 2	13.19
Alumina,	4 to 5	3.29
Oxide of Iron,	2 to 3	3.47
Loss,		8.00
	100	100.00
	Panzenberg.	*Dolomieu.*

Geognostic and Geographic Situations.—Occurs in imbedded masses, beds and veins, in primitive transition, and secondary rocks. It is found in sandstone in Arran; in traprocks in the Calton Hill at Edinburgh; and in the coal formation in the river district of the Forth.

Observations.—In this country it is named Blind Coal.

Third Kind.

Columnar Glance-Coal.

Stangenkohle, *Voigt.*—Houille bacillaire, *Haüy.*

External Characters.—Colour black. Occurs massive, disseminated; also in prismatic concretions. Lustre shining and glistening, and imperfect metallic. Fracture conchoidal or uneven.

Chemical Characters.—Burns without flame or smoke.

Geognostic and Geographic Situations.—It forms a bed several feet thick, in the coal field of Sanquhar in Dumfries-shire, and occurs in other parts of Scotland.

Fourth Kind.

Fibrous Glance-Coal, or Mineral Charcoal.

Mineralische Holzkohle, *Werner.*

External Characters.—Colour black. Occurs massive, in thin layers, and single pieces; also in fibrous distinct concretions. Is glimmering, bordering on glistening, and lustre silky or pearly. Soils strongly. Soft, passing into friable. Very easily frangible.

Chemical Characters.—When exposed to a strong heat, it burns without flame or smoke; some varieties scarcely yield to the most intense heat.

Geognostic and Geographic Situations.—Occurs imbedded, or in thin layers, in black coal, sometimes inclosed in pitch-stone, and it is said also occasionally associated with some varieties of brown coal. It is met with in the different coal-fields of Great Britain, and in similar situations on the Continent of Europe.

The Brown coals when burnt emit a very bad smoke

The Glance coals have certain vegetables [illegible] formed before vegetables [illegible]

APPENDIX

TO THE

SYSTEM,

CONTAINING

DESCRIPTIONS of some M*INERALS*, *which do not occur Regularly Crystallized, and of others whose Specific Characters have not been completely determined.*

I.

DESCRIPTIONS of such MINERALS as do not occur Regularly Crystallized, and cannot be satisfactorily referred to any Species in the System.

1. Lithomarge.

Steinmark, *Werner*.

There are two kinds, viz. Friable, and Indurated.

First Kind.

Friable Lithomarge.

Zerreiblicher Steinmark, *Werner*.

External Characters.—Colours snow-white, and yellowish-white. Occurs massive, disseminated, and sometimes in crusts. Consists of very fine scaly or dusty, feebly glimmering particles. Becomes shining in the streak. Slightly cohering, or loose. Soils feebly. Feels rather greasy. Adheres to the tongue. Light.

Constituent Parts.—Silica, 32.00; Alumina, 26.50; Iron, 21.00; Muriate of Soda, 1.50; Water, 17.00; *Klaproth.*

Geognostic and Geographic Situations.—Generally occurs in tinstone veins, in Saxony and other countries.

Second Kind.

Indurated Lithomarge.

Verhärtetes Steinmark, *Werner*.

External Characters.—Colours white, grey, blue, red, and yellow; and the colours sometimes disposed in clouded, spotted, veined, and striped delineations. Occurs massive, disseminated, globular, and amygdaloidal. Internally dull. Fracture earthy in the small, and flat conchoidal or even in the large. Fragments blunt angular. Opaque. Shining in the streak. Soft, sectile, and easily frangible. Adheres strongly to the tongue. Feels fine and greasy. Sp. gr. = 2.435—2.492, *Breithaupt.*

Constituent Parts.—Silica, 45.25 ; Alumina, 36.50 ; Oxide of Iron, 2.75 ; Water, 14.0; = 98.50, *Klaproth.*

Geognostic and Geographic Situations.—Occurs in veins, drusy cavities, and nidular, in rocks of various descriptions, such as porphyry, gneiss, topaz-rock, serpentine, and different trap-rocks. The secondary, trap and porphyry rocks of Scotland sometimes contain nidular portions of this mineral.

2. Mountain Soap.

Bergseife, *Werner.*

External Characters.—Colour brownish-black. Occurs massive. Dull. Fracture earthy. Fragments indeterminate angular. Opaque. Shining in the streak. Writes, but does not soil. Soft, and sectile. Easily frangible. Adheres strongly to the tongue. Feels greasy.

Geognostic and Geographic Situations.—Occurs in secondary trap-rocks in the island of Skye.

Uses.—It is valued by painters as a crayon.

3. Yellow Earth.

Gelb Erde, *Werner.*

External Characters.—Colour ochre-yellow. Occurs massive. Dull in the cross fracture, but glimmering on the principal fracture. Fracture in the large slaty, in the small earthy. Fragments tabular or indeterminate angular. Rather shining in the streak. Opaque. Soils, and writes slightly. Soft, passing into friable. Easily frangible. Adheres pretty strongly to the tongue. Feels rather greasy. Sp. gr. = 2.240 *Breithaupt.*

Chemical Characters.—Before the blowpipe is converted into a black and shining enamel.

Constituent Parts.—Silica, 92; Alumina, 2; Lime, 3; Iron, 3; = 100.

Geognostic and Geographic Situations.—Occurs along with clay and clay iron-stone, in Upper Lusatia.

Uses.—Used as a yellow pigment.

4. Cimolite.

Cimolith, *Klaproth.*

External Characters.—Colours greyish-white, and pearl-grey. Occurs massive. Dull. Fracture earthy, inclining to slaty. Opaque. Shining in the streak. Soils slightly. Very soft. Rather easily frangible. Adheres pretty strongly to the tongue. Sp. gr. = 2.00.

Chemical Character.—Infusible without addition before the blowpipe.

Constituent Parts.—Silica, 54.00; Alumina, 26.50; Iron, 1.50; Potash, 5.50; Water, 12.00; = 99.50, *Klaproth.*

Geognostic and Geographic Situations.—Occurs in beds in Argentiera or Comolia, and Melo, in the Mediterranean.

Uses.—Used for cleansing woollen and other stuffs.

5. Kollyrite.

Kollyrit, *Klaproth.*

External Characters.—Colour white. Occurs massive. Dull. Fracture fine earthy in the small, flat conchoidal in the large. Fragments indeterminate angular, and rather sharp-edged. Translucent on the edges. Shining and resinous in the streak. Soils slightly. Very soft. Rather brittle, and easily frangible. Adheres strongly to the tongue. Feels rather greasy. Light.

Chemical Characters.—Infusible. Becomes transparent in water, and falls into pieces with a crackling noise.

Constituent Parts.—Silica, 14; Alumina, 45; Water, 42; *Klaproth.*

Geognostic and Geographic Situations.—Occurs in veins in porphyry, in Hungary.

6. Bole.

Bol, *Werner.*

External Characters.—Colours brown, yellow, red, and black. Sometimes spotted and dendritic. Occurs massive and disseminated. Lustre glimmering; rarely dull. Fracture perfect conchoidal. Fragments indeterminate angular, and rather sharp-edged. Red, rarely feebly translucent; yellow, translucent on the edges; and brown and black opaque. Soft. Feels greasy. Shining and resinous in the streak. Adheres to the tongue. Sp. gr. = 1.922, *Karsten.*

Chemical Characters.—When immersed in water, it breaks in pieces with an audible noise, with the evolution of air bubbles, and falls into powder.

Constituent Parts.—Silica, 47.00; Alumina, 19.00; Magnesia, 6.20; Lime, 5.40; Iron, 6.40; Water, 7.50; *Bergmann.*

Geognostic and Geographic Situations.—Occurs imbedded in secondary trap-rocks in Scotland, and Ireland.

7. Sphragide, or Lemnian Earth.

Sphragid, *Werner.*

External Characters.—Colours grey and white. Occurs massive. Dull. Fracture fine earthy. Meagre to the feel. Adheres slightly to the tongue. When immersed in water, it falls in pieces, and numerous air-bubbles are evolved.

Constituent Parts.—Silica, 66.00; Alumina, 14.50; Magnesia, 0.25; Lime,0. 25; Natron, 3.50; Oxide of Iron, 6.00; Water, 8.50; = 99, *Klaproth.*

Geographic Situation.—Occurs in the island of Lemnos, in the Mediterranean.

8. Aluminite.

Reine Thonerde, *Werner.*

External Characters.—Colour white. Occurs in small reniform, and globular pieces. Dull. Fracture fine earthy. Opaque. Soils slightly. Affords a glistening streak. Adheres feebly to the tongue. Soft, passing into friable. Feels fine, but meagre. Sp. gr. = 1.669, *Schreiber.*

Constituent Parts.—Alumina, 30; Sulphuric Acid, 24; Water, 45; *Stromeyer.*

Geognostic and Geographic Situations.—Occurs filling fissures in chalk, and in small globular masses at Newhaven in Sussex; also near Halle in Saxony.

9. Magnesite.

Reine Talkerde, *Werner.*—Magnesie Carbonateé, *Haüy.*

External Characters.—Colous white, grey, and cream-yellow; and marked with grey spots, and dendritic delineations, Occurs massive, tuberose, reniform, and vesicular. Surface rough. Dull. Fracture flat conchoidal. Fragments sharp-edged. Nearly opaque. Hardness 3.5. Adheres pretty strongly to the tongue. Feels rather meagre. Sp. gr. = 2.881.

Constituent Parts.—Magnesia, 45.42; Carbonic Acid, 47.00; Silica, 4.50; Alumina, 0.50; Ferruginous Manganese, 0.50; Lime, 0.8; Water, 2.00; *Bucholz.*

Geognostic and Geographic Situations.—Occurs in serpentine in Moravia and other countries.

10. Meerschaum.

External Characters.—Colour white. Occurs massive. Dull. Fracture earthy, passing sometimes into conchoidal and uneven. Opaque, or translucent on the edges. Slightly shining in the streak. Does not soil. Very soft. Sectile. Difficultly frangible. Adheres strongly to the tongue. Feels rather greasy. Sp. gr. = 0.988,—1.279, *Breithaupt.*

Chemial Characters.—Before the blowpipe it melts on the edges into a white enamel.

Constituent parts.—Silica, 41.50; Magnesia, 18.25; Lime, 0.50; Water and Carbonic Acid, 39.00; = 98.25, *Klaproth.*

Geognostic and Geographic Situations.—Occurs in serpentine in Cornwall; Navarre; Crimea, &c.

Uses.—Used for washing, but principally in the manufacture of tobacco-pipes.

II.

DESCRIPTIONS of MINERALS, whose Specific Characters have not been completely determined.

1. Allophane.

Allophane, *Stromeyer, Jameson,* 3d edit. iii. 531.

External Characters.—Colours blue, green, and brown. Occurs massive, disseminated, reniform and botryoidal. Externally and internally shining or glistening, and vitreous. Fracture conchoidal. Transparent or translucent. Semi-hard, brittle, and uncommonly easily frangible. Sp. gr. = 1.852,—1.889, *Stromeyer.*

Constituent Parts.—Water, 41.301; Silica, 29.922; Alumina, 32.202; Carbonate of Copper, 3.058; Lime, Sulphate of Lime, and Hydrate of Iron, a trace; = 100, *Stromeyer.*

Geognostic and Geographic Situations.—Occurs in a bed of limestone, subordinate to grey-wacke, in Thuringia.

2. Amblygonite, *Breithaupt.* (SPAR.)

Specific Character.—Prismatic. $P + \infty = 106° \; 10'$. Cleavage, $P + \infty$. Less distinct $\breve{P}r + \infty$. Hardness = 6.0. Sp. gr. = 3.00,—3.04, *Breithaupt.*

Geognostic and Geographic Situations.—Occurs in granite along with green topaz and tourmaline, near Penig in Saxony.

3. Aplome, *Haüy.* (GEM.)

Specific Character.—Tessular. Cleavage, hexahedral, but imperfect. Hardness = 7.0. Sp. gr. = 3.44, *Hauy.*

Geographic Situation.—Found on the banks of the river Lena in Siberia.

4. Azure-Stone, or Lapis Lazuli, *Jameson*, 3d edit. i. 399. (SPAR.)

Specific Character.—Tessular. Form dodecahedral. Cleavage, unknown, imperfect. Azure-blue. Hardness = 5.5, —6.0. Sp. gr. = 2.767,—2.959.

External Characters.—Colour azure-blue, of all degrees of intensity, also Berlin-blue, and smalt-blue. The white spots it sometimes shews are caused by intermixed calcareous spar or quartz, as the bronze-yellow are by disseminated iron-pyrites. Occurs massive, disseminated, and crystallized, in rhomboidal dodecahedrons. Internally glistening or glimmering. Fracture fine-grained uneven. Fragments indeterminate angular, and rather blunt-edged. Feebly translucent on the edges. Easily frangible. Iron Pyrites in the

Constituent Parts.—Silica, 46.00; Alumina, 14.50; Carbonate of Lime, 28.00; Sulphate of Lime, 6.50; Oxide of Iron, 3.00; Water 2.00; = 100, *Klaproth.*

Geognostic and Geographic Situations.—Occurs in primitive rocks in Tartary, China, and Persia.

Uses.—It is cut and polished for ornamental purposes; is used in mosaic-work, and is much valued on account of the fine colour named *Ultramarine*, which is prepared from it.

Lapis Lazuli has been met with in Vesuvian

5. Bergmannite, *Haüy*. (SPAR).

Spreustein, *Hoffmann*—Variety of Scapolite, *Jameson*, 3d edit. ii, 43.

Specific Character.—Form unknown. Soft, inclining to semihard, *Breithaupt.* Scratches glass, and even quartz, *Haüy.* Sp. gr. = 2.300, *Schumacher.*

External Characters.—Colours grey, white and red. Occurs massive, and in fibrous concretions, which are scopiform or promiscuous. Internally faintly glistening or glimmering and pearly. Fragments blunt-edged. Opaque. Rather brittle, and rather difficultly frangible.

Geognostic and Geographic Situations.—Occurs in primitive rocks near Stavern in Norway.

6. Bismuthic Silver.

Wissmuth Silbererz, *Selb.*—Bismuthic Silver, *Jameson*, 3d edit. iii. 554.

Specific Character.—Colour pale lead-grey. Occurs disseminated aud rarely crystallized, in acicular and capillary crystals. Lustre glistening and metallic. Fracture fine-grained uneven. Soft. Sectile. Easily frangible.

Constituent Parts.—Bismuth, 27.00; Lead, 33.00; Silver, 15.00; Iron, 4.30; Copper, 0.90; Sulphur, 16.30; = 95.50, *Klaproth.*

Geognostic and Geographic Situations.—Occurs in the Black Forest, in veins that traverse gneiss, along with copper-pyrites, quartz, iron-pyrites and galena.

7. Calaite, or Mineral Turquois. (SPAR).

Jameson, 3d edit. i. 403.

Specific Character.—Crystallization unknown. Massive. Colour blue...green, rather bright. Streak white. Hardness = 6.0. Sp. gr. = 2.830,—3.000, *Fischer.*

External Characters.—Colours blue and green. Occurs massive, disseminated, reniform, and botryoidal. Internally dull, or feebly glistening or resinous. Fragments indeterminate angular, and sharp-edged. Opaque, or feebly translucent on the edges.

Constituent Parts.—Alumina, 73; Oxide of Copper, 4.50; Water, 18; Oxide of Iron, 4; Loss, 0.50; = 100, *John.*

Geognostic and Geographic Situations.—Occurs in veins in clay-stone, and also in alluvial clay, in Persia.

Uses.—It is prized as an ornamental stone, and is therefore cut, polished, and made into various articles of jewellery.

8. Chiastolite, *Jameson*, 3d edit. ii. 49.

Macle, *Haüy.*—Hohlspath, *Werner.*

Specific Character.—Prismatic. $P + \infty = 84° \ 48'$. $\bar{Pr} = 120°$ (nearly). Cleavage, $P - \infty$. $\breve{Pr} + \infty$. $\bar{Pr} + \infty$. More distinct. Hardness = 5.0,—5.5. Sp. gr. = 2.9,—3.0

External Characters.—Colours white and grey. Crystallized in four-sided prisms, in which the centre, and sometimes also the angles are filled with black clay-slate, and lines of the same substance run from the angles to the central mass. Internally lustre of cleavage glistening, that of the fracture glimmering. Fracture splintery. Translucent on the edges.

Geognostic and Geographic Situations.—Occurs in clay-slate, in Wolfserag, near Keswick, and near the summit of Skiddaw, in Cumberland; near Balahulish in Argyleshire; and in the county of Wicklow, in Ireland.

9. Cerine, *Hisinger*. (Ore.)

Specific Character.—Prismatic. Cleavage, prismatoidal. Colour brownish-black. Streak yellowish-grey,...brown. Hardness = 5.5,—6.0. Sp. gr. = 4.1,—4.3.

Prismatic Cerium-Ore, *Jameson*, 3d edit. iii. 181.

Allanite, *Thomson.*

Specific Character.—Prismatic. $P + \infty = 117°$ (nearly). Colour brownish-black. Streak greenish-grey. Hardness unknown. Sp. gr. = 3.523,—4.001, *Thomson.*

External Characters.—Colour brownish-black. Occurs massive, disseminated, and crystallized, in oblique four-sided prisms, and also in six-sided prisms, acuminated with six planes set on the lateral planes. Externally dull. Internally shining and resino-metallic. Fracture conchoidal. Opaque.

Constituent Parts.—Oxide of Cerium, 33.9; Oxide of Iron, 25.4; Silica, 35.4; Lime, 9.2; Alumina, 4.1; Moisture, 4.0; = 112.0, *Thomson.*

Geognostic and Geographic Situations.—Occurs in granite in Greenland, and also in Sweden.

10. Crichtonite. (Ore).

Jameson, 3d edit. iii. 557.

Specific Character.—Rhomboidal. Rhomboid 18° (plane angle at the summit). Cleavage unknown, imperfect. Colour velvet-black. Lustre imperfect-metallic. Opaque. Hardness = 4.5, *Bournon.* Sp. gr. unknown.

Constituent Parts.—Said to be a compound of titanium and iron.

Geognostic and Geographic Situations.—Occurs along with octahedrite, in the countries where that mineral is found.

11. Comptonite, *Brewster*. (ZEOLITE?)

External Characters.—Colour white. Occurs crystallized in oblique four-sided, and in eight-sided prisms. The angles of the oblique prism probably 90° 51′ and 88° 9′. Hardness 5.0. Sp. gr. unknown.

Chemical Characters.—Is converted into jelly, by exposing it in the state of powder to the action of nitric acid.

Optical Structure.—It has two axes of double refraction, one of which is parallel, and the other perpendicular, to the axis of the prism. It consequently gives the double system of coloured rings. The inclination of the resultant axis, or diameters of no polarisation, is nearly 56°; or they are inclined about 98° each to a line at right angles to the faces *a*, *e*, which is the *principal* axis of the crystal. The action of this axis is *positive*, like that of *topaz*. The plane passing through these resultant axes is perpendicular to the axis of the prism. Its index of refraction is 1.553, when the ray passes through *a* and *c*, and no separation of its images can be seen; but through *a* and *m n*, the images may be distinctly separated.

Geognostic and Geographic Situation.—Among the rocks of Vesuvius. Vid. *Edinburgh Philosophical Journal*, Vol. iv for Dr Brewster's Account of this mineral.

12. Conite, *Friesleben*.

Jameson, 3d edit. iii. 538.

External Characters.—Colour grey, but on exposure becomes brown. Occurs massive, also stalactitic, and in crusts. Dull. Fracture uneven, splintery, or flat conchoidal. Translucent on the edges, and opaque. Semihard. Brittle, and rather easily frangible. Sp. gr. = 2.88,—2.899.

Constituent Parts.—Carbonate of Magnesia, 67.5; Carbonate of Lime, 28.0; Oxide of Iron, 3.5; Water, 1.0; = 100.

Geognostic and Geographic Situations.—Occurs in the trap of the Meisner in Hessia, and also in Saxony and Iceland.

13. Fossil Copal. (Mineral Resin). *Jameson*, 3d edit. iii. 480.

External Characters.—Colour muddy yellowish-brown. Occurs in irregular roundish pieces. Lustre resinous. Semi-transparent. Brittle. Yields easily to the knife. Sp. gr. = 1.046.

Chemical Characters.—It yields a resinous odour when heated; melts into a limpid fluid; takes fire when applied to the flame of a candle; and burns away entirely before the blowpipe. Insoluble in potash ley, *Aikin.*

Geognostic and Geographic Situation.—Is found in a bed of blue clay at Highgate, near London.

14. Argentiferous Copper-Glance.

Argentiferous Copper-Glance, *Jameson*, 3d edit. iii. 551.—Silver Kupfer-glanz, *Hausmann.*

Specific Character.—Colour blackish lead-grey. Occurs massive and disseminated. Internally shining or glistening, and metallic. Fracture flat conchoidal. More shining in streak. Soft. Sectile, and rather difficultly frangible. Sp. gr. = 6.255, *Stromeyer.*

Constituent Parts.—Sulphuret of Copper, 38.654; Sulphuret of Silver, 60.646; Sulphuret of Iron, 0.700; = 100, *Stromeyer.*

Geognostic and Geographic Situations.—Found only at Schlangenberg in Siberia, where it is associated with copper-pyrites, calcareous-spar and hornstone.

15. Plumbiferous Copper-Glance.

Bleifahlerz, *Hausmann*, (Glance).

Specific Character.—Prismatic. Cleavage, $P - \infty$. Less distinct $P + \infty = 95^{\circ}$ (nearly). $\mathring{P}r + \infty$. $\bar{P}r + \infty$. Metallic. Steel-grey, inclining to lead-grey. Hardness = 2.5,—3.0. Sp. gr. = 5.7,—5.8.

Constituent Parts.—Lead, 34.50; Copper, 16.25; Antimony, 16.00; Iron, 13.75; Sulphur, 13.50; Silver, 2.25.

Geognostic and Geographic Situations.—Occurs in veins in clayslate, associated with lead-glance, copper-pyrites, and calcareous-spar, at Andreasberg in the Hartz.

16. Diaspore, *Haüy*. (SPAR.)

Specific Character.—Prismatic. Cleavage, $P+\infty=130°$ (nearly). Perfect $\breve{P}r+\infty$. Scratches glass, *Haüy*. Sp. gr. = 3.4324, *Haüy*.

Its geognostic situation is unknown.

17. Elaolite, *Jameson*, 3d edit. ii. 41. (SPAR).

Specific Character.—Prismatic. Cleavage, $P-\infty$. $\bar{P}r+\infty$. Less distinct $P+\infty$. Hardness = 5.5,—6.0. Sp. gr. = 2.54,—2.61, *Hoffmann*.

External Characters.—Colours blue, green, grey and red. Occurs massive, and in minute intimately aggregated granular concretions. Internally shining, or glistening and resinous. Fracture conchoidal. Translucent.

Constituent Parts.—Silica, 44.00; Alumina, 34.00; Lime, 0.12; Potash and Soda, 16.50; Oxide of Iron, 4.00; = 98.62, *Vauquelin*.

Geognostic and Geographic Situations.—Occurs in syenite, near Laurwig, Stavern, and Friedrickswärn, in Norway.

Uses.—The blue variety, which is sometimes opalescent, is cut, and worn as a ring or seal stone.

18. Eudialyte, *Stromeyer*.

Specific Character.—Tessular. Cleavage, octahedral; traces of the dodecahedron. Colour brownish-red. Hardness = 5.0,—5.5. Sp. gr. = 2.8,—3.0.

19. Fibrolite, *Bournon*. *Jameson*, 3d edit. iii. 535.

Specific Character.—Prismatic. $P+\infty=100°$. Cleavage, imperfect. Harder than quartz. Sp. gr. = 3.214.

External Characters.—Colours white and grey. Occurs in fibrous concretions, and crystallized in rhomboidal prisms. Internally glistening. Fracture uneven.

Constituent Parts.—Alumina, 58.25; Silica, 38.0; Iron and Loss, 3.75; =100, *Chenevix.*

Geographic Situation.—Occurs in the Carnatic.

20. Gehlenite. (SPAR.) *Jameson*, 3d edit. i. 138.

Specific Character.—Pyramidal or prismatic. Cleavage, unknown, imperfect. Hardness =5.5,—6.0. Sp. gr. = 2.9, —3.1.

External Characters.—Colours green, grey, and white; all of which are muddy. Crystallized in short four-sided prisms. Externally rough, and dull, or feebly glimmering. Internally glistening, often nearly dull, and resino-vitreous. Fracture splintery. Translucent on the edges, or opaque.

Chemical Characters.—Before the blowpipe melts into a brownish-yellow transparent glass.

Constituent Parts.—Silica, 29.64; Alumina, 24.80; Lime, 35.30; Oxide of Iron, 6.50; Water, 3.30, *Fuchs.*

Geognostic and Geographic Situations.—Occurs along with calcareous-spar in the valley of Fassa in the Tyrol.

21. Gieseckite, *Stromeyer, Sowerby.*

Specific Character.—Rhomboidal. Form R—∞. R+∞. Cleavage, none. Colour grey and brown. Streak white. Hardness =2.5,—3.0. Sp. gr. = 2.7,—2.9.

22. Hauyne, *Neergard.* (SPAR.) *Jameson*, 3d edit. i. 394.

Specific Character.—Prismatic. Cleavage P. More distinct P—∞. Colour blue, rather bright. Scratches glass. Sp. gr. = 2.687, *Gmelin.*

External Characters.—Colour blue. Occurs in imbedded grains, and rarely crystallized. Externally and internally alternates from splendent to glistening, and lustre vitreous. Fracture imperfect conchoidal. Transparent or translucent. Brittle, and easily frangible.

Geognostic and Geographic Situations.—Occurs in the basalt rocks of Frascati and Albano, along with mica, augite, leucite, and vesuvian; also in the basalt of Andernach.

23. Iserine, *Jameson*. (Ore).

Specific Character.—Form unknown. Lustre imperfect-metallic. Colour black. Streak black. Hardness = 5.5. Sp. gr. = 4.650.

External Characters.—Colour iron-black, inclining to brownish-black. Occurs in obtuse angular grains, and in rolled pieces, with a rough, strongly glimmering surface. Internally alternates from splendent to glistening, and lustre imperfect metallic. Fracture conchoidal. Opaque.

Constituent Parts.—Oxide of Titanium, 28; Oxide of Iron, 72; = 100. *Klaproth.*

Geognostic and Geographic Situations.—Found in the sand of the river Iser in Silesia, and in the sand of the rivers Dee and Don in Aberdeenshire.

24. Karpholite, *Werner*.

Specific Character.—Form unknown. Occurs in thin prismatic concretions. Colour yellow. Hardness unknown. Sp. gr. = 2.935, *Breithaupt.*

25. Lievrite, *Jameson*, 3d edit. iii. 539. (Ore).

Specific Character.—Prismatic. Pyramid = 139° 57′; 117° 38′; 77° 16′. Cleavage, $P\bar{r}$ = 113° 2′. $P + \infty$ = 112° 37′. $P\check{r} + \infty$. None distinct. Colour black. Streak black, inclining sometimes to green or brown. Hardness = 5.5,—6.0. Sp. gr. = 3.825,—4.061, *Lelievre.*

External Characters.—Colours black, and blackish green. Occurs massive; also in distinct concretions, which are scopiform radiated, or straight prismatic; also crystallized in oblique four-sided prisms, variously modified by truncations and bevelments. Lustre of the fracture glistening and semi-metallic. Fracture uneven. Opaque.

Constituent Parts.—Silica, 30.0; Alumina, 1.0; Lime, 14.8; Oxide of Iron, 49.0; Oxide of Manganese, 2.0; = 96.8, *Vauquelin.*

Geognostic and Geographic Situations.—Occurs in primitive limestone along with epidote, quartz, garnet, magnetic iron-ore, and arsenical pyrites, in the island of Elba; and it is said also in Siberia.

26. Manganese-Spar. (BARYTE.)

Specific Character.—Form unknown. Colour bright rose-red. Hardness 5.0,—5.5. Sp. gr. = 3.5,—3.7.

This mineral is distinguished from red manganese by its superior hardness and specific gravity.

27. Mellilite, *Haüy.*

Specific Character.—Prismatic. $P + \infty = 115°$. $\overset{o}{Pr} =$ 70° (nearly). Colour yellow. Strikes fire with steel. Sp. gr. unknown.

28. Menachanite, *Jameson,* 3d edit. iii. 135.

Specific Character.—Form unknown. Cleavage imperfect. Hardness = 5.5,—6.0. Sp. gr. = 4.427, *Gregor.*

External Character.—Colour greyish-black, inclining to iron-black. Occurs in flat angular grains, having a rough glimmering surface. Internally glistening or glimmering, and lustre adamantine, inclining to imperfect metallic. Opaque. Streak black. Brittle, and easily frangible.

Physical Characters.—Attractable by the magnet, but in a weaker degree than magnetic iron-ore.

Constituent Parts.—Oxide of Iron, 51.00; Oxide of Titanium, 45.25; Oxide of Manganese, 0.25; Silica, 3.50; = 100, *Klaproth.*

Geognostic and Geographic Situations.—Loose in alluvial land in the valley of Manacan in Cornwall, and in a similar situation in other countries.

29. Menac Ironstone, or Titaniferous Iron-Ore. *Jameson,* 3d edit. iii. 135. (ORE.)

Menac-Eisenstein, *Hoffmann.*

Specific Character.—Form unknown. Cleavage, imperfect. Lustre, imperfect. Metallic. Colour black. Streak black. Hardness = 6.0. Sp. gr. = 4.75, *Breithaupt. Mohs* says, "It is probable that Iserine, Menachanite, and Menac-Ironstone, together with several similar varieties, from Gastein in Salzbourg, Ohlapian in Transylvania, Klattau in Bohemia, &c. form a particular mineral species."

30. Molybdena-Silver, *Werner*.

Specific Character.—Rhomboidal. Cleavage, R — ∞, perfect. Metallic lustre. Colour pale steel-grey. Elastic. Soft. Sp. gr. = 8.0, *Breithaupt*.

31. Native Nickel, *Jameson*, 3d edit. iii. 559.

Haarkies, *Werner*.

Specific Character.—Colour brass-yellow, which inclines to bronze-yellow, or steel-grey. Occurs in delicate capillary crystals, which are shining or glistening, and metallic. Crystals are rigid and brittle.

Constituent Parts.—Nickel, with a small portion of cobalt and arsenic.

Geognostic and Geographic Situations.—Occurs in veins traversing gneiss in Saxony; and in cavities of nickel pyrites in Cornwall.

32. Needle-Ore. (Glance).

Acicular Bismuth-glance, *Jameson*, 3d edit. iii. p. 381. —Nadel-erz, *Hoffmann*.—Bismuth sulphuré plombo-cuprifere, *Haüy*.

Specific Character.—Prismatic. Cleavage, unknown, imperfect metallic lustre. Colour blackish lead-grey. Hardness = 2.0,—2.5. Sp. gr. = 6.125, *John*.

External Characters.—Colour blackish lead-grey, which acquires a bright copper-red tarnish. Occurs disseminated, and crystallized in oblique four-sided prisms. Internally splendent on the cleavage, but only shining on the uneven fracture, and lustre metallic. Cleavage, imperfect. Fracture uneven. Opaque. Brittle.

Constituent Parts.—Bismuth, 43.20; Lead, 24.32; Copper, 12.10; Sulphur, 11.58; Nickel, 1.58; Tellurium, 1.32. Gold, 0.79; = 94.89, *John*.

Geognostic and Geographic Situations.—Occurs imbedded in quartz, and associated with galena and native gold, and has hitherto been found only in Siberia.

33. Nephrite, *Jameson*, 3d edit. ii. 287.

Jade néphrétique, *Haüy*.

Specific Character.—Form unknown. Colour green. Hardness = 7.0. Sp. gr. = 2.9,—3.1. Some of the varieties, according to Bournon, probably Prehnite.

External Characters.—Colours green, grey, and white. Occurs massive, in blunt-edged pieces, and rolled pieces. Internally dull, or glimmering, owing to intermixed talc or asbestus. Fracture coarse splintery, and splinters greenish-white. Fragments indeterminate angular, and rather sharp-edged. Strongly translucent. Difficultly frangible. Rather brittle. Feels rather greasy.

Constituent Parts.—Silica, 50.50; Magnesia, 31.00; Alumina, 10.00; Iron, 5.50; Chrome, 0.05; Water, 2.75. *Karsten.*

Geognostic and Geographic Situations.—Occurs in imbedded masses and veins in gneiss, granite, and other primitive rocks in Germany, Persia, Egypt, and America.

Uses.—When cut and polished, it is valued as an ornamental stone. The Turks cut it into handles for sabres and daggers.

34. Nickeliferous Grey Antimony, *Jameson*, 3d edit. iii. 403. (Pyrites.)

Antimoine sulphuré nickelifere, *Haüy*.

Specific Character.—Tessular. Cleavage, hexahedral, perfect. Metallic lustre. Colour steel-grey, somewhat inclining to silver-white. Hardness = 5.0,—5.5. Sp. gr. = 6.4,—6.6.

Constituent Parts.—Antimony, 43.80; Nickel, 36.60; Sulphur, 17.71; Iron and Manganese, 1.89, *Stromeyer.*

Geognostic and Geographic Situations.—Occurs in veins near Freussberg in the county of Sayn-Alten Kirchen in the principality of Nassau, along with sparry iron, galena, and copper-pyrites.

35. Phosphat of Manganese, *Jameson*, 3d edit. iii. 248.

Pitchy Iron-ore, *Jameson*, 2d edit. id. p. 408.—Eisen pecherz, *Hoffmann*.—Manganese phosphaté, *Haüy*.

Specific Character.—Pyramidal or prismatic. Cleavage, three planes perpendicular to each other, one of them less distinct. Colour brown. Streak yellowish-grey...brown. Hardness = 5.0...5.5. Sp. gr. = 3.439, *Vauquelin*. 3.775, *Ullmann*.

External Characters.—Colours blackish-brown and brownish-black. Occurs massive and disseminated. Internally shining or glistening, and lustre adamantine, inclining to resinous. Fracture flat conchoidal. Translucent on the edges, or opaque. Brittle, and easily frangible.

Constituent Parts.—Phosphoric Acid, 27; Manganese, 42; Oxide of Iron, 31; = 100, *Vauquelin*.

Geognostic and Geographic Situations.—Occurs in a quartz vein in granite, along with beryl, near Limoges in France.

36. Pinite, *Jameson*, 3d edit. ii. 227.

Specific Character.—Rhomboidal. Cleavage, none. Composition R— ∞. Soft, passing into very soft. Sp. gr. = 2.914, *Haüy*. 2.980, *Kirwan*.

External Characters.—Colour blackish-green, and sometimes iron-shot. Occurs massive, in lamellar and granular concretions, and crystallized in six-sided prisms. Fracture glistening and glimmering, and lustre resinous. Fracture uneven. Opaque or translucent on the edges. Sectile, and easily frangible. Not flexible. Feels somewhat greasy.

Constituent Parts.—Silica, 29.50; Alumina, 63.75; Oxide of Iron, 6.75; = 100, *Klaproth*.

Geognostic and Geographic Situations.—Imbedded in porphyry in Ben Gloe and Blair Gowrie, near Inverary, &c.; and in granite in Cornwall.

37. Pyrosmalite, *Hausmann.*

Jameson, 3d edit. iii. 561.

Specific Character.—Rhomboidal. Cleavage, R — ∞, perfect. Less distinct, R + ∞. Colour liver-brown. Streak brownish-white. Semi-hard. Sp. gr. = 3.081, *Hausmann.*

External Characters.—Colour liver-brown, inclining to pistachio-green. Occurs in straight lamellar concretions, and crystallized, in regular six-sided prisms, and six-sided tables. Internally lustre of the cleavage shining and pearly; that of the fracture glimmering. Fracture uneven. Translucent on the edges. Brittle.

Constituent Parts.—Silica, 35.8; Protoxide of Iron, 21.8; Protoxide of Manganese, 21.1; Sub-muriate of Iron, 14.09; Lime, 0.01; Water, Carbonic Acid, Loss 0.05, *Berzelius.*

Geognostic and Geographic Situations.—Occurs in a bed of magnetic iron-ore, along with calcareous-spar and hornblende in Wermeland in Sweden.

38. Radiated Acicular Olivenite, *Jameson*, 3d edit. ii. 335. (MICA.)

Strahlerz, *Hoffmann.*—Cupreous arseniate of iron, *Bournon.*

Specific Character.—Prismatic. P + ∞ = 105° (nearly). Cleavage P — ∞, very perfect. Streak verdigris-green. Hardness = 2.5,—3.0. Sp. gr. = 4.1,—4.3.

External Characters.—Colour green, frequently inclining to blue. Occurs massive, and flat reniform; also in scopiform radiated, concretions, and crystallized in oblique four-sided prisms, variously modified by truncations, bevelments, and acuminations. Internally lustre intermediate between shining and glistening, and pearly. Translucent on the edges. Brittle, and easily frangible.

Geographic Situation.—Has hitherto been found only in the mines of Cornwall.

39. Skorodite, *Breithaupt.*

Jameson, 3d edit. iii. 547.

Specific Character.—Prismatic. Cleavage, $\breve{P}r$, imperfect.

Traces of $P + \infty$. Colour green. Streak white. Hardness $= 3.5, - 4.0$. Sp. gr. $= 3.1, - 3.3$.

External Characters.—Colours green and brown. Occurs massive, and disseminated, but most frequently crystallized in short, broad, and rectangular four-sided prisms, acutely acuminated on the extremities with four planes, set on the lateral edges. Lustre ranging from shining to splendent, and vitreo-pearly. Fracture uneven, inclining to small conchoidal. Translucent on the edges, or semi-transparent. Easily frangible.

Constituent Parts.—Conjectured to be an arseniate of iron, combined with manganese.

Geognostic and Geographic Situations.—Occurs in a bed of quartz, in primitive rock in Saxony; also in Carinthia.

40. Spak, *Breithaupt.* (Salt).

Jameson, 3d edit. iii. 547.

External Characters.—Colour white. Occurs in thin radiated concretions. Shining and resinous. Three-fold rectangular cleavage. Fracture uneven and splintery. Translucent. Soft, or very soft. Brittle, and easily frangible. Has a feeble saline taste, but different from that of common salt.

Chemical Character.—Completely soluble in water.

Geognostic and Geographic Situations.—Occurs in the salt mines of Poland.

41. Sphærulite, *Breithaupt.*

Jameson, 3d edit. iii. 545.

External Characters.—Colours brown and grey. Occurs in imbedded balls and grains, which are sometimes reniformly aggregated; also in stellular fibrous concretions. Internally glimmering or dull. Fracture even and splintery. Opaque, or translucent on the edges. Nearly as hard as quartz. Brittle, and easily frangible. Sp. gr. $= 2.50$.

Chemical Character.—Nearly infusible before the blowpipe.

Geognostic and Geographic Situations.—Occurs in pearlstone and pitchstone porphyry in Iceland, Saxony, and also in Scotland.

42. Spinellane, *Haüy.*

Jameson, 3d edit. iii. 549.

External Character.—Colour plum-blue. Rhomboid = 117° 23′. Cleavage, rhomboidal, P + ∞. Scratches glass. Sp. gr. unknown.

Geognostic and Geographic Situations.—Occurs on the shores of the Lake of Laach, in a rock composed of grains and crystals of glassy felspar, quartz, hornblende, black mica, and magnetic iron-ore in small grains.

43. Stilpnosiderite, *Ullmann.*

Jameson, 3d edit. iii. 545.

External Characters.—Colours brownish-black, and blackish-brown. Occurs massive, reniform, dendritic, and in curved lamellar concretions. Internally shining, and splendent, and resinous. Fracture conchoidal. Opaque. Streak yellowish-brown. Hard in a low degree. Brittle, and easily frangible. Sp. gr. = 3.77, *Breithaupt.*

Constituent Parts.—Oxide of Iron, 80.50; Silica, 2.25; Water, 16; = 98.75.

Geognostic and Geographic Situations.—Occurs in Saxony and Bavaria along with brown iron-ore.

44. Tantalite, *Eckberg.* (Ore).

Prismatic Tantalum-Ore, *Jameson*, 3d edit. iii. 174.

Specific Character.—Hemi-prismatic. Cleavage, unknown, imperfect. Colour black. Streak brown. Hardness = 6.5. Sp. gr. = 7.8,—8.0.

External Characters.—Colour black. Occurs massive, disseminated, and crystallized in oblique four-sided prisms, bevelled on the extremities. Externally and internally shining or glistening, and lustre semi-metallic adamantine. Fracture uneven, or imperfect conchoidal. Opaque. Brittle, and difficultly frangible.

Constituent Parts.—Oxide of Tantalum, 83; Oxide of Iron, 12; Oxide of Manganese, 8; = 103, *Vauquelin.*

Geognostic and Geographic Situations.—Occurs disseminated in granite in Finland; and also near Bodenmais in Germany.

45. Tennantite, *Phillips.* (PYRITES).

Jameson, 3d edit. iii. 563.

Specific Character.—Tessular. Cleavage dodecahedral. Colour lead-grey, inclining to iron-black. Streak reddish-grey. Hardness = 4.0. Sp. gr. = 4.375, *Phillips.*

Constituent Parts.—Copper, 45.32; Sulphur, 28.74; Arsenic, 11.84; Iron, 9.26; Silica, 5.00; = 100.16, *Phillips.*

Geognostic and Geographic Situations.—Occurs in Cornwall, in copper-veins that traverse granite and clay-slate, associated with common copper-pyrites, vitreous copper, and variegated copper.

46. Tin-Pyrites, *Jameson*, 3d edit. iii. 325.

Etain sulphuré, *Haüy.*—Zinnkies, *Hoffmann.*

Specific Character.—Form unknown. Metallic lustre. Colour steel-grey, inclining to yellow. Hardness = 4.0. Sp. gr. = 4.350, *Klaproth.*

External Characters.—Colour intermediate between steel-grey and brass-yellow. Occurs massive and disseminated. Internally glistening, or shining and metallic. Fracture uneven, sometimes inclining to conchoidal. Brittle and easily frangible.

Constituent Parts.—Tin, 26.50; Copper, 30.00; Iron, 12.00; Sulphur, 30.50; = 99, *Klaproth.*

Geognostic and Geographic Situations.—Has hitherto been found only in the copper-mines of Cornwall.

47. Velvet-Blue Copper, *Jameson*, 3d edit. ii. 320.

Kupfer-Sammt-erz, *Hoffmann.*

External Character.—Short capillary crystals. Colour bright blue. Lustre silky or glistening.

Geognostic and Geographic Situations.—Is a rare mineral, and has hitherto been found only in the Bannat, along with common malachite, and brown iron-ore.

48. Wavellite, *Jameson*, 3d edit. i. 389.

Specific Character.—Prismatic. Cleavage, $P+\infty$. $P\breve{r}+\infty$. Rather distinct. Implanted globular concretions. Streak white. Hardness = 3.5,—4.0. Sp. gr. = 2.2,—2.4.

External Characters.—Colours white, grey, green, and brown. Occurs botryoidal, globular, stalactitic, and these forms are composed of fibrous distinct concretions, which are scopiform or stellular. Sometimes these fibrous concretions are collected into others, which are granular, and both are occasionally traversed by others, having the lamellar form. Occurs crystallized in oblique four-sided prisms, bevelled on the extremities; the bevelling planes set on the obtuse lateral edges. Externally shining, internally shining, passing into splendent, and lustre pearly. Translucent.

Constituent Parts.—Alumina, 35.35; Phosphoric Acid, 34.40; Fluoric Acid, 2.06; Lime, 0.50; Iron and Manganese, 1.23; Water, 26.80; = 99.36, *Berzelius.* From this analysis, wavellite appears to be a hydrous phosphate of alumina.

Geognostic and Geographic Situations.—Occurs in veins along with fluor-spar, tin-ore, and copper-pyrites, in granite in Cornwall; in veins in clay-slate at Barnstaple in Devonshire; and in the Shiant Isles, on the west coast of Scotland.

49. Yellow Gold-Glance, or Yellow Tellurium, *Jameson*, 3d edit. iii. 379.

Weissilvanerz, *Hoffmann.*

Specific Characters.—Form unknown. Metallic lustre. Colour silver-white, inclining to yellow. Soft. Sp. gr. = 10.678, *Müller von Reichenstein.*

External Character.—Colour silver-white, inclining to brass-yellow. Occurs disseminated, less frequently massive, and very rarely reticulated, and seldom crystallized in broad four-sided prisms, which are generally acicular. Externally splendent and shining. Internally splendent, shining, or glistening, and metallic. Fracture uneven.

Constituent Parts.—Tellurium, 44.75; Gold, 26.75; Lead, 19.56; Silver, 8.50; Sulphur, 0.50; = 100, *Klaproth.*

Geognostic and Geographic Situations.—Occurs in veins in porphyry in Transylvania.

50. Yttro-cerite, *Berzelius.*

Jameson, 3d edit. i. 566.

External Characters.—Colours white and blue. Occurs massive, and in crusts. Indistinct cleavage. Lustre glistening. Opaque. Scratches fluor. Sp. gr. = 3.447, *Berzelius.*

Constituent Parts.—Oxide of Cerium, 13.15; Yttria, 14.66; Lime, 47.77; Fluoric Acid, 24.45, *Berzelius.*

Geognostic and Geographic Situations.—Occurs at Finbo in Sweden, in quartz, or incrusting physalite

DESCRIPTION AND ARRANGEMENT

OF

MOUNTAIN ROCKS.

1. Structure of Mountain Rocks.
2. Stratified Structure; Seamed Structure; and Structure of Veins.
3. Description of Primitive Rocks.
4. Description of Transition Rocks.
5. Description of Secondary or Flœtz Rocks.
6. Description of Alluvial Rocks.
7. Description of Volcanic Rocks.
8. Description of Veins and Mineral Beds.
9. Arrangement of Mountain Rocks depending on their Structure; and Short Characters for determining the different Species.
10. Organic Remains found in Mountain Rocks.

I. Structure of Mountain Rocks.

Mountain Rocks or Stones, are those mineral masses of which the greater portion of the crust of the Earth is composed. Minerals, or mineral aggregates, to have the true characters of mountain rocks, must occur not only in great masses, but frequently, and present in their structure and composition such characters as shall serve to distinguish them, and make them known in whatever situation they may be found.

They are either simple, that is composed of one mineral species, or are aggregations of various minerals. In the one case, they are denominated *Simple Mountain Rocks;* in the other *Compound Mountain Rocks.*

Simple mountain rocks are either compact, slaty or granular. Clay-slate, Limestone, and Serpentine are examples of simple mountain rocks.

When minerals occur disseminated through simple mountain rocks, they are to be considered as accidental mixed parts, and do not entitle us to consider such varieties of rock as distinct species. Thus garnets imbedded in granite or mica-slate are accidental mixed parts.

not homogeneous

Compound mountain rocks are either *conglomerated* or *aggregated.* This distinction is founded on the mode of their formation. The grains or masses in the *conglomerated mass,* according to some naturalists, have not been formed on the spot where they are now found, but have been carried thither, and connected together by a cement. To this class belong Sandstone, Puddingstone, and different kinds of fragmented or brecciated stones.

In *aggregated mountain rocks* or stones, their present structure is their original one, and the parts of which they are composed have been formed on the spot where we now find them. Their parts are immediately connected together; hence this structure is termed *aggregated.*

Aggregated mountain rocks are either *determinately* or *indeterminately* aggregated. The parts in the *indeterminately aggregated*, are irregularly and confusedly joined together. This kind of structure occurs in those varieties of serpentine, where limestone and serpentine are so conjoined that it is difficult to say which predominates, and where the one sometimes incloses the other. The Campan marble, which is an irregular mixture of limestone and steatite, and many Cipolin marbles, which contain veins and patches of green talc, are of the same description.

The *determinately aggregated structure* presents a number of subordinate differences. It is either *simple* or *double* aggregated. The *Simple Aggregated* contains two subordinate kinds. In the *first*, the minerals are connected together in such a manner that one serves as a basis for the other, which is included in it; and it also contains two subordinate kinds. These are denominated the *porphyritic* and *amygdaloidal.* In the *second*, all the parts are immediately connected, or joined together; and here we have also two subordinate kinds, the *granular* and *slaty.*

The *Double Aggregated* includes five subordinate kinds: These are, 1. *Granular slaty.* 2. *Slaty granular.* 3. *Granular porphyritic.* 4. *Slaty porphyritic;* and, 5. *Porphyritic and amygdaloidal.* The first four kinds of double aggregated structure comprehend one structure in another, so that, as the denominations intimate, a smaller structure is contained in a greater. In the fifth, or last kind, one does not include the other; but, as the denomination expresses it, they are placed near or beside each other.

We shall now describe each kind in particular.

Simple Aggregated Structure.

1. *Porphyritic structure.*—When one of the constituent parts of the mountain rock is disseminated through a basis, in the form of grains or crystals, the rock presenting this appearance is said to be *porphyritic.* Porphyry, and gypsum

a basis including crystals

containing crystals of quartz, may be mentioned as examples of this kind of structure. The crystals or grains are here of cotemporaneous formation with the basis, and not mechanically mixed, as some have maintained.

2. *Amygdaloidal structure.*—When vesicular cavities, generally of an amygdaloidal form, are dispersed through a basis or ground, and appear empty, encrusted, half filled, or completely filled, such a structure is denominated *amygdaloidal.* a basis containing cavities or other forms

The rock named Amygdaloid is a principal example of this kind of structure. Its basis approaches more or less to basalt or greenstone, and is frequently much iron-shot, when it becomes harder and more solid. It is alleged, that while the amygdaloidal rock was still soft, bubbles of air were disengaged, which being prevented from escaping by the viscosity of the mass, various shaped cavities, often however of an amygdaloidal shape, were formed. Water holding in solution the various minerals met with in these amygdaloids, is conjectured to have traversed the rock, penetrated into the empty vesicular cavities, and to have deposited on their walls its mineral contents. Hence it is maintained, that the amygdaloidal portions are of posterior origin to the basis in which they are contained. It cannot be questioned, that some amygdaloidal structures have originated in this manner, but many others are certainly of cotemporaneous formation with the rock in which they are contained. The minerals that usually occur in these vesicles, are lithomarge, zeolite, steatite, calcedony, agate, heavy-spar, and calc-spar. Those filled with agate and calcedony present many interesting phenomena. vid: the secondary trap rocks

* 3. *Granular structure.*—This kind of structure is formed by the immediate aggregation of different species of minerals, which are intimately joined together either by the power of cohesion, or by mutual penetration or interlacement. These minerals are generally in grains, and may be regarded as imperfect crystals. Granite affords an example of this kind of structure.

4. *Slaty structure.*—The slaty structure in rocks composed of different minerals, differs from the granular in this circum-

* the grains joined without basis or cement.

stance, that the constituent parts are flat, having considerable length and breadth, but inconsiderable thickness. Mica-slate, which consists of small plates of quartz and small plates of mica, placed upon each other, is an example of this kind of structure.

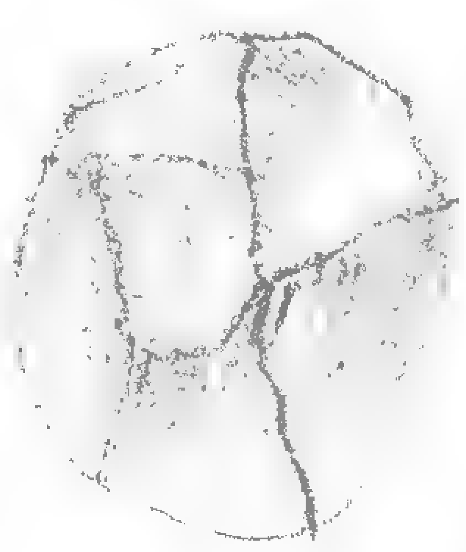
Double Aggregated Structure.

Under this head we include those varieties where two structures occur together. The following are the different kinds.

A 1. *Granular-slaty structure.*—Gneiss affords a good example of this kind of structure; the quartz and felspar which are in grains, are immediately aggregated together, thus forming the granular structure; and these aggregations are generally disposed in plates, which are interposed between the plates of mica, and hence the slaty structure.

A Slaty Granular

2. *Slaty-granular structure.*—It is composed of large granular masses, which have a slaty structure; the slates consist of fine granular quartz, thin columnar schorl, and small granular topaz. It is said to be slaty in the small, and granular in the large. In the drusy cavities that occur between the large granular concretions, lithomarge, crystals of topaz, and schorl, sometimes occur; the schorl, however, is but rarely crystallized. The only example of this kind of structure is the topaz-rock of Schneckenstein, in Voightland, in the Kingdom of Saxony. of rare occurrence



Base granular 3. *Granular-porphyritic structure.*—This kind of structure is granular in the small, and porphyritic in the great. When large and distinct crystals of felspar appear dispersed through a granular base, as is often the case with granite, sienite, and greenstone, this kind of structure is formed.

Base slaty 4. *Slaty-porphyritic.*—This kind of structure is slaty in the small, and porphyritic in the great. The basis is slaty, and the porphyritic structure is formed by interspersed crystals or grains of minerals different from the basis. Mica-slate, when it contains grains or crystals of garnet, is said to have a slaty-porphyritic structure.

5. *Porphyritic and Amygdaloidal.*—Here two kinds of structure are placed together, not included in each other, as in the preceding kinds. It occurs in many amygdaloidal and porphyritic stones. When Amygdaloid contains, besides the elliptical-shaped masses, also crystals of hornblende and mica, it is then said to have an amygdaloidal and porphyritic structure, the amygdaloidal being the predominant. In Basalt, on the contrary, where the two kinds of structure sometimes occur, the porphyritic is the predominating. Green Porphyry, although rarely, sometimes possesses this kind of double structure. of frequent occurrence in [illegible] Calton hill

II. Stratified Structure; Seamed Structure; and Structure of Veins.

a. Stratified Structure.

When a mountain, mountain-mass, or bed, composed of one species of rock, is divided by means of parallel seams into masses, whose length and breadth are greater than their thickness, or into what may be denominated Tabular Masses, which extend generally through the whole mountain, it is said to be stratified, and the individual masses are termed Strata. Of this kind of structure we have instances in Granite, Limestone, Clay-slate, and Mica-slate. The seams that separate the strata are named *strata seams*, or seams of stratification. On a general view, we say the globe is composed of formations; formations of beds; beds of strata; and such strata as are slaty, of layers, or slates.

In determining the stratification of a rock, we have to observe, 1. The *direction* of the strata. 2. Their *inclination*. 3. Their *thickness*. 4. *The differences in their direction and inclination.*

1. *The direction* is the angle which the stratum makes with the meridian, and is determined by the compass; or, viewing the strata as planes, the direction is that of a horizontal line, drawn on the surface of the plane; therefore, to determine

W direction [illegible] direction E
Angle of inclination
Dip

the direction, is to indicate the point of the compass towards which this line is directed. It is always at right angles to the dip.

2. *The inclination* is the angle which the stratum forms with the horizon, and is determined by the quadrant.

3. *The dip* is the point of the compass towards which the stratum inclines. If we know the dip, the direction is given, because it is always at right angles to it. Thus, if a stratum dip to the east, its direction must be north and south; if it dip to the north, its direction must be east and west. But we cannot infer the dip from the direction, because a stratum, whose direction continues the same, may dip in opposite directions; thus, a stratum ranging from north to south may dip either to the east or to the west.

4. *Differences in the direction and inclination.*—Strata are frequently variously waved, thus producing changes in their direction; but these changes in direction are in general subordinate to the general direction. It is therefore of importance, in making observations with regard to the position of strata, to distinguish the *general direction* and inclination, from the *partial.* To effect this, we must take the results of a number of particular observations, and compare them together; and those similar angles which are the most numerous, are to be considered as expressive of the general inclination and direction. It sometimes happens, that this general position has also its variations: these must also be attended to and noted. An acquaintance with the shape of a mountain group, will assist us very much in such investigations, as it is intimately connected with the general disposition of the stratification of the masses of which it is composed. It is also of importance to know the fall or declivity of a mountain group, as its direction and inclination are frequently conformable, particularly in the older formations, with that of the superimposed masses.

b. Seamed Structure.

Those rocks which are divided by parallel seams, that do not extend throughout the whole bed, are said to have the *seamed structure.* The following are the different kinds of this structure: 1. Polyhedral. 2. Lamellar. 3. Globular.

1. *Polyhedral.*—In this kind of structure the rock is divided into columns. The columns are sometimes regular, sometimes approach to the globular form, and occur even curvated. They are from a few inches to many fathoms in length. In the islands of Staffa and Eigg, and on the Craig of Ailsa, there are admirable examples of this kind of structure. These columns are sometimes collected into groups, and such groups are often separated from each other by seams or rather rents, which render them more distinct. Groups of this sort may be considered as immense distinct concretions. The columns of such a group often tend towards a centre, others are perpendicular; some are horizontal; and all this variety occasionally occurs in the same hill. The columns are sometimes jointed, so that the convex extremity of the one column is fitted to the concave extremity of the other; and these columns are usually composed of globular distinct concretions. These globular concretions are composed of curved lamellar concretions. The spaces between the different globular concretions are composed of a looser matter than the concretions themselves; and it is by the falling out of this less compact substance that the structure of such columns is first developed.

No rock shews this kind of structure more distinctly than basalt: in it we have all the varieties of the seamed structure, from the smallest, which is the lamellar distinct concretion, to the largest, which is formed by the grouping of columns.

This kind of structure occurs also in porphyry, greenstone, and lava.

2. *Tabular.*—In this kind of structure, the rock is divided into tables a few inches thick, and of small extent. These tables frequently change their direction, and then the bed of rock is divided into many groups or systems of tables, having in each group a different direction.

Their inconsiderable length, frequent change of direction, and the even surface of the planes, distinguish them from strata. Basalt, in the lower parts of an individual deposition, has often this kind of structure. It also occurs in columnar porphyry.

3. *Globular.*—In this kind of structure the rock is either wholly, or only partially arranged into globes or balls of various magnitudes. These balls are either simply granular, as in granite, syenite, greenstone, or sandstone; granular and lamellar, as in the syenite of Corsica: compact as in basalt; porphyritic as in porphyry; or radiated as in limestone. Globular formations are sometimes met with in rocks and minerals having a less crystalline aspect than granite or syenite. As examples, we may mention balls of hornstone in limestone, and masses of flint in chalk.

The roundish balls of granite found dispersed over low countries, have been considered as boulder or rolled stones, although they are frequently only slightly altered globular concretions, and many theories have been formed to account for their transportation. The granite of the Island of Arran presents this kind of structure.

c. Structure of Veins.

Veins are tabular masses that almost always traverse the direction of the strata, and are composed of materials that differ more or less from the rocks which they intersect, or are of the same nature. They occur in all classes of rocks, and in many districts in extraordinary abundance. In describing veins, we have to attend to their external relations and to their internal relations.

1. *External Relations.*—These are the breadth, length, depth, outgoing, sides, walls, and position. The *breadth* is the space between the walls; the *length* is the space between the ends of the vein; the *depth* is the space from the outgoing to the bottom; the *outgoing* is the upper part of the vein where it appears at the earth's surface; the *sides* are those planes of the vein in contact with the bounding rock; the *walls* are the parts of the bounding rock of the district when in contact with the sides of the vein; and the *position* is the situation of the vein in regard to the points of the compass and the horizon; thus, if we say of a particular

vein that it extends north and south, dips to the west, under an angle of 45°, we express its position. If the vein is inclined, the upper side is called the *hanging side*, and the lower side the *lying side*.

2. *Internal Relations or Structure of Veins.*—Under this head we include, 1. The division of veins into *branches*, and the various convolutions and crossings of these. 2. The *substances* of which veins are composed, and the various modes in which these are *arranged in the veins*, whether in strata, veins, or cavities: And, 3. The *intersection* of different formations of veins, and their *distribution* in countries of different descriptions.

III.—VII. Description of Rocks.

Mountain rockss are divided, in a geognostical view, into five great classes, distinguished by the names Primitive, Transition, Secondary, Alluvial, and Volcanic. We shall describe them in the order just mentioned.

Class I. Primitive Rocks.

Urgebirge, *Werner*.—Terrains Primitifs, *Daubuisson*.

Primitive rocks are those whose period of formation is considered as antecedent to that of the creation of organic beings. Hence we arrange in this class all those formations which have not been found to contain petrifactions or fossil organic remains. Should future observations, however, prove that these rocks do occasionally inclose animal or vegetable remains, still it would be well to consider them as a distinct class, and retain the name Primitive, because from their lying under the rocks of the other classes, they are to be considered as having been formed before them, and may, therefore, be said to be primitive, or first formed.

They are of chemical formation; and if mechanical deposites do occur associated with them, the quantity is inconsiderable. All those kinds which abound in mica are distinctly stratified, while the others that do not contain it, are less distinctly stratified. The direction of the strata is frequently parallel with that of the mountain range in which they are contained.

All the different rocks of the class alternate with, and pass into each other.

The principal constituent parts of primitive rocks are quartz, felspar, mica, limestone and hornblende, minerals, indeed, of which nearly the whole mass of the upper coat of the Earth is composed. Of these minerals, the felspar, quartz, mica, and hornblende occur together, and in various forms of aggregation, while the limestone forms beds of greater or less extent, which are variously connected with the bounding strata.

The following are the rocks of this class:

1. Granite, with syenite, protogine, and topaz-rock.
2. Gneiss, with some varieties of white stone.
3. Mica-slate, with different varieties of talc-slate.
4. Clay-slate, with alum-slate, flinty-slate, &c.
5. Primitive limestone, and primitive gypsum.
6. Primitive trap.
7. Serpentine.
8. Euphotide or diallage-rock.
9. Porphyry.
10. Quartz-rock.

I. Granite.

Moorstone of Cornwall. Whinstone and Sandstone in some parts of Scotland.

1. The name *granite* is a corruption of the Latin word *geranites*, used by Pliny to designate a particular species of stone. The first modern writer who uses this word is Tournefort, the celebrated naturalist. It occurs in the *Account of his Voyage to the Levant*, published in 1699. Antiquarians appear to have named every granular stone capable of being used in architecture or statuary, Granite, and it continued to be used in this vague sense by mineralogists until about fifty years ago, when true granite was distinguished as a particular mountain-rock.

2. *Constituent Parts.*—It is a rock composed of grains or concretions of felspar, quartz, and mica, intimately joined together, but without any basis or ground. These parts vary in quantity, so that sometimes one, sometimes the other, and frequently two of them, predominate. Felspar is generally the predominating, as mica is the least considerable, ingredient of the rock. In some varieties, the quartz is wanting, in others the mica, and these have received particular names. Such distinctions, however, are useless, as these masses are to be considered as mere varieties, not distinct species.

3. *Magnitude of the Constituent Parts.*—The constituent parts differ also considerably in their magnitude: they alternate from large to small, and even to very fine granular. In some varieties, the concretions of felspar and quartz are several inches in size, and the mica is in plates upwards of a foot square; while in others, the grains are so small that the granite appears nearly compact.

4. *Colour of the Constituent Parts.*—It differs also considerably as to colour; and this depends principally on the predominating ingredient, the felspar, the quartz and mica having usually a grey colour. The felspar is usually white, and most commonly greyish and yellowish white; also reddish or milk-white, or flesh-red. It is seldom grey, yellow or green. The quartz is usually grey, seldom milk-white, and generally translucent. The mica is usually grey, and sometimes dark brown, or nearly black.

5. *Condition of the Constituent Parts.*—The felspar in granite has usually a vitreous lustre, and perfect foliated fracture, yet in some varieties it passes into earthy, with the loss of its lustre and hardness; in short, it is in the state of porcelain earth. This appearance is sometimes produced by the weathering of the felspar; sometimes it appears to be its original state. When veins containing pyrites traverse granite, the felspar and mica in their vicinity are converted into a kind of steatitical matter, by the action of the sulphuric acid, formed during the decomposition of the pyrites. The mica sometimes also decomposes by exposure

to the atmosphere; but the quartz is never altered. Granite, with earthy felspar, is found in Cornwall.

6. *Crystallization of the Constituent Parts.*—Sometimes the constituent parts of granite are regularly crystallized; principally, however, the felspar and quartz. The mica sometimes occurs in nests, unmixed with the other constituent parts, and these have been confounded with fragments. Sometimes the constituent parts are so arranged, that when the specimen is cut, its surface bears a resemblance to written characters: hence this variety has been denominated *Graphic Stone*, and is the *Pegmatite* of some geologists. This particular variety is found at Portsoy, Island of Harris, and in the Island of Arran *. Granite, with regularly crystallized felspar, occurs in the Island of Arran, in many places on the Continent of Europe, and also in South America. At Mount St Gothard, all the three constituent parts are found crystallized together. In the Island of Arran and in the Saxon Erzgebirge, there is a remarkable variety of granite, in which the felspar, quartz, and mica, have a diverging radiated structure.

7. *Imbedded and Venigenous Minerals.*—Besides felspar, quartz, and mica, the essential constituent parts of granite, and those minerals that take the place of the mica, viz. hornblende and chlorite, others sometimes occur in it. These are schorl, garnet, and tinstone. The following also occasionally occur either imbedded in the rock, or in veins that traverse it, viz. rock-crystal, adularia, chlorite, pinite, actynolite, common opal, topaz, corundum, fluor-spar, beryl, diallage, epidote, apatite, magnetical iron-ore, and iron-pyrites.

8. *Structure.*—Granite, besides the granular, exhibits various other kinds of structure, such as *porphyritic*, *globular*, *tabular*, *columnar*, and *stratified*.

a. Porphyritic.—When large crystals of felspar occur imbedded in a basis of smaller granular granite, the porphyritic variety is formed. These imbedded crystals are sometimes upwards of a foot in magnitude, as is the case with some granites in Saxony, and in other countries.

* Graphic granite frequently contains crystals of beryl and topaz.

b. Globular.—Some granites are disposed in roundish balls or concretions, which are from a foot to several fathoms in diameter. These balls are sometimes composed of curved lamellar concretions, which always include a harder central mass or nucleus. The spaces between the concretions are filled with granite of a softer nature, which decays readily, and thus leaves the harder central masses heaped on each other, or strewed about. Such heaps, or tumuli, have been erroneously described as rolled masses brought from a distance to their present situation, by the agency of currents that formerly swept the surface of the earth. Examples of this kind of structure occur in the Island of Arran, Bohemia, the Hartz, the Fichtelgebirge, and in other countries.

c. Tabular.—Some granites, when they are traversed by parallel seams, appear divided into tables. These tables vary in extent from a few inches to several fathoms. They appear in some cases to be mere varieties of the stratified structure.

d. Columnar.—When the seams are arranged in directions parallel to several planes, the granite is divided into columnar masses, which resemble the columnar structure of trap and porphyry rocks. We many years ago, as mentioned in our Account of the Hebrides, observed this columnar structure in the granite of Mull; and since that time Humboldt has described it as occurring in the granite of Caraccas, as it does in the granite rocks of Carlsbad.

e. Stratified structure, or *Stratification.*—Granite is sometimes disposed in great beds in gneiss and other rocks, and occasionally these beds appear divided into strata. In other instances, in granite mountains, we observe, besides the tabular, globular, and other structures, also the stratified; but this latter is, in general, less perfect than what is observed in gneiss, and other similar rocks.

9. *Beds in Granite.*—Granite does not afford so many different beds and veins as gneiss, mica-slate, and other similar rocks. In Scotland, it sometimes contains beds of quartz and of felspar. In Switzerland, the beds of quartz

in granite have large drusy cavities, the walls of which are lined with magnificent crystals, and groups of rock-crystal. At the tin-mines of Zinnwald, in Bohemia, the tin is worked in a quartz bed, situated in the middle of the granite. Beds of limestone are also met with in granite mountains, as in the Pyrennees; and some of these are of great extent, having been traced by that excellent observer, Charpentier the younger, for four leagues, and with a thickness of ninety feet. We need not speak of the beds of gneiss, mica-slate, clay-slate, porphyry, trap, &c. upon which it often rests, and with which it frequently alternates.

10. *Metals in Granite.*—On a general view, this rock contains fewer and less extensive metalliferous veins and beds than the slaty rocks of the primitive class. Tin, of all the metals, is that which is most peculiar to granite. Tin-stone occurs in the granite of Cornwall, Saxony, Limoges, and in these countries is generally associated with wolfram.

Iron is frequent in granite. The mines of Traversella, in Piedmont, are situated in a granite which is subordinate to mica-slate. The mines of brown iron-ore at Taurynià, and of Fillolo in the eastern Pyrennees, are in granite. Iron-pyrites is frequently found disseminated through granite; and galena, or lead-glance, graphite, molybdena, bismuth, gold, silver, copper, zinc, manganese, and cobalt, are among the metals sometimes met with in this rock.

11. *Formations of Granite.*—Granite occurs in masses, often many miles in extent, surrounded by gneiss, mica-slate, and clay-slate, and so connected with these rocks, that the whole may be considered as the result of one grand process of crystallisation; that is, the granite is of cotemporaneous formation with the gneiss, as the gneiss is with the superimposed mica-slate; and the mica-slate, again, with the clay-slate which rests upon it. In other instances, the granite alternates in beds, often of enormous magnitude, with gneiss, mica-slate, clay-slate, and other primitive rocks, or it traverses these in the form of veins.

12. *Decomposition of Granite.*—Some granites resist, for ages, the destroying effects of the weather; while others are

resolved into sand or clay in a comparatively short period. The obelisk in the place of Saint Jean de Lateran, at Rome, which was quarried at Syene, under the reign of Zetus, King of Thebes, thirteen hundred years before the Christian era; and that in the place of Saint Pierre, also at Rome, which a son of Sesostris consecrated to the sun; have resisted the effects of the weather for three thousand years.

On the other hand, there are granites, as those in some districts in Scotland, which are speedily disintegrated into gravel or sand. But between these two extremes, of great durability and rapid decay, there are numerous and intermediate degrees. In the same mountain, or even in the same hillock, granites of different qualities will sometimes be met with. One portion will be excessively obdurate, and resist long the gnawing effects of the weather; another variety, immediately beside it, will be of a very decomposable nature; while a third, associated with the two former, will possess an intermediate degree of durability. Granites vary in their mode of decomposition. Some assume the globular form; others that of rhomboidal or irregular masses. These masses are further disintegrated, and then the constituent parts fall asunder, forming a kind of gravel or sand, depending on the size of the grains of the granite. The felspar in this gravel is further altered, and changed into a clay, which is carried into hollows or plains, and forms beds of clay; the quartz grains, by attrition, are reduced in size, rounded in form, and give rise to beds of sand; and, when mixed with the matter of felspar, to sandy clays. The mica is broken down, and becomes mixed with the clays and sands formed from the felspar and quartz.

The soil formed from decomposed granites, is in general comparatively unproductive.

13. *Shape of Granite Mountains.*—In those granite districts in which the granite is of a loose texture, and easily acted on by the weather, the hills have a rounded form, and the lower granite tracts have a waved, or rather a mamillary outline.

But if very hard and indestructible granite rises through softer and more easily disintegrated, the harder portions appear in the form of peaks, needles, or in deeply dentated ridges, or cristæ, and thus give rise to the bristled and denticulated aspect so peculiar to many granite districts. The valleys, in granite countries, are in general very deep, narrow, and their sides often resemble immense perpendicular walls.

Granite rocks are frequently much traversed by rents or fissures. When these rents widen by the action of the weather, the mass separates into fragments of greater or less magnitude, which remain long piled on each other in a most fantastic manner, often appearing like vast artificial tumuli, or masses brought together by a flood. The upper parts of the granite mountains in Arran present very striking appearances of this kind, and I have observed the same in many places of the high granite ridges of the Riesengebirge. Travellers have described similar appearances in the mountains of Switzerland; those of Siberia; the Hartz; the Böhmerwald-gebirge, and the Carpathians.

14. *Geographical distribution of Granite.*—It is one of the most frequent and widely extended rocks. It occurs in almost every extensive mountain group, and there it frequently juts out, forming its central and highest part, having the newer primitive rocks resting on it, or placed beside it. It forms mountains in this country, as in the island of Arran, and in the Grampians. The same is the case in the Hartz, the Riesengebirge, the Böhmerwald-gebirge, the Fichtelgebirge, and the Alps, particularly those of Savoy; also in Bavaria, Bohemia, Franconia, Lusatia, Moravia, Upper Saxony, Thuringia, Austria, Stiria, and the Tyrol. As granite is the basis on which the other primitive rocks sometimes rest, it may also appear in low mountainous situations, owing to the newer primitive rocks either not having been deposited, or having been washed away since deposition. Instances of this we have in the Island of Arran, near Carlsbad in Bohemia, and many other places.

The following list of localities, shews the known extent of granite in the different quarters of the globe, without, however, any reference to its forming the centre and highest, or the lowest part of mountains or mountain-groups.

In Europe, it forms the range of Sewoga in Scandinavia; the rocks of Finland; occurs also in Cornwall in England, in the Hartz, the Forest of Thuringia, Erzgebirge in the Kingdom of Saxony, the Fichtelgebirge, Lusatia, the Riesengebirge, the Bohmerwald-gebirge, the Schwarzwald (Black Forest,) the Alps of Switzerland, and Savoy; also in the Tyrol, Salzburg, Stiria, Archduchy of Austria, the Carpathian Mountains, Auvergne, Dauphiny, and the Pyrenean Mountains.

In Asia, it forms the centre of Caucasus; occurs at Kolywan, and other places in Siberia; forms a very considerable portion of the Uralian, Altain, and Himalya chains of mountain-groups.

In Africa, it is said to form a principal constituent part of the mountains in Upper Egypt, the Atlas Mountains, and the country about the Cape of Good Hope.

America.—It occurs but in comparatively small quantity in the United States; and in Mexico, owing to the deep and high cover of porphyry, it is found only low down, as at Acapulco. In the Andes of South America it is usually covered with gneiss, mica-slate, and trachyte, and in general is not observed higher than 6000 feet; but it abounds in the low mountains and regions of Venezuela, and of Parima, and descends even to the plains, and to the level of the sea, as is the case on the sides of the Orinoco, and the coasts of Peru.

Uses.—It forms an excellent building and paving stone, and has been extensively employed in ornamental architecture.

Two of the most remarkable varieties of granite are named Protogine and Sienite.

Protogine.—In this variety, talc, either in the lamellar, compact, or steatitic form, or as chlorite, takes the place of the mica. Mont Blanc, and the surrounding mountains, are formed of protogine. It is named Protogine, (primævi,) because Jurine, the author of the name, considers it as of very old formation. Daubuisson proposes to name it simply Talcose or Steatitic Granite.

Sienite.—Sienite is a granite, in which the mica is generally replaced by hornblende; not always, as some varieties contain also mica. Werner says it is a granular aggregated rock, composed of felspar and hornblende, with occasional grains of quartz and scales of mica. It is named from Syene in Upper Egypt, where the ancients quarried it in blocks of great magnitude.

Topaz-Rock.—This rock, which appears to be intimately connected with granite, has the following characters. Its constituent minerals are quartz, tourmaline, topaz, and lithomarge. It is composed of numerous small masses, which have the appearance of fragments, although they are true granular concretions. Each of these masses is composed of thin layers of quartz, tourmaline, and topaz; and these layers have different directions in the different masses or concretions. The quartz and topaz are in granular concretions, and the tourmaline in small black needles. Frequently hollow spaces occur between these concretions, which are partly filled with crystals of quartz and topaz, but rarely contain tourmaline. The lithomarge occurs amongst these crystals, and has generally an ochre-yellow, rarely a green, and seldom a white colour. It is worthy of remark, that the colour of the crystals of topaz depends on that of the lithomarge; as if this substance, or at least its colouring matter, was the same as that of the topaz.

Topaz-rock is very distinctly stratified, and the strata are of considerable thickness. It rests upon granite, and is covered by clay-slate.

It has hitherto been found only near to Auerbach, in Voightland, in Saxony, where it forms a rock named *Schneckenstein*, which was formerly of considerable extent, but has been much diminished by the operations of the miners in procuring topazes.

The inconsiderable extent of this mass prevents our viewing it as a distinct species of mountain rock.

II. Gneiss.

Gneiss, and Granite veiné, *Saussure.*

1. *Name.*—The name *Gneiss* is of Saxon origin, and was applied by miners in the vicinity of Freyberg, to the decomposed stone that forms the walls of their metalliferous veins. Henkel describes gneiss as an indurated stone, mixed with steatitical and clayey matter; but Werner ascertained that it was a compound of felspar, quartz, and mica.

2. *Constituent Parts.*—This rock, like granite, is a compound of felspar, quartz, and mica; but it contains more mica than granite. It is granular in the small, and slaty in the large; hence it is said to be granular-slaty. The granular felspar and quartz form plates, which are separated from each other by the mica.

Felspar, although the predominant mineral, is still in less quantity than in granite. The felspar is usually greyish, yellowish, and reddish white; and sometimes so much altered that it appears earthy. The mica is most commonly ash-grey, which passes through various shades into blackish-grey. The quartz is almost always greyish-white, and generally in smaller grains than the felspar.

3. *Imbedded Minerals.*—Besides felspar, quartz, and mica, it sometimes contains schorl; more rarely garnet, and also hornblende. The schorl occurs more rarely, and in less quantity, than in granite; but the garnet is more frequent and abundant than in granite.

4. *Kinds of Gneiss.*—There are three principal kinds of gneiss, of which we shall now give short descriptions.

(1.) In this kind the mica occurs in small quantity: the scales of mica, although separated from each other, are arranged in parallel ranges, and the rock breaks in a direction conformable with these. It is the parallelism of the ranges of mica which distinguishes this kind of gneiss from granite, because its slaty structure is very indistinct, and the quantity of felspar is nearly the same as in granite. The quartz and the mica form each separate layers; those of the felspar are thicker, and such varieties, when broken across, have a ribbon-like aspect. Sometimes the quartz, in place of being disposed in layers or plates in the felspar, is in small parallel rods or bars; and when this variety is cut perpendicular to the direction of the rods, it appears not unlike petrified wood.

(2.) This, which is named *common gneiss*, consists of small layers, or lenticular plates, composed of grains of felspar and quartz, placed over each other, and separated by layers formed of scales of mica. It is sometimes glandular, or contains balls of quartz, or of compounds of quartz and felspar, or of mica. This variety has been confounded with Conglomerate. The island of Fetlar, one of the Shetlands, affords an example of this variety.

(3.) This, the third variety, is very slaty, and very micaceous. The scales of mica, from their smallness, appear indistinct, and form continuous plates. The felspar and quartz are in very small grains, and are sometimes so enveloped in the mica that it is difficult to distinguish them. It is also sometimes glandular, and in some instances almost an aggregation of balls of mica.

The gneiss which passes into granite belongs to the first kind, as that which passes into mica-slate does to the third.

5. *Stratification.*—It is distinctly stratified, and the strata are parallel with the slaty structure. But when the beds rest upon granite, they sometimes follow all the sinuosities of the irregular surface of that rock, and form the mantle-shaped stratification; in other cases the stratification is saddle-shaped, or it does not appear affected by the granite, the strata passing without change of direction from one mass of granite to the other.

6. *Decomposition.*—This rock, like granite, is much affected by the atmosphere, but the decomposition is in general more rapid. The felspar is at first changed into kaolin, and, owing to the greater abundance of mica, the disintegration of the mass is more rapidly effected. Hence it is that this rock does not occur so often in great isolated blocks as granite; and hence also it is that mountains of gneiss are often less sharp in their outline than those of granite, that their sum-

mits are generally roundish, and that they rarely shoot into needles, or are formed into denticulated ridges.

Sometimes the decomposition, in penetrating the gneiss, loosens the adherence of the parts; the folia are then easily separated by the finger, and the mass appears as if rotten.

7. *Beds.*—These beds are more considerable and more numerous in gneiss than in granite. The following may be enumerated.

a. Limestone.—It is generally highly crystallised. Occurs in Aberdeenshire, Perthshire, and other parts of Scotland; and on the Continent of Europe, in the Pyrenees, in Dauphiny, &c.

b. Trap.—This rock, in the form of hornblende-rock, hornblende-slate, and greenstone, occurs in beds, and in imbedded masses, and is often very much intermixed with the gneiss. When the gneiss abounds in hornblende, it is named *hornblendic gneiss.*

c. Porphyry.—Beds, and imbedded masses of porphyry, sometimes of great magnitude and extent, are not unfrequent in some gneiss districts. Perthshire, Aberdeenshire, and Inverness-shire, afford fine examples of porphyry in beds, imbedded masses, and veins.

d. Compact and granular felspar.—The White stone, Weisstein of *Werner.*—This rock sometimes occurs in layers, which are not more than a few inches thick; in other instances in beds, so thick as to form the whole mountains. The felspar is white, and very fine granular: it contains numerous grains of red garnet, even grains of quartz, and sometimes scales of white mica. In short it is to be considered as a granular felspar, generally containing scales of mica, with some grains of quartz, and of other minerals. It forms beds and whole hills in Saxony, Moravia, and Sweden.

e. Quartz Rock.—This rock occurs in great beds, in gneiss districts.

f. Mica-slate.—Beds of mica-slate, sometimes of great magnitude, occur occasionally in gneiss districts.

g. Clay-slate.—This mountain rock sometimes occurs in beds in gneiss.

h. Granite.—Beds of granite, varying in magnitude from a few feet to many fathoms in thickness, are met with in gneiss.

8. *Veins.*—Strata of gneiss are frequently traversed by veins, and of these the most frequent are granite, felspar, and quartz: less frequent are sienite, porphyry and trap.

9. *Metalliferous Minerals.*—Gneiss is one of the most metalliferous of the primitive rocks. All the useful metals, with the exception of mercury, occur in this rock. The metals occur in *veins*, *imbedded masses*, and *beds*, but in greatest variety in veins. The great iron-mines in Norway, Sweden and Lapland, and the most valuable mines in Saxony, Bohemia, and Salzburg, are situated in this rock. The lead-mines of Strontian in Argyleshire are in veins that traverse gneiss.

Geographic distribution.—It is a very widely distributed rock. It is found in almost every country where granite occurs; and is often interposed between granite and mica-slate, or is contained in mica-slate, or even in clay-slate. It is an abundant rock in Scotland, forming extensive tracks in the middle and northern divisions, and also in the islands. It is the principal rock in Sweden and Norway. It occupies almost the whole of the Saxon metalliferous mountains: it abounds in Bohemia and Silesia; it is not uncommon in the Black Forest, the Upper Palatinate, in Carinthia, in the Southern Alps, the Pyrenees, and the Vosges. It occurs also in Greece; and in the vicinity of Athens, the old mine-works of the ancients are situated in it. It is an abundant rock in the United States of America; and in South America, Humboldt met with it in the high chain of the Andes of Quito, in the mountains of Parima, and Venezuela.

III. Mica-Slate.

Glimmer-Shiefer, *Werner.*—Micaceous Shistus, *Kirwan.*—Schiste micacé, *Brochant.*—Roche feuilletée, quartz et mica, ou Schiste micacé, *Saussure.*—Schiste micacé, *Daubuisson.*

1. *Constituent Parts.*—This rock is composed of mica and quartz, and, like gneiss, has a slaty structure. The mica is generally the predominating ingredient; its colour is grey,

sometimes inclining to green, sometimes to yellow, and more rarely to brown. It is often disposed in continuous plates, not in distinct scales, as in gneiss. The quartz is grey, with its usual vitreous lustre, and is disposed in thin lenticular masses, interposed between the plates of mica. Sometimes these masses increase in magnitude, and become globular, and then the rock acquires a conglomerated structure. Although the mica forms the principal and predominating ingredient in mica-slate, yet it sometimes happens that the quartz is the most abundant, and thus a transition is formed into quartz-rock.

2. *Varieties.*—We can distinguish different kinds of mica-slate. These are *Common*, *Undulated*, *Talcky*, and *Fine Slaty*. The *common* is straight, and rather thick slaty, and contains garnets, and sometimes felspar. The *undulated* has a waved structure, and contains neither garnets nor felspar. The *talcky* is straight slaty; contains thick layers of quartz, and the mica has a green colour, and inclines to talc. The *fine slaty* borders on clay-slate, (the next rock in the order of succession,) has a light yellowish-grey colour, contains extremely little quartz, and passes imperceptibly into clay-slate. Of these, the oldest is the Common, and the newest the Fine-slaty.

3. *Imbedded Minerals.*—It frequently contains imbedded minerals of different kinds. The principal of these are the following:

(1.) *Garnet*, either in grains or in crystals, and so frequent and abundant, that it may almost be considered as a characteristic and principal ingredient of the rock. It abounds in mica-slate districts in Scotland, as in the tract between Loch-Earn Head and Tyndrum, Moulinearn, Tumel Bridge, &c.

(2.) *Tourmaline and Schorl.*—These are met with in the mica-slate of Scotland, and in other countries.

(3.) *Grenatite.*—This mineral occurs in the mica-slate of Aberdeenshire, of the county of Wicklow in Ireland, and in districts of the same description on the Continent of Europe.

(4.) *Chiastolite.*—This curious mineral is found in mica-slate in the Pyrenees.

(5.) *Kyanite.*—Is found in the mica-slate of the Shetland islands, and also in a similar rock in Banffshire.

(6.) *Emerald.*—The beautiful emerald found in Egypt occurs in mica-slate.

Besides the minerals already enumerated, many others, as vesuvian, rutile, graphite, &c. occur in mica-slate.

4. *Stratification* and *Position.*—It is very distinctly stratified. The strata are sometimes variously convoluted, and the same character occurs in the substance of the strata. It often rests on gneiss, and is covered by clay-slate. It passes on the one hand into gneiss, and on the other into clay-slate. The outgoings of the strata are frequently lower than those of the gneiss, on which they rest, and higher than those of the clay-slate that cover them. It sometimes also occurs in beds in gneiss, and clay-slate, and even in granite.

5. *Beds.*—It contains greater variety of beds than gneiss. The following have been observed: Granular limestone, dolomite, hornblende-slate, and hornblende-rock, actynolite, garnet, talc, serpentine, chlorite, quartz-rock, magetic iron-ore, magnetic-pyrites, copper-pyrites, iron-pyrites, arsenic-pyrites, blende, lead-glance, and red ironstone.

6. *Form of Mountains.*—The acclivities of the mountains are gentle, and the cliffs it forms are not so considerable as those in gneiss mountains. When mural precipices occur, they are seldom of great height. The summits of the hills are often round-backed.

7. *Metalliferous Minerals.*—The ores it contains occur both in beds and veins. The ores that occur in beds are the following: magnetic iron-ore, iron-pyrites, copper-pyrites, arsenic-pyrites, red iron-ore, lead glance, blende, gold, and glance-cobalt; and these ores are accompanied with actynolite, garnet, and asbestus.

The veins that occur in mica-slate contain in general the same ores as those in gneiss.

The gold mines at the foot of Monte Rose are principally in mica-slate; and this is also the case with some of those in the country of Salzburg. The silver-mines of Johan-Georgenstadt and Braunsdorf in Saxony; those of Sweden and

Norway, and many in Silesia and Bohemia, are in mica-slate.

The mines of Dalecarlia and Fahlun in Sweden; those of Roraas in Norway; many in Hungary and Salzburg, Saxony and Bohemia, are situated in this rock.

8. *Geographical Distribution.*—It occurs in great abundance in Scotland; as in the valley between Dunkeld and Blair-in-Athol; the mountain of Schihallion, and the neighbouring country; islands of Jura and Isla, Cantyre, &c. It is also very widely distributed in the continent of Europe; as in Saxony, Bohemia, Silesia, France, Spain, the Bannat, Transylvania, Switzerland, Salzburg. It also occurs in the United States, in South America, and in the continents of Africa and Asia.

These four rocks generally occur in the order here placed

IV. Clay-Slate. minute scales of Mica

Thonschiefer, *Werner.*—Primitive argillaceous Schistus, *Kirwan.*—Schiste argileux, *Brochant.*—Phyllade, *Daubuisson.*

1. *Characters.*—Clay-slate is a simple mountain rock, which exhibits the following characters:

External Characters.—Colours grey, green, black and red; and these are sometimes disposed in spots, or stripes. Occurs massive. Surface smooth, or traversed by striæ. Internally glistening, or glimmering and pearly. Fracture more or less perfectly slaty, and either straight or undulating. Sometimes a double obliquely intersecting cleavage. Fragments generally tabular, seldom long splintery or trapezoidal. Opaque. Affords a greyish-white dull streak. Soft. Sectile, and splits easily. Feels rather greasy. Sp. gr. = 2.661, *Kirwan.*—2.786, *Karsten.*

Constituent Parts.—Silica, 48.6; Alumina, 23.5; Peroxide of Iron, 11.3; Potash, 4.7; Magnesia, 1.6; Water, and volatile matter, 7.6; Carbon and Manganese, 1.0.

2. *Varieties.*—There are four kinds of clay-slate. The *first kind* has a yellowish-grey colour, and shining lustre: it is the oldest kind, to use the language of Werner, and is that which reposes immediately on mica-slate; it is in short

the link that connects clay-slate with mica-slate. The *second kind* is dark-grey; sometimes even bluish-grey and greyish-black, forming what is denominated *roof-slate*, from the circumstance of its splitting into thin and large tables, and being used in the roofing of houses. We must be careful, however, not to consider all roof-slate as of primitive formation. To this follows, in the order of succession, the *third kind*, which has a greenish-grey colour. The *fourth* and last, which is the newest kind of clay-slate, is bluish-grey, and reddish: it contains few intermixed scales of mica; possesses but little lustre; and is the link that connects primitive clay-slate with transition clay-slate.

3. *Stratification.*—It is distinctly stratified, and its slaty structure is generally parallel to the seams of the strata; in some cases, however, a double cleavage is observable; and Count de Bournon observes, that many clay-slates break under angles of 60° and 120°, which he supposes may be owing to the presence of mica. The strata are in general much inclined, and are often variously convoluted and waved, and sometimes they appear to be composed of distinct concretions, of various forms and magnitudes.

4. *Imbedded Minerals.*—Independent of the grains of quartz and scales of mica irregularly distributed through mica-slate, we find it containing large imbedded masses of quartz, and hornblende, and crystals of chiastolite.

5. *Subordinate Beds.*—It contains a greater variety and number of beds than gneiss or mica-slate; and of these some are nearly peculiar to it, and characterise the whole formation. We shall first mention those which are common to gneiss and mica-slate, as well as clay-slate, and then those that are, to a certain extent, peculiar to clay-slate.

(1.) Rocks that occur in gneiss, mica-slate, and clay-slate. 1. *Limestone.* 2. *Hornblende-rock.* 3. *Primitive Greenstone.* 4. *Hornblende-slate.* 5. *Porphyry.* 6. *Quartz.* 7. *Actynolite.*

(2.) *Rocks peculiar to the clay-slate formation, or which occur very frequently in it.* 1. *Whet-slate.* It occurs in beds in Saxony, Bavaria, Silesia, Stiria, and other countries. 2.

Roof-slate. This is but a variety of clay-slate, distinguished by its bluish or ash-grey colour; its straight slaty fracture; its splitting into large tables, and its being nearly pure and unmixed. It seldom or never forms whole mountains, but occurs usually in single thick beds with other kinds of clay-slate. 3. *Chlorite-slate.* This usually follows the preceding. It forms whole beds, and includes garnets, crystallised magnetic iron-ore, iron-pyrites, common schorl, tourmaline, and quartz. 4. *Talc-slate.* This is usually the next in the order of succession. 5. *Alum-slate.* It occurs in considerable beds in clay-slate; and the two subspecies, the common and shining, alternate with each other. It contains a portion of carbon, and also iron-pyrites. 6. *Drawing-slate.* It occurs usually in the vicinity of alum-slate, and is very nearly allied to it. It contains more carbon than alum-slate, but less iron-pyrites. 7. *Potstone* occurs in considerable beds. 8. *Flinty-slate* occurs in considerable beds in this great formation. 9. *Lydian-stone* occurs in beds and imbedded masses.

6. *Formations.*—This rock occurs along with mica-slate, and sometimes in beds in gneiss, and even in granite.

7. *Form of Mountains.*—It sometimes forms whole mountains, and even chains of mountains. Its mountains have usually a gentle acclivity; and its cliffs are not so steep and rough as those of mica-slate or gneiss. It is more favourable to vegetation than any of the rocks already described; and it is observed that the quantity of vegetation increases from granite to clay-slate; a circumstance which appears to depend, not so much on the lower level of the outgoings of its strata, as on the nature of the rock itself.

We can thus observe a gradual change in the shape of mountains, also of their cliffs and valleys, from granite to clay-slate; and these differences are so striking and characteristic, that a long-experienced eye can, at a glance from the summit of a mountain, point out with considerable certainty the different formations of which a country is composed. Landscape-painters, by confounding together all these differences, or by combining them irregularly, fail not only in accuracy, but in giving their work that appearance, which shews, at first glance, that it is not only a copy of nature, but a copy by one who has formed a distinct conception of the general and particular features of the inequalities observable on the surface of the earth. Some affect to maintain, that the grand features of mountains and plains, are different in different zones. Thus, that in the torrid zone, for example, the shape, cliffs, and other appearances in mountains, are different from those in the temperate zone. This opinion, however, is erroneous; for the same formation in all countries presents similar external characters; and as the great formations are universal, no such differences can exist. It is true, that the blue colour of the heaven, its degree of illumination, the appearance of distant mountain-vapour, the shape of animals, the luxuriance of vegetables, combined with the features of mountains, will form a particular character for each climate; but still the aspect of the rocks of the same formation, in whatever country they occur, will be the same. Thus cliffs of granite and mica-slate, have the same appearance in India and Siberia as in Scotland; and the valleys of the Urals, do not differ in shape and other features from those formed by similar rocks in this neighbourhood.

7. *Metalliferous Minerals.*—Clay-slate is rich in metals. It contains many of the venigenous formations that occur in the preceding primitive rocks, as tin, lead, cobalt, and silver. Very considerable metalliferous beds also frequently occur, and these contain copper-pyrites, red copper-ore, copper-green, blue copper, malachite, iron-pyrites, magnetic pyrites, glance-cobalt, grey cobalt-ore, arsenic-pyrites, blende and lead-glance. Gold also occurs in this formation, and it is said also cinnabar.

8. *Geographical Distribution.*—It is a very widely extended rock. In this country, it skirts the Highlands from Lochlomond by Callender, Comrie, and Dunkeld; in the whole of that extensive district, resting on, and gradually passing into mica-slate; the same appearances are to be observed in many other quarters in Scotland. On the continent of Europe, it has been traced through a great extent of country; thus it occurs in Saxony, Bohemia, Silesia, Franconia, Bava-

ria; the Alps of Switzerland, Austria, Hungary, and many other parts in Europe. It occurs also in considerable quantity in North America, as Pennsylvania; also in immense quantity in South America; thus it is said that nearly the whole country between Potosi and Lima, is composed of it. In some of the districts above enumerated, transition clay-slate has been confounded with the primitive kind.

V. Primitive Limestone.

Ur Kalkstein, *Werner*.—Primitive Limestone, *Kirwan*.—Calcaire Primitif, *Brochant* and *Daubuisson*.

Characters.—This is a simple mountain-rock. Its most common colours are snow, yellowish, greyish, greenish, and reddish white; it is sometimes also grey, and the newer varieties incline to yellow. Its structure is always granular. Those varieties which are associated with granite and gneiss are generally more crystalline than those contained in mica-slate and clay-slate; and primitive limestone is usually more crystalline than secondary. Werner remarks, that in the oldest members of the series, that is in those contained in granite, the colour of the limestone is pure white, translucent, and coarse granular; in the newer members, the colour is less pure, the translucency less considerable, and the granular distinct concretions smaller; and in the newest, the concretions are so small as only to be discoverable by their glimmering lustre. according to the formation is in the state of crystallization

2. *Imbedded Minerals*.—It frequently contains accidental ingredients, and these occur oftener in the older than in the newer members of the series. The following may be enumerated: 1. *Quartz*. It occurs in massive pieces of greater or less magnitude, and sometimes also in crystals: 2. *Mica*. It sometimes occurs in such quantity as to give the stone a slaty fracture. These two minerals, namely, quartz and mica, are the most common accidental minerals met with in primitive limestone. Those of less frequent occurrence are the following: common hornblende, actynolite, asbestus, serpentine, augite, talc, steatite, felspar, epidote, tremolite, garnet, calcareous-spar, slate-spar, and pyrites.

3. *Stratification.*—It occurs more or less distinctly stratified. It was once erroneously maintained, that granular aggregated stones, as primitive limestone, granite, sienite, and greenstone, were never stratified. Primitive limestone also occurs in beds of greater or less magnitude; sometimes these beds are short and thick, and are then said to form lying masses (liegende Stöcke;) or the beds are so thick and extensive as to form whole mountains, but this latter is a rare occurrence.

4. *Formations.*—There are several formations of primitive limestone. Thus it forms one formation in granite, another in gneiss, a third in mica-slate, and a fourth in clay-slate. It is more abundant in mica-slate than in granite or gneiss, or even in clay-slate.

5. *Metalliferous Minerals.*—It frequently contains ores of different kinds, and these occur often in beds, but seldomer in veins. The metalliferous beds contain lead-glance, blende, magnetic iron-ore, magnetic-pyrites, auriferous arsenic-pyrites, and native gold. The veins are very inconsiderable, and by some mineralogists are said to contain principally manganese.

6. *Geographical Distribution.*—Several beautiful varieties occur in this country, as in the islands Tiree, Icolmkill, and Skye; also in Perthshire, as in Glen Tilt; in Assynt, in the county of Sutherland, and many other places. The promontory of Athos, in the Archipelago, is said to be composed of primitive limestone; also the Island of Paros, and part of the Apennines, as about Carrara and Massa, of the Alps of Switzerland, the Pyrenees, Carrapatos in Portugal, Bohemia, Saxony, Silesia, and many other parts of the continent of Europe.

8. *Uses.*—The finest statuary marbles are found in primitive mountains, and also many of the varieties used in ornamental architecture.

Primitive Gypsum.

Urgyps.—*Werner.*

Hitherto this rock has not been observed to form masses or beds of considerable extent in primitive mountains. The principal authentic example recorded of primitive gypsum, is that given by Daubuisson, who informs us he discovered a bed of it in mica-slate in the valley of Aoste, and near the village of Cogne.

VI. Primitive Trap.

Ur-Trapp, *Werner.* — Granitelles, Trapp Corneennes, Ophites, *Saussure.*—Trapps Primitifs, *Brochant.*—Amphibolite, *Daubuisson.*

1. *Name.*—The name Trap is derived from the Swedish word *trappa*, signifying a stair, and it would appear that it was first used by Rinman, in a memoir on ferruginous stones, published in 1754. The Swedes applied this name to rocks which, on exposure to the air, assumed shapes resembling the steps of a stair. It was, however, soon extended to many rocks of very different formation; hence it was found necessary to restrict its signification. Geologists now consider as primitive trap-rocks, all those in which hornblende is the principal constituent part.

The following Table exhibits the rocks of this series.

1. Common hornblende-rock.
    - *a.* Granular hornblende-rock.
    - *b.* Hornblende-Slate.
2. Hornblende mixed with felspar, and sometimes with hypersthene.
    - *a.* Greenstone. *Diabase,—Brongniart.*
        - *α.* Common Greenstone.
        - *β.* Porphyritic Greenstone.
        - *γ.* Greenstone Porphyry. } *Aphanite,—Haüy.*
        - *δ.* Green Porphyry. }
    - *b.* Greenstone Slate. *Diabase schisteuse.*
    - *c.* Hypersthene Greenstone.
3. Hornblende mixed with mica.

1. *Common Hornblende-rock* is almost entirely composed of hornblende. It contains two subordinate kinds; the first is denominated *Granular Hornblende-rock*; the second,

which differs from the first only in having a slaty structure, is denominated *Hornblende-slate*. It passes sometimes into gneiss, and sometimes into chlorite-slate, and often into hornblende-rock. These two rocks occur in beds, in gneiss, mica-slate, and clay-slate, but the beds are thicker and more numerous in the clay-slate than in mica-slate or gneiss.

It occurs in the Islands of Arran, Coll, and Tiree; also in the district extending from Lochlomond to Dunkeld, and many other places of the Highlands of Scotland. It abounds also in Bohemia, Saxony, the Tyrol, Siberia, and many other countries.

2. *Hornblende mixed with Felspar.*—This species contains three subordinate kinds; the first is *Greenstone*, the second *Greenstone-slate*; and the third *Hypersthene Greenstone.*

(1.) *The Greenstone* comprehends the following varieties: *Common Greenstone*, *Porphyritic Greenstone*, *Greenstone-porphyry*, and *Green Porphyry.*

a. *Common Greenstone* is a granular aggregate of hornblende and felspar. b. *Porphyritic Greenstone* is the preceding kind, including large crystals of felspar, and consequently having a porphyritic structure. c. *Greenstone Porphyry.* In this variety the granular basis, which is very compact, includes crystals of felspar. It is the Black Porphyry of the ancients. d. *Green Porphyry.* In this variety the granular nature of the basis is no longer visible to the naked eye; it appears uniform and simple; has a blackish-green or pistachio-green colour, and includes crystals of compact felspar. It is the *Porfire verte*, or antique green porphyry of antiquaries.

Greenstone appears sometimes stratified. Its different varieties first appear in gneiss, then in mica-slate, and lastly in clay-slate. In mica-slate, but more particularly in gneiss, the beds are few and inconsiderable; whereas, in clay-slate, they are numerous and of great magnitude. It probably, in some instances, occurs in an unconformable and overlying position.

It occurs abundantly in this country. Thus the clay-slate and mica-slate, that form so great a portion of the country extending from Loch Lomond, by Callendar, Comrie and Dunkeld, contain numerous beds of greenstone; and there, as is the case in all other countries, the clay-slate contains more numerous and larger beds than the mica-slate. It is also very abundant on the continent of Europe, as in Norway, Saxony, Bohemia, Silesia, Thuringia, Hungary, the Alps of Switzerland, and Savoy.

(2.) *Greenstone-Slate* is composed of hornblende and compact felspar, and has a distinct slaty structure. The felspar in general is rather more abundant than the hornblende. It sometimes contains scales of mica.

It occurs only in clay-slate, and according to Werner is the newest of the primitive traps. It occurs in great beds, and even in mountain-masses; so that in some countries, as Sweden, it is said to form ranges of hills. It is very metalliferous. The celebrated mining district of Gersdorf, in Saxony, is situated in this rock. The mining districts of Rudolstadt in Silesia, and of Adelfors in Sweden, are also in greenstone-slate.

(3.) *Hypersthene Greenstone.*—This greenstone, besides hornblende and felspar, contains hypersthene, and magnetic iron-ore is also a frequent imbedded mineral. In the Island of Skye it forms whole mountains, where it is associated with common greenstone, and also with porphyry.

3. *Hornblende mixed with Mica.*—This is an intimate mixture of hornblende and felspar, including scales of mica. It occurs, in beds, in gneiss and mica-slate.

So called from its resemblance to the colouring of the [illegible]

VII. Serpentine.

Serpentin, *Werner*.—Serpentine, *Kirwan*.—Serpentine, *Brochant*.

1. *Characters.*—This rock appears to the eye as a simple mineral, although there are many circumstances that go to prove its compound nature. Its colour is green, sometimes variously marked with tints of brown, red, yellow, and grey. The lustre alternates from dull to glistening, and the fracture from splintery to conchoidal. It ranges from translu-

cent on the edges to translucent or to semitransparent, as in the finer kinds of the Precious Serpentine of authors. It yields easily to the knife, but not to the nail. Feels rather greasy, and has a specific gravity of 2.468,—2.704. Its constituent parts are, Silica, 32; Magnesia, 37.24; Water, 14; and Iron, 5.50; with minute portions of chrome, alumina, lime, and manganese.

2. *Imbedded Minerals.*—It frequently contains accidental minerals, or is indeterminately mixed with another mineral. Of the latter only one instance is known. It is the mixture of limestone and serpentine, forming what is denominated *verde antico.* The imbedded minerals are common talc, indurated lithomarge, steatite, common asbestus, amianthus, mica, schiller-stone, native magnesia, magnesite, meerschaum, actynolite, rock-cork, rock-wood, diallage, pyrope, opal, chrysoprase, hornstone, amethyst, quartz, and hornblende crystals.

3. *Subordinate Beds.*—The only beds it contains are limestone and euphotide.

4. *Stratification.*—It is scarcely ever stratified, and when traces of stratification do appear, they are very indistinct.

5. *Metalliferous Minerals.*—It always contains magnetic ironstone, either in imbedded grains and masses, or in veins, and these are sometimes so considerable, as to be worthy of being worked as mines. There are mines of this description in the Alps. The chromate of iron, so much valued in the arts, occurs disseminated, also in imbedded masses and in veins in this mountain-rock, in the Shetland Islands, and at Portsoy; also in Provence and in Stiria; and in the New World, in the United States of America. With exception of iron, this rock contains but few metalliferous minerals; nevertheless, near to Joachimsthal in Bohemia, it contains so much galena, that a mine is established in it; in Cornwall, and the Shetland Islands, it contains native copper.

6. *Formations.*—It occurs in beds and mountain masses in gneiss, mica-slate, and clay-slate.

7. *Decomposition.*—On exposure to the weather, its surface becomes earthy, and the colour changes from green to

ochre-yellow, owing to the change of the protoxide of iron into hydrate of iron. It resists the destroying effects of the weather more obstinately than the gneiss, mica-slate, or clay-slate, with which it is associated, and hence peaks and other projecting forms of serpentine, are observed rising through the softer and less durable surrounding gneiss and other rocks.

Like all other magnesian rocks, it is inimical to vegetation. The mountains of which it is composed, are bare and bleak; and this nakedness, joined to the sombre colour, gives a dreary and monotonous aspect to most serpentine districts.

8. *Geographical Distribution.*—It occurs in great beds in the Shetland Islands, along with gneiss, mica-slate, chlorite-slate, and quartz-rock; in beds at Portsoy in Banffshire, along with quartz-rock, trap-rock, mica-slate, and limestone; near Cortachie in Angusshire; near to Drimnadrochit in Inverness-shire; in Sutherland, and other parts of Scotland; and abundantly in Cornwall in England.

It is very abundant in the Alps, in beds, often of enormous thickness. Occurs in the Pyrenees, but not so frequently as in the Alps. Frequent in the mountains of Silesia, Saxony, the Fichtelgebirge, &c.

Common in the mountains of the United States of America. It occurs in the mountains of Valentiana in Mexico, where it alternates with beds of sienite, primitive-trap, and clay-slate; and in the island of Cuba it is associated with sienite.

9. *Uses.*—It is cut and polished, and used as an ornamental stone.

Perhaps ought to be considered a variety of [illegible]

VIII. Euphotide, or Diallage-rock.

Euphotide, *Haüy.*—Gabbro of the *Italians.*

1. *Constituent Parts.*—This rock is composed principally of felspar and diallage; and contains occasionally, in the form of accidental intermixed parts, chlorite, mica, quartz, actynolite, hornblende, garnet, and iron-pyrites. Those varieties that occur in the vicinity of serpentine are frequently intermixed with that rock.

2. *Structure.*—Is disposed in beds, varying in thickness from a few inches to many fathoms, in various primitive rocks,

and sometimes these beds contain cotemporaneous portions of the rocks.

3. *Veins and Imbedded Masses.*—Veins of diallage, chlorite, asbestus, actynolite, steatite, and of the rock itself, occasionally traverse it in all directions; and imbedded masses of various forms and magnitude, of the rock itself, and of the minerals already enumerated, occur in the euphotide of Shetland, and other countries.

4. *Beds in Euphotide.*—It sometimes contains beds of serpentine, or of gneiss, and other rocks, with which it is associated.

5. *Formations.*—It occurs in beds in gneiss, mica-slate, clay-slate, and serpentine.

6. *Decomposition.*—On exposure to the weather it acquires a whitish crust, and frequently splits into numerous angular masses, owing to intermixed thin layers of chlorite; and these in the course of time become disintegrated, and form beds of clay.

7. *Geographical Distribution.*—Occurs abundantly in the Shetland Islands, particularly in the Islands of Unst, Balta, Houna, Fetlar, and Mainland; also in the serpentine districts in Scotland, and in Cornwall in England. Von Buch found it in great abundance in Norway, even so far north as North Cape; and it has been met with in Germany, Switzerland, and Italy.

8. *Uses.*—Some of the varieties, when cut and polished, present a very beautiful surface; hence it is much esteemed in some countries, as Italy, as an ornamental stone. The *Nero* di prato, Verde di prato, Granito di gabbro, of the Italians, are either varieties of euphotide, or of serpentine with disseminated metalloidal diallage.

IX. Porphyry.

Porphir, *Werner.*—Porphyre, *Brochant* and *Daubuisson.*

1. *Name.*—The Grecian word from which the name porphyry is derived, signifies *red;* hence the name of the formation is borrowed from that kind which is denominated Antique Red Porphyry. It is worthy of remark, that red, or

colours bordering on it, or passing into it, prevail in rocks belonging to the porphyry formation.

2. *Composition and Varieties.*—It is a compound rock, having a basis, in which the other cotemporaneous constituent parts are imbedded, either in the form of grains or crystals. Neither the base nor the imbedded parts are always of the same kind. On the differences of the first, depends the distinction of the different kinds of porphyry. The base is sometimes claystone, forming *claystone porphyry*, hornstone forming *hornstone porphyry*, compact felspar forming *felspar porphyry*, pitchstone, when it is named *pitchstone porphyry*; and if it contains much hornblende, it has been named *sienitic porphyry*. The imbedded parts are most commonly felspar and quartz, which are usually more or less perfectly crystallized. The quartz is usually crystallized, and in double six-sided pyramids. The felspar crystals are broad six-sided prisms, but usually very indistinct. The felspar is more or less fresh, sometimes even glassy, sometimes completely disintegrated and earthy, or only in white specks. The frequency and magnitude of these mixed parts, of quartz and felspar, modify the appearance of the different kinds of porphyry very much. Sometimes one, sometimes the other, but more frequently both, occur together, and along with several other minerals which are less frequent, as crystals of hornblende and mica. The basis and the mixed parts of the porphyry also differ in colour and several other properties. It sometimes contains calcedony and agate, which are in massive pieces, or in small layers or plates. Further, there sometimes occur balls of a greater or less size; in clay-porphyry the centre of these balls is calcedony, but their exterior is hornstone porphyry; but in pitchstone-porphyry, these balls are composed of a particular kind of conchoidal hornstone, but the centre is quartz. It sometimes also contains precious and common opal, and these are either disseminated through it, or traverse it in the form of very small veins.

3. *Structure.*—Porphyry is seldom stratified, and when it is stratified, the strata are very indistinct. It is usually either massive, and merely traversed by numerous accidental rents,

or disposed in distinct concretions, which are tabular and columnar, or they are globular, and these, again, are composed of concentric lamellar concretions.

4. *Beds in Porphyry.*—Porphyry contains few beds, with the exception of those of granite, gneiss, and greenstone. One of the best examples of porphyry with beds, is that given by Beudant, who describes three different sorts as occurring in the sienitic porphyry in the environs of Schemnitz in Hungary. These are, 1. Thin beds of mica-slate, that alternate with small granular sienite. 2. Beds of quartz. 3. Beds of compact limestone, impregnated with steatite, and intermixed with serpentine.

5. *Metalliferous Minerals.*—It contains many metalliferous minerals. They occur more frequently in veins than in beds; but as the porphyry is seldom stratified, and as the surface of superposition is not often seen, it is difficult to determine to which of the two kinds of repositories they belong. The richest mines at present known, those of Mexico, are situated in enormous veins that traverse sienitic porphyry. The mines of Hungary, the most considerable on the continent of Europe, are situated in the same kind of porphyry; and it would appear that the famous mines of Cyprus, so much extolled by the ancients, were also in porphyry. The numerous veins of lead, copper, and silver, worked at Giromagny, in the Vosges, are in a porphyry tract.

6. *Formations.*—Porphyry occurs in imbedded masses, beds, and veins, in granite, gneiss, mica-slate, and clay-slate.

7. *Form of Mountains.*—They are often conical, sometimes like truncated cones, or appear dome-shaped.

8. *Geographical Distribution.*—It occurs in the Shetland Islands, in several of the Hebrides, and on the mainland of Scotland, in Sutherland, Ross-shire, Inverness-shire, Perthshire, &c. In England it is met with in Cornwall, and in other districts. On the continent of Europe, it occurs in Sweden; it forms a part of the Vosges, and rises in mountains in the granite district of Forez; also in France. It has not been met with in the Pyrenees, nor is it mentioned as occurring in the Alps of Switzerland, nor in the northern side

of the grand chain of the Alps, but it occupies a considerable tract on the southern side, from the Lake of Como to Carinthia and Carniola. It appears, although not very abundantly, in Silesia, Saxony, and Thuringia, and forms extensive tracts in Hungary. It abounds in some districts in Upper Egypt, Siberia, and in North and South America.

9. *Uses.*—It was formerly used extensively in ornamental architecture, and is still worked in considerable quantity as an ornamental stone, in Elfdal in Sweden, where there are considerable quarries of porphyry.

Quartz-Rock.

Quarz fels, *Werner.*—Quartz en Roche, *Daubuisson.*—
Quartzite, *Brongniart* and *Bonnard.*

1. *Characters.*—Quartz occurs not only as an essential constituent part of granite, gneiss, and mica-slate, and disseminated in beds and veins in these rocks, but also in mountain masses and mountains. Quartz-rock, properly so called, is generally of a white colour, and sometimes reddish or bluish. It has a granular structure; the concretions vary from the smallest size visible to the naked eye, to that of an egg, or even larger; or it is compact. It frequently contains grains of felspar, and also scales of mica. When the felspar and mica increase in quantity, it passes into granite, or into gneiss; when only the mica, into mica-slate.

2. *Structure.*—Occurs either distinctly stratified, or massive, and without the stratified structure.

3. *Metalliferous Minerals.*—It often contains disseminated iron-pyrites, and occasionally lead-glance, copper-pyrites, and blende.

4. *Form of Mountains.*—Mountains of quartz-rock are often conical, sometimes even peaked, or they are crenated.

5. *Geognostic Situation.*—Occurs in beds and mountain masses, in granite, gneiss, mica-slate, and clay-slate, and indeed in a certain degree associated with most of the rocks of the primitive series.

6. *Geographical Distribution.*—Abounds in many districts in Scotland, as in the islands of Jura and Isla, the Shetland

islands; on the mainland, in Sutherland, Caithness, Inverness-shire, Argyleshire, &c.

Class II. Transition Rocks.

Übergansgebirge, *Werner.*—Terrains intermediaires, *Daubuisson.*

The rocks of the primitive class, as already remarked, are distinguished in a general view by their highly crystalline structure, and want of petrifactions, or fossil organic remains. In some countries we observe resting upon them, and even alternating with them, a series of rocks, of which clay-slate is a predominating member, having less of the crystalline aspect, and which contains fossil organic remains. Werner considers this set of rocks as interposed between the grand series of primitive and secondary rocks; and that, although it occasionally alternates, on the one hand, with the primitive, and on the other with some members of the secondary class, still its characters are so well marked, that he views it as a distinct class, to which he gave the name *Transition*, from its forming, as it were, the transition or passage from the primitive to the secondary rocks. Although some mineralogists have abandoned this view, and now arrange the transition rocks along with those of the primitive or secondary classes, we are still inclined to consider them as deserving a separate place in the geognostic system. It is true, that the transition rocks are but a continuation of the primitive, and, on a general view, might with propriety be considered as a portion of that series; but their imbedded fossil organic remains, less crystalline aspect, and particular rocks, such as greywacke, appear to characterise them, if not as a distinct class, yet as a separate group, in the grand series of rock formations.

The following are the rocks of this class:

1. Greywacke.
2. Limestone.
3. Granite and porphyry.
4. Gneiss, mica-slate, &c.
5. Serpentine.

6 Quartz-rock.
7. Red Sandstone.
8. Trap.
9. Gypsum.

I. Greywacke.

is clay slate with imbedded frag

Grauwacke, *Werner.*—Traumate, *Daubuisson.*—Psamite, *Brongniart.*—Breche, Poudingue, and Gres, *of some French geologists.*

1. *Composition.*—It is composed of angular or other shaped portions of quartz, felspar, Lydian-stone and clay-slate, connected together by means of a basis or ground of the nature of clay-slate, which is often highly impregnated with silica, thus giving to the mass a considerable degree of hardness. The imbedded portions vary in size, but seldom exceed a few inches in breadth and thickness. When the imbedded portions become very small, the rock assumes a slaty structure, and forms the *Greywacke slate* of geognosts. When the grains almost entirely disappear, and the rock is principally composed of clay-slate, it is named *transition clay-slate.* This clay-slate has frequently a much more earthy aspect than the varieties found in primitive districts. Besides the greywacke already described, another rock is occasionally met with in transition districts, and is named *transition conglomerate*, or *transition puddingstone.* It is composed of roundish or angular masses of granite, porphyry, gneiss, and clay-slate, often larger than a man's head, imbedded in clay-slate, or nearly without a basis or ground.

Common greywacke does not occur so frequently as greywacke-slate, and transition clay-slate.

2. *Subordinate Beds.*—Transition clay-slate, and greywacke, contain occasionally different kinds of rocks in subordinate beds, or in veins. The following are the principal of these:

a. Quartz.—It occurs in beds, imbedded masses, and veins, and frequently in very considerable quantity.

b. Talc.—This mineral occurs in imbedded masses, and in layers in transition clay-slate.

c. Whet-Slate.—This mineral forms beds in clay-slate.

d. Serpentine.—Beds of serpentine, often of great thickness, and of considerable extent, occur along with transition clay-slate.

e. Lydian Stone.—Beds of this rock occur in clay-slate.

f. Alum-Slate.—This rock is clay-slate impregnated with carbon and sulphur. The sulphur is either combined with the carbon, or united with iron, forming iron-pyrites. On exposure to the weather the sulphur becomes oxygenated, is converted into sulphuric acid, which acts on the alumina of the slate, and thus forms a sulphate of alumina.

g. Drawing-Slate or *Black-Chalk.*—This also is clay-slate, but more highly impregnated with carbon than the alum-slate. When soft it is used as crayons for sketching.

h. Glance-Coal.—This mineral occurs in beds subordinate to varieties of clay-slate and grey-wacke, which sometimes contain vegetable impressions. Of this there are examples in Switzerland and in the kingdom of Saxony.

i. Compact Felspar.—Beds of this mineral occur in the transition clay-slate and grey-wacke of Dumfriesshire, and along with rocks of the same description in France, Italy, and Spain.

k. Greenstone.—This rock is met with in the transition ranges in the south of Scotland, and in similar mountains on the Continent of Europe.

3. *Vegetable Remains.*—Transition clay-slate occasionally contains vegetable impressions, particularly those varieties which are associated with glance-coal. Animal remains are seldom met with in the clay-slate, and still less frequently in the grey-wacke. These are *madreporites, trilobites, ammonites* of a particular description, and *hysterolites,* which are, in some degree, characteristic of this formation, and which appear to be the nucleus of the *terebratulites valvarius* and *paradoxus.* It sometimes also contains *turbinites* and *cumites.* But the rarest and most interesting of the animal remains which occur in transition clay-slate, are those of *fishes,* of which there is an instance at Plattenberg, two leagues south-east of Glaris, in Switzerland. This fact is stated by several

geologists, but we are of opinion, that it has not been fully proved that the rocks of Plattenberg are truly transition.

4. *Metalliferous Minerals.*—Ores of various descriptions abound in grey-wacke and transition clay-slate; thus, the lead-mines of Leadhills and of Wanlockhead, are situated in these rocks, and the same is the case with the productive lead and silver mines of the Hartz in Hanover, of Vorespotack in Transylvania, of Brittany in France, and of Guanaxuato and Zacatecas in Mexico.

5. *Geographical Distribution.*—Grey-wacke and transition clay-slate abound in all the mountain ranges to the south of the Frith of Forth, are also frequent to the north of the same boundary, and are widely distributed in England. On the Continent of Europe they form a principal feature in the mountains of the Hartz, and extend through Switzerland and the Pyrenees. They occur in vast abundance both in North and in South America.

II. Transition Limestone.

Übergangs Kalkstein, *Werner.*—Calcaire intermediaire.—*Daubuisson.*

1. *Characters.*—This limestone is in general more compact than that met with in decided primitive districts; yet it is not always so, for it occasionally occurs coarse granular or highly crystallized. Its fracture is, in general, splintery, usually combined with very minute foliated, and is translucent on the edges. It varies very much in colour. It is often black, and frequently many colours occur together, thus forming the *variegated marbles* of authors. Many of the varieties are traversed by small cotemporaneous veins of calcareous spar. Most of the ornamental marbles used in architecture belong to the transition class, while the statuary marbles are of primitive, and the coarser marbles of secondary formation.

2. *Subordinate Beds and Imbedded Minerals.*—*a. Lydian Stone.*—It occurs abundantly in bituminous transition limestones in the north of France, where it is disposed, either in irregular masses like flint in chalk, or it forms small plates or

tables, or it alternates in beds. The same disposition is met with in the transition limestones of the Pyrenees, Alps, &c.

(*b.*) *Mica* occurs disseminated or in layers, and sometimes associated with talc or steatite.

(*c.*) *Quartz.*—It occurs disposed in veins, beds, or disseminated, and sometimes in the form of rock-crystal.

(*d.*) *Pyrites.*—It occurs massive, disseminated, or in veins.

(*e.*) *Brown Ironstone.*—Occurs in veins and beds.

(*f.*) *Glance-Coal.*—Some varieties of black transition limestone are highly impregnated with carbonaceous matter, which is occasionally accumulated in particular points, thus forming imbedded masses of glance-coal.

3. *Petrifactions.*—Fossil organic remains occur but rarely extensively distributed in this rock, but are sometimes abundantly accumulated in particular situations. Petrified madrepores, millepores, sponges, orthoceratites, and terebratulites, are the most frequent, and along with these are entrochites, encrinites, turbinites, ammonites and belemnites.

4. *Geographical Distribution.*—It occurs, in Scotland, near the Crook, on the road to Moffat, and in other quarters both to the south and north of the Frith of Forth. On the Continent, it occurs at Christiania in Norway; in many places in the Hartz, as at Blankenberg, where there are extensive marble quarries, which afford a marble equal to that named *rosso corallino;* in the country of Bareuth, in Saxony, where there are several beautiful varieties, one in particular, of a black colour, with fragments of entrochi, nearly resembles the *Nero d'Egitto* of the Italians. Werner remarks of this petrifaction, the entrochus, that it occurs most frequently in black marble, while petrified madrepores and millepores are most common in those of a red colour. In the south of France, and in the Pyrenees, it is a very abundant rock; while in the north of France it forms a part of the great transition zone which extends from Flanders to the Hartz.

III. Granite, Sienite, and Porphyry.

The granite, sienite, and porphyry of the transition series, bear a strong general resemblance to those of the primitive class. The nearest point to Edinburgh where these rocks occur is Fassneyburn, about twelve miles from Haddington, where transition granite, and porphyry, and also sienite, are met with. Rocks of the same species are also found in Galloway, and in other parts to the south of the Frith of Forth. To the north of the Forth we may mention the vicinity of Macduff in Banffshire, as an example of transition-granite. On the Continent, one of the most striking displays of these rocks occurs in the vicinity of Christiania in Norway, where the following arrangement was detected by Von Buch and Hausmann.

1. Gneiss. 2. Transition clay-slate and limestone. 3. Granite. 4. Clay-slate and limestone. 5. Greywacke-slate. 6. Flinty slate. 7. Sandstone. 8. Porphyry. 9. Granite. 10. Sienite, with imbedded crystals of zircon.

In this series the gneiss is the undermost, while the zircon-sienite forms the uppermost bed of the series. The limestone, in some places, is white and highly crystallized, and contains tremolite, epidote, garnet, blende, &c. but more frequently it is black and compact, and contains orthoceratites, some feet in length, along with pectinites, chamites, trilobites, &c.

Similar arrangements have been observed in other parts of the world.

IV. Gneiss, Mica-slate.

These rocks occur in small quantity, associated with greywacke and greywacke-slate, in the alpine land to the south of the Frith of Forth, and in some districts to the north of the Forth. An arrangement of the same nature is described by Brochant as existing in Switzerland.

V. Serpentine.

In some districts in the Alps, serpentine occurs in beds in transition rocks.

VI. Quartz-Rock.

It occurs in beds and in mountain masses, along with clay-slate and greywacke, not only on the Continent, but also in this island.

VII. Red Sandstone.

This rock, which is very nearly allied to quartz-rock, occupies the same position as that rock in the primitive series.

VIII. Transition Trap.

Übergangstrapp.—*Werner*.—Amphibolite.—*Daubuisson.*

The transition trap-rocks are amygdaloid, greenstone, and basalt. These occur in beds and in imbedded masses in Dumfriesshire, and other transition districts in the south of Scotland. In Ireland it forms beds in a limestone which appears to belong to the transition series. The trap-rocks of Oberstein, on the Rhine, and of Voightland, also belong to the transition class.

IX.—Transition Gypsum.

Transition gypsum, according to Brochant, is generally white, very fine granular or compact, and contains particles of calcareous spar, scales of mica and talc, and portions of rock-salt and of sulphur. He refers the gypsum of Pesey to this class; also that of Brigg in the Vallais, which is covered with a granular micaceous limestone, and also the deposite in the Val-Canaria. The transition clay-slate of Salzburg also contains beds and imbedded masses of gypsum. M. Von Charpentier is of opinion, that the saliniferous gypsum of Bex is situated in beds in a transition limestone. The gypsum is anhydrous in the middle parts of the beds, but nearer the surface it is in the common state.

Class III.—Secondary or Flœtz Rocks.

Flœtz gebirge, *Werner*.—Terrain secondaire, *Daubuisson.*

Secondary rocks, in the regular succession, rest on those of the transition class; and sometimes the older rocks of the series alternate with clay-slate and other members of the preceding class. They are less crystalline than primitive and transition rocks, and are particularly characterised by the number, variety, and abundance of fossil organic species which they contain. The principal secondary rocks are, Sandstone, Limestone, Gypsum, and Trap.

We shall now describe the different formations of these sandstone, limestone, gypsum, and trap rocks, beginning with sandstone.

I. Sandstone.

This rock is formed of angular or roundish grains of different minerals connected together by means of a basis or ground, or immediately joined without any basis. When the grains are not larger than a hazel-nut, the compound is simply named sandstone, but when they exceed that magnitude, they are denominated *conglomerate*, if the masses are roundish, but *breccia*, if angular. Sandstone is divided into three kinds, named *siliceous*, *argillaceous*, and *marly* or *calcareous*. In the siliceous kind, the particles are connected by a ground or basis of quartz; in the argillaceous by a basis of clay, which is sometimes highly impregnated with red oxide of iron, and gives a red cast to the whole rock; and the particles in the marly or calcareous kind, are set in a marly or calcareous basis.

The following are the formations of sandstone:

1. First, or red sandstone, with the coal formation.
2. Second, or variegated sandstone.
3. Third sandstone, or quartzy sandstone.
4. Fourth sandstone formation.

I. *Red Sandstone, or Old Red Sandstone.*

Œlter rother Sandstein, *Werner.*—Rothe todte-liegende, *German Miners.*—Gres ancien, *Daubuisson.*

1. *Characters.*—The predominating colour of this rock is reddish-brown; but some varieties are grey, and others white. It occurs in the form, not only of sandstone, but also of conglomerate and breccia. The grains in the sandstone are prin-

Chalk Marl

cipally quartz, with occasional intermixtures of felspar, flinty slate, and scales of mica; the roundish and angular masses in the conglomerate and the breccia are frequently of quartz, or of granite, gneiss, mica-slate, clay-slate, porphyry, sienite, quartz-rock, &c. The basis or ground is generally an iron-shot clay, or it is composed of smaller particles of quartz or felspar, as is often the case in the conglomerates and breccias. The basis is sometimes highly impregnated with silica, and then it is very hard; and, in other varieties, it has a porphyritic character.

2. *Subordinate Beds and Veins.*—It contains beds and veins of porphyry, sienite, quartz-rock, slate, limestone, and various trap-rocks, such as amygdaloid, greenstone, basalt, trap-tuff, and pitchstone.

3. *Petrifactions.*—Very few animal remains occur in this formation, although it frequently alternates with a limestone which contains abundance of marine shells and other similar organic productions. But petrified vegetables are not so uncommon, and these are generally of trunks and branches of trees, belonging to the monocotyledonous class, as is proved by their being composed of simple longitudinal fibres, without concentric rings.

4. *Metalliferous Minerals.*—The principal metals found in this formation, are iron, copper, and lead. The iron-ores are the brown and red; the copper ores pyrites and blue copper; and the lead, galena or lead-glance.

5. *Geognostic Situation.*—In Scotland and Ireland it is observed resting on primitive and transition rocks. The same arrangement occurs in Germany, and in other countries on the continent of Europe.

6. *Geographical Distribution.*—It forms considerable tracts of country in Scotland.

Observation.—The transition red sandstone, which is connected with quartz-rock, is nearly allied to the present formation.

Coal Formation.

Coal-measures, or coal-field, *English miners.*—Steinkohlengebirge, *Werner.*—Terrain houiller, *Daubuisson.*—Terrain à charbon de terre, *Older French Geologists.*

This very interesting and important formation consists of a considerable number of different rocks. The following may be enumerated: 1. Coal. 2. Slate. 3. Sandstone. 4. Quartz-rock. 5. Limestone. 6. Ironstone. 7. Clay. 8. Trap. 9. Graphite. Of these rocks, the most frequent are, the sandstone, slate, ironstone, and coal; the others, from their comparative rarity, may be viewed as subordinate members of the formation.

1. *Coal.*—Two species of coal are found in this formation, viz. *black coal*, and *glance coal*, or *blind coal;* the former has a resinous lusture, and is bituminous, and burns with much flame and smoke; while the other is not bituminous, has a metallic lustre, and burns without flame and smoke.

This mineral, whether black coal, or glance coal, occurs rarely in veins, generally in beds, which vary in thickness from a few inches to several yards; and there are rare instances of their attaining a thickness of three hundred feet, as in the vicinity of St Aubin, in Rouergue; but in this case, the coal is disposed rather in enormous imbedded masses, or kidneys, than in true beds. The thickness of the beds often continues wonderfully regular for a great extent; but in other instances, they contract and expand in the line of direction; so that, in the course of the same bed, the thickness will vary from an inch to several yards.

2. *Slate.*—Under this head, we include bituminous shale, slate-clay, and flinty slate.

a. Bituminous Shale.—This mineral is clay, more or less impregnated with coaly matter, of a black colour, with a slaty fracture, and affording a shining resinous streak. It frequently contains impressions of reeds and ferns. It passes into coal, is frequently intermixed with it, or alternates in beds, often of considerable magnitude, with the other rocks of the coal formation.

b. Slate-Clay.—This rock is of a grey, or black colour, with a slaty fracture, and affords a dull streak. It sometimes contains scales of mica, and grains of quartz and felspar; and when these increase in quantity, it passes into sandstone. It frequently contains *vegetable impressions*, which are principally of ferns and reeds. Like bituminous shale, it alternates, in beds of various magnitudes, with the other rocks of the coal formation.

c. Flinty Slate.—The slate-clay is sometimes highly impregnated with silica, and then it is very hard and flinty-looking, and passes into the mineral named Flinty Slate. Imbedded masses, and beds of flinty slate, occur in the slate-clay, and occasionally associated with other members of the coal formation.

3. *Sandstone.*—The predominating mineral in this sandstone is quartz, in granular concretions, which is variously intermingled with flinty slate, felspar, mica, and portions of different species of rock of the primitive species; all of which are generally connected together by a basis or cement of a grey-colour and earthy aspect. Sometimes the earthy basis is wanting, when the grains are joined together in the same manner as in granite and other rocks of the same description. The constituent parts are sometimes so large as to form conglomerates and breccias; but generally they are small, and when much intermixed with clay, pass into slate-clay, and then they contain more vegetable impressions than usual.

4. *Quartz.*—This mineral, in the form of quartz-rock, sometimes occurs in beds.

5. *Limestone.*—A grey-coloured compact limestone sometimes occurs in considerable beds, in coal-fields, and alternates with the various rocks of the formation. In some districts the limestone is abundant; in others it is rare; and in many it is entirely wanting. It occurs in the coal-fields near Edinburgh, and in those in the north of England.

+The trap in this

6. *Iron-Stone.*—This iron-stone, which is sometimes carbonate, sometimes hydrate of iron, occurs in beds that alternate with slate-clay or bituminous shale, or it is disposed in balls and lenticular masses, either irregularly, or in regular rows in the strata. It is a very abundant mineral in most of the coal-fields in Scotland and England, and affords nearly all the iron of commerce produced in Great Britain.

7. *Clay.*—The different kinds of fire-clay, so well known in the arts, occur in beds in the coal formation.

8. *Trap and Porphyry.*—Different species of these rocks are met with in the coal-fields of Scotland, and of other countries. We have observed the following, viz. *Greenstone, Amygdaloid, Basalt, Trap-tuff,* and *Porphyry,* in beds and in veins varying in magnitude and extent.

9. *Graphite,* or Black Lead.—Beds of graphite occur but rarely in this formation. There are examples of this arrangement in Ayrshire.

Arrangement of the beds in the Coal Formation.—Although no very regular arrangement of the beds occurs in this formation, nevertheless it has been remarked that in some districts beds of coal are generally contained in the slate; and that as we recede from the coal, the slate becomes coarser and coarser, and at length passes into sandstone; in others, the sandstone most generally forms the floor, while the roof is of slate; and in others, the coal is covered with trap or limestone, or rests upon these rocks.

In many coal-fields the beds of coal and their accompanying rocks are frequently repeated in precisely the same order, and in nearly the same thickness.

The number of beds of coal superimposed on each other in the same field is very considerable. At Newcastle, twenty-five beds have been penetrated in sinking pits. The hill of Dutweiler in Saarbruck, contains thirty-two beds; at Liége, there are sixty beds, and at Anzin more than fitfy.

Identity of Character of the Formation in different countries.—In Scotland, the predominating and characteristic members of the formation are sandstone, bituminous shale, slate-clay, clay ironstone, and coal. In England we find in all the coal-fields precisely the same sandstones, slates, ironstones, and coals, as in Scotland; and the same is the case in all the coal mines of France, Germany and America. Every where we meet with the same rocks, the same vegetable impressions, and the same general arrangements of the different rocks of the formation.

Stratification.—All the rocks of this formation are stratified, some more, and others less, distinctly. The most perfectly stratified are the sandstone and slate; and those having this structure in the most imperfect degree, are the trap and porphyry rocks. The strata often follow every inequality of the fundamental rock on which they rest; and as the the surface of the fundamental rock is frequently remarkably uneven, the superimposed strata acquire a very irregular and contorted aspect. In some cases the strata do not appear to follow the inequalities of the fundamental rock, but have directions that appear independent both of the surface of the rock, and of the cavity or hollow in which they are contained.

Situation.—The rocks of this formation are generally situated at the foot of mountains, or in bason or trough shaped hollows, which vary from a few hundred yards to many miles in extent. It seldom rises high above the level of the sea, and the countries it forms have generally a waved and soft outline. In this island it rests either on the mountain limestone or red sandstone, and is covered by magnesian limestone and other newer formations.

Dikes.—The strata of this coal formation are frequently traversed by veins, composed of earthy minerals, which are popularly named *Dikes.* These dikes are sometimes only a few inches wide, and not many fathoms in extent; in other cases they are upwards of one hundred feet wide, and extend for some miles. Their direction varies, as also their angle of inclination, which latter ranges from the nearly horizontal to the vertical position. The strata in the walls of the dikes, in some cases, correspond on opposite sides, while in others, the corresponding strata on the hanging side are depressed some feet, or even fathoms, so that miners, in working a bed of coal for example, when stopped in their progress by a dike, do not find it directly opposite on cutting through it, but some feet or fathoms out of the line of bearing of the bed. When the strata present such an appearance, they are said to be *shifted.* The materials of these dikes, or veins, vary, as appears from the following enumeration of the rocks of which they are sometimes formed: Greenstone, amygdaloid, trap-tuff, porphyry, sandstone, and fragments of the various surrounding strata. The strata, where in contact with dikes, appear sometimes of a different nature from the other parts of their mass; thus, beds of coal, where in contact with the dike, appear as if charred, slate-clay hardened, and sand and lime indurated; yet in the midst of these apparently changed portions there occur unaltered minerals, such as calcareous spar, iron pyrites, and clay.

Metalliferous Minerals.—The ores most frequently met with in this formation, are clay iron-ore, and galena or lead-glance. The iron-ore occurs every where in the coal-fields of this island; but the lead-glance is found in quantity only in the coal districts in the north of England and in Wales. Copper, silver, and even gold, are enumerated among the metalliferous productions of this formation; and it would appear that cinnabar or sulphuret of mercury, is sometimes also contained in it.

Petrifactions.—Mineralized organic remains are not unfrequent in the coal-fields of different countries; and it is worthy of remark, that hitherto the same tribes and species have been met with in the coal formations of Great Britain, Ireland, Germany, and France, as in North America and New Holland. Both vegetable and animal remains occur, but of these the former are by far the most varied and abundant. The impressions of plants are frequent, both in slate-clay and bituminous shale; and we do not recollect a coal-mine where these rocks have not been found to contain organic vestiges of this description. Many belong to the monocotyledonous class of plants, such are the *large reeds* and *bamboos;* besides these, we meet with numerous remains of *ferns,* and species of the genera *lycopodium, equisetum, eu-*

phorbia, casuarina, &c. Impressions of the branches and fruit of palms, or of vegetables resembling this order, are also occasionally met with. None of these plants are identical with any of the present known living species; and many of them have a tropical aspect.

These vegetable remains seldom occur in the coal, but are abundantly distributed in the slate, particularly where it is near the surface of the bed of coal; and the most frequent remains are those of leaves or of flattened trunks, sometimes changed into coal, enclosed in the layers of the slate; but in other instances the reeds, and other vegetables of large diameter, are upright, and are filled with clay, or with the same substances as that in which they are contained.

The animal remains found in the coal formation are principally of shells, and of these the most frequent are those which resemble the fresh-water species; such are the different species of mytulites.

Origin of Coal.—Two opinions are entertained in regard to the origin and formation of coal. According to the one it is of vegetable origin; and according to the other it is an original chemical formation. Its chemical properties, and numerous accompanying vegetable remains, which are sometimes changed into coal, are the principal facts adduced in favour of its vegetable origin; while its distribution in regular conformable beds, its occurrence in veins, and imbedded masses, its manifold alternations and connections with different strata, some of which never contain vegetable remains, its rhomboidal structure, external characters, its connection with glance-coal, on the one hand, and with bituminous shale and sandstone on the other, are the appearances which are considered as illustrating its formation as an original deposit from a state of chemical solution.

2. *New Red or Variegated Sandstone.*

Bunter Sandstein, *Werner.*—Red Ground, *English Geologists.*—New Red, *Buckland.*—Second formation de Gres, et Gres avec argile, *Daubuisson.*—Gres bigarre, *French Geologists.*

Characters.—It is small granular, with an argillaceous or marly basis. Its colour varies extremely, being frequently disposed in bands or zones, of red, grey, green, yellow, and brown; hence the name *variegated*, given to it by Werner. These different colours are owing to the different states of oxidation of the iron in the basis or cement; but it may be remarked, that the dark colours are often superficial, the interior of the rock being of a grey or white colour, while the exterior, by exposure, becomes brown or red.

This sandstone frequently contains masses of variously coloured clay or marl, which are often lenticular, vary much in size, and contribute to increase its liability to decomposition. The clay is sometimes greasy to the feel, and forms a kind of fuller's earth. Although the most common cement or basis of this sandstone is clay, yet some beds have a marly, and others a quartzy basis.

It sometimes contains mica, and occasionally in such quantity, that it passes into sandstone-slate.

It alternates with beds of a red-coloured clay, or marl, which is often slaty, and generally intermixed with sand and mica, and sometimes passes into sandstone-slate. These beds are sometimes of great thickness, and from their being frequently short, and very thick, appear like great imbedded masses. Sometimes the marly or calcareous sandstone passes into limestone. The colouring principle in the clay is occasionally so abundant in some parts of the beds, that a red crayon is formed. The thick beds of clay occur principally towards the upper part of the formation, which indeed is principally red clay. Sometimes beds of conglomerate occur associated with the sandstone, marl, and clay.

Subordinate Beds.

1. *Limestone.*—Beds of limestone are met with in this formation; but, in general the limestone is very impure, being mixed with clay and sand; and thus forms a more or less arenaceous marl.

2. *Oolite or Roe-stone.*—This curious kind of limestone occurs but in small quantity, and generally in beds varying from a few inches to two or three feet in thickness.

3. *Iron-ore.*—The principal ore of iron met with in this formation, is the red ore, which occurs either in imbedded portions, disseminated, or so minutely diffused, as to colour some of the sandstones of a deep red colour.

4. *Heavy Spar, Sulphate of Barytes.*—This mineral occurs in veins in the sandstone.

5. *Celestine or Sulphate of Strontites.*—This mineral occurs in the clay and sandstone, in the form of veins and beds, near Bristol.

6. *Gypsum.*—It occurs in imbedded masses, beds and veins, in the marl or sandstone of this formation.

7. *Rock Salt.*—The salt of the principal salt mines in Europe is arranged in beds, and imbedded in this formation.

8. *Copper Ore.*—Traces of copper ore are rarely met with in this formation.

9. *Coal.*—This mineral occurs very rarely, and usually in inconsiderable beds.

10. *Petrifactions.*—The most frequent petrifactions are pectinites, pinnites, pholades, turbinites, and large ostracites; and sometimes petrified wood, and impressions of leaves.

Geognostic Situation.—It rests upon the magnesian or second limestone, and sometimes even alternates with it, and is immediately covered with the oolite formation.

Geographical Distribution.—It is a very widely distributed formation in England, extending, with little interruption, from the northern bank of the Tees in Durham, to the northern coast of Devonshire: Also occurs in Scotland, particularly in the southern division.

3. *Third Sandstone Formation.* 7

Green Sand of *English Geologists.*—Troisieme Formation de Gres, *Daubuisson.*—Quader-Sandstein, *Werner.*—Gres presque entièrement quartzeux, *French Geologists.*

This formation, the characters of which are still but imperfectly known, is described by English Geologists, under the name Green-sand, and, according to Mr Buckland, is associated with various strata

Characters.—The sandstone is composed of particles of white quartz, which are either cemented by a calcareous basis, or are united without any cement, and frequently contain scales of mica, and imbedded grains and portions of a green substance, of the nature of chlorite or augite.

The quartzy particles are sometimes so arranged and connected, that the sandstone is as massive and compact as quartz, while, in other instances, it occurs in the state of loose grains or sand.

It frequently contains imbedded cotemporaneous masses of *chert*, and the same mineral occurs also in beds; and sometimes both the green-sand and chert are traversed by veins of calcedony.

Subordinate Beds.—Limestone of a blue and reddish colour in the form of beds, is occasionally met with, and sometimes the limestone is also distributed through the sandstone in masses of varying magnitude. Mr Buckland enumerates the following beds as occurring in this formation: 1. Lead-coloured clay; 2. Micaceous and sandy blackish clay, with disseminated green earth; 3. Iron-sand, usually red and yellow, and containing subordinate beds of clay, ochre, and fuller's earth, either pure, or inclosing nodules of heavy spar.

Petrifactions.—It contains musculites, mytilites, and tellinites, and sometimes impressions of leaves and stems resembling those of the palm-tree and the pine.

Coal.—It sometimes contains beds of coal, but these are in general so thin, as to be of no value in an economical point of view.

Geognostic Situation.—It rests upon the upper oolite, and is covered by the chalk formation.

Geographical Distribution.—It occurs abundantly in England, as in Wilts, Dorset, Sussex, Devon, Oxford, Isle of Wight, Surrey, &c. And on the Continent of Europe it is met with, both in Upper and in Lower Saxony.

4. *Fourth Sandstone Formation.* 9

This formation is associated with the rocks that rest upon chalk, and will, therefore, be describd along with these.

II. Secondary or Flœtz Limestone.

The limestones of this series are more compact and less translucent than those of the transition class; and, further, they abound much more in organic remains of different kinds. The following are the formations which have been enumerated by authors, viz.

1. First Secondary Limestone.
2. Second Secondary Limestone.
3. Third Secondary Limestone.
4. Fourth Secondary Limestone.
5. Fifth Secondary Limestone.

1. *First Secondary Limestone.* 3.

Premier formatoin du Calcaire Secondaire, *Daubuisson.*—Alpine and Jura Limestones of German, and some French Geologists.—Mountain Limestone of English Geologists.

Characters.—The colours of this limestone are grey, blue, and black. Its lustre varies from glistening to dull; the fracture is splintery, or granular foliated; and it is opaque or translucent in the edges. Some of the varieties are *stinkstone*, while the black varieties are those known under the name *lucullite*, and both these, when pounded, emit a very disagreeable smell.

Stratification.—It is distinctly stratified, and the strata are sometimes undulated and contorted.

Caves and caverns are not unfrequent in this formation, and extensive fissures frequently traverse it, which either reach to the surface, or extend to a greater or less distance under ground, and afford channels for great springs and subterranean rivers.

It frequently contains imbedded portions and beds of Lydian stone, of quartz in the form of *chert*, which is either of a grey or black colour, and very much resembles the flint in chalk, in the various relations it bears to the limestone.

Petrifactions are not unfrequently met with in this formation; and the following are the kinds which have been found in England, viz. entrochites, tubeporites, encrinites, corallites, madreporites, ammonites, pectinites, orthoceratites, &c.

Subordinate Beds.—These are amygdaloid, greenstone, trap-tuff, and basalt; also sandstone, magnesian limestone, slate-clay, bituminous shale, coal, and clay.

Metalliferous Minerals.—This formation in some districts, as in the north of England and in Derbyshire, is particularly abundant in ores of different descriptions. The lead-mines of Northumberland and Durham, and the lead and copper-mines of Derbyshire, are situated in mountain limestone.

Geognostical Position.—In what is called the regular succession, it comes immediately after the old red sandstone, and therefore rests upon it.

Geographical Distribution.—It abounds in the North of England, also in Derbyshire, Wales, and Gloucestershire.

Observations.—It is said to occur sometimes in clay-slate, and also in the coal formation.

2. *Second Secondary Limestone.*

Erster Flœtz Kalkstein, *Werner?*—Magnesian Limestone of English Geologists.

Characters.—The colours of this limestone are yellow, and sometimes brown and grey. It is generally small granular, and glimmering or glistening. One variety is flexible. It contains about 20 *per cent.* of carbonate of magnesia. Its surface is, in many places, covered with a poor herbage, uncommon in limestone, which is said to be owing to the magnesia, which is known to be unfavourable to vegetation.

Petrifactions.—Organic remains are found in it, such as madreporites, encrinites, producti, and fishes.

Geognostic Position.—It rests upon the coal formation, and sometimes alternates with new red sandstone, and with a breccia composed of angular portions of sandstone and limestone, cemented by magnesian limestone. When it comes in contact wi h coal it deteriorates it. It frequently contains imbedded balls of fetid limestone, from the size of a pea to two feet in diameter, which have a stellular radiated structure. The limestone containing these balls, is generally soft, marly, and magnesian, although the balls themselves contain no magnesia. It forms hills in some places 600 feet high.

Geographic Situation.—It abounds in some districts in England; thus it extends from Sunderland to Nottingham; the coal formation near Whitehaven lies under it, and the same is the case in Derbyshire.

3. *Third Secondary Limestone.* 7

Muschel Kalkstein, *Werner?*—Oolite *of Buckland.*—Lias and Oolite of others.

Geognostic Situation.—This formation, according to Mr Buckland, is divided into the following principal members: viz. *Lower Oolite*, including the *Lias Limestone.* 2. *Middle Oolite.* 3. *Upper Oolite.* The first or lower oolite rests upon the variegated or new red sandstone, and the upper oolite lies immediately under the third sandstone-formation. The following is Mr Buckland's account of this formation.

1. *Lower Oolite or Lias.*—The lowest member of this portion of the series, or that which rests upon the new red sandstone, is the *lias*, which is a blue, grey, or white argillaceous limestone, disposed in thin beds, in a bluish-grey slaty marl, or clay. It rarely contains chert, more frequently various petrifactions, such as ammonites, pentacrinites, plagiostomites, ostracites, and occasionally remains of crocodiles, as near Lyme, in Dorsetshire.

Geographic Situation.—It extends from a little to the west of Ilchester, in Somersetshire, by Bath and Gloucester, nearly through the centre of England, and terminates a little beyond Lincoln. A few miles beyond Gloucester, it rises to the height of 1124 feet above the sea.

Above the *lias* is the *sand of the inferior oolite*, which is thus described by Buckland.

Sand of inferior oolite.	Fine grained yellow, micaceous, loamy sand. Green and yellow calcareo-siliceous sandstone, highly micaceous. Green and yellow sandy marl, abounding in large concretions, called sand bats.

It occurs in Gloucestershire, Somersetshire, and Oxfordshire.

Above this sand, sandstone and marl, is the *inferior or bastard oolite*, described as a coarse calcareous freestone, granular, with shelly fragments, and usually ferrugineous. It occurs around Grantham, and in other parts of England.

The inferior or bastard oolite is immediately covered by *fuller's earth*, which forms the uppermost layer of the lower oolite. This fuller's earth occurs in layers in a grey-coloured clay, in the middle region of hills around Bath.

2. *Middle Oolite.*—The lowest member of this series is named *Great Oolite*, or Ketton Stone, and is described as a durable yellow freestone, composed of oolitic concretions and shelly fragments, united by a calcareous cement. It occurs at Ketton in Northamptonshire, and Windrush in Oxfordshire. Resting on it is the next member of the series, named *Stonesfield Slate*, which is a calcareo-siliceous oolite, sometimes passing into sand, and associated with thin beds of bad coal. The coal of Cleaveland Hills, in Yorkshire, belongs to this slate. Above the Stonefield slate is the *Forest marble*, which is a coarse slaty limestone, full of large fragments of shells (Yeovil marble,) and met with near Bath, and in Dorsetshire. The *Cornbrash* rock lies upon the Forest marble, and is a soft earthy, yellow limestone, often blue and sandy, and occurs in Oxfordshire, and in Wiltshire. Resting on the Corn-brash is the *Kelloway rock*, which is a coarse sandy limestone, with many peculiar ammonites, and other shells, found at Kelloway Bridge, near Calne, in Wilts. A thick deposit of clay, named *Oxford*, *Forest*, or *Fen Clay*, is the next member of the series. The clay is of a bluish-grey

colour, and includes hard and large septaria. It occurs in the Vale of Thames, from Oxford upwards; Vale of Ouse, from Bedford downwards; and the Vale of Blackmore, Dorset.

3. *Upper Oolite.*—The lowest member of this series, or that next in succession to the uppermost of the middle oolite, is a *calcareous grit* or *sandstone.* It is a siliceous sand, and sandstone with calcareous cement, often shelly, and is met with at Filey, near Scarborough, in Yorkshire, and near Abingdon in Berks. The next member of the series is *Coral rag*, which is a loose earthy oolite limestone, full of coralline remains, and found at Kiddington, near Oxford; at Highworth and Calne Wilts; and Kirby Moorside, Yorkshire. *Oxford oolite* is the next rock of the series. It is a perishable freestone, composed of oolitic concretions and shelly fragments united by a calcareous cement. It occurs at Heddington in Oxfordshire; Calne, Wilts; and New Malton, Yorkshire. *Kimmeridge clay* is the rock next in succession. It is a blue slaty clay, with selenite, and is sometimes highly bituminous: Occurs at the base of Shotover Hill, near Oxford; in the Island of Portland; and at Kimmeridge, in Isle of Purbeck, Dorset. Above the Kimmeridge clay is the *Portland stone,* which is a calcareo-siliceous durable freestone, often oolitic, containing beds and nodules of chert. It occurs in the Isles of Purbeck and Portland; Chilmark, Wilts; Twindon, Aylesbury. The uppermost rocks of the series are the *Purbeck beds.* These are strata of slaty clay and marl, alternating with beds of coarse shelly limestone. They occur at Sandwich, Lulworth Cove, and Upway, Dorset; Lady Down, near Tisbury, Wilts.

4. *Fourth Secondary Limestone, or Chalk.*

Kreide-Gebirge, *Werner.*—Formation crayeuse, *Daubuisson.*

This formation consists of three members, viz. *chalk-marl, hard chalk*, and *soft chalk.*

1. *Chalk-Marl.*—This is an argillaceous grey coloured chalk, without flints or cherts, passing into a fine micaceous

grey sand, or into a grey marl or clay. It rests upon the third sandstone formation, which therefore separates it from the oolite formation. It occurs at Benson in Oxfordshire; Cherhill and Norton, Bevant, Wilts; Lewes; Guilford; Folkstone; Byarsh near Wrotham, Kent.

2. *Hard Chalk or Lower Chalk.*—This chalk is harder than that which forms the upper part of the formation, and is sometimes of a brick-red colour. It contains few flints or petrifactions. It occurs near Warminster, Shakespeare's Cliff, Dover; Flamborough Head, Yorkshire; county of Antrim, Ireland. The red varieties occur in Lincolnshire and Yorkshire.

3. *Soft Chalk or Upper Chalk.*—This is the common chalk of mineralogists, which is soft enough to mark with. It contains abundance of flint, in the form of tuberose, roundish, and ovoidal masses, either irregularly distributed in the mass, or disposed in horizontal layers: the flint is sometimes also arranged in beds, which occasionally extend, without interruption, for more than a mile; and, in other cases, veins of flint traverse the chalk in all directions. The flinty masses are sometimes hollow in the centre, and the walls of the cavities are lined with crystals of common quartz. The petrifactions found in the chalk and flint are belemnites, echinites, alcyonites, spongites, ostracites, pectinites, terebratulites, ammonites, plagiostomites, milleporites, &c.; also teeth and palates of fishes of the shark tribe. At the Hill of St Pierre near to Maëstrich, the remains of a species of *monitor* have been found in a kind of chalk.

Both the hard and soft chalk occur stratified: the strata are generally horizontal; sometimes inclined at a considerable angle, or even perpendicular; and there are instances, as in the Isle of Wight, of perpendicular strata meeting with horizontal, and also of horizontal, or slightly inclined strata resting on vertical strata. Metalliferous minerals occur rarely in this formation, and almost the only species hitherto met with is iron-pyrites, which is sparingly disseminated through the chalk.

Geognostic Situation.—It rests upon the third sandstone formation.

Geographic Situation.—Chalk does not occur any where in Scotland; but in England it forms extensive tracts of country, and has been traced from near Sidmouth, in Devonshire, to Filey Bay in Yorkshire.

5. *Fifth Secondary Limestone.*

This formation is one of the members of the series above chalk, and will be included in the description of the Paris formation.

III. Secondary Gypsum.

Flœtz Gyps, *Werner.*

There are two principal formations of this rock; one is associated with the rocks of the variegated or new red sandstone, and the other is a member of the series above chalk, or what is called the Paris formation.

1. *First Secondary Gypsum, including Salt.*

Erster und Zweiter Flœtz Gyps, and Steinsalzgebirge, *Werner.*

Characters.—It occurs granular, foliated, fibrous, compact, in crystals (selenite,) and sometimes anhydrous. Its principal colours are white and grey, seldom red or brownish. It occasionally contains imbedded crystals of different kinds, such as quartz, boracite, arragonite, and sulphur; and sometimes disseminated and imbedded masses of clay, marl, sandstone, limestone, sulphur, and salt.

Subordinate Beds.—It contains beds of marl, clay, limestone, sandstone, sulphur, and salt. These beds of salt afford the mineral salt of commerce, and are worked in the salt-mines of Cheshire, Austria, and Poland.

Structure.—It is either distinctly stratified, or is disposed in short, but thick and unstratified beds. Caves varying in magnitude from a few yards to many fathoms in extent, occur in it; and of these there are striking examples in Thuringia, and in other countries. It is conjectured that they owe their origin to masses of salt they formerly contained, and which have been removed in the course of ages by the action of subterranean waters. The magnitude of these caves is further increased by the action of percolating water traversing the gypsum itself. Frequently the roofs of the caves yield and fall in, and thus hollows, often funnel-shaped, are formed in the surface of the country.

Petrifactions.—It rarely contains petrifactions; and of these, species of the following genera have been met with; viz. madreporites, ammonites, tellinites, and branches and trunks of trees variously bituminized.

Geognostic Situation.—It is contained in, or rests upon, the new red or variegated sandstone.

Geographic Situation.—It occurs but in small quantities in Scotland, whereas in England it is abundant in some districts, as in Cheshire, Worcestershire, &c.

2. *Second Secondary Gypsum.*

This formation occurs along with the rocks of the Paris formation, and will be described under that head.

IV. Secondary or Flœtz-Trap Rocks.

Under this division we include, as a matter of convenience, the secondary traps and porphyries. We shall first describe the Traps, and next the Porphyries.

Secondary Trap.

Flœtz-Trap, *German Mineralogists.*

The rocks of this series are compounds of hornblende, augite and felspar. The following are the different kinds of these rocks, viz. 1. Greenstone; 2. Syenite; 3. Amygdaloid; 4. Wacke; 5. Basalt; and, 6. Trap-tuff.

1. Greenstone.

Grünstein, *Werner*.

Composition.—Is a granular aggregate rock, generally of a green colour, of which there are two principal kinds, one composed of hornblende and felspar, and another of augite and felspar. The first kind may be named *Hornblende-greenstone*, the second *Augite-greenstone*. The felspar is generally grey, or of a greenish tint, rarely reddish, and is either compact or foliated; the augite, and also the hornblende, are of a dark blackish-green, or even in some instances of a nearly pure black colour. Of these ingredients the hornblende and augite are the most abundant, the felspar the least frequent, hence the general dark green colour of greenstone. It varies from rather coarse granular to compact, when the concretions are only discernible by means of their glimmering, and then the mass has much of the basaltic character.

Imbedded Minerals.—These are augite, basaltic hornblende, common felspar, glassy felspar, compact felspar, calcareous spar, steatite, mica, diallage, magnetic and specular iron, and iron-pyrites. In the true porphyritic greenstone, as that of Arthur Seat, the imbedded crystals are of felspar*.

Structure.—It is sometimes amygdaloidal, and the amygdaloidal portions are of zeolite, calcareous-spar or quartz. Frequently it is disposed in columns or pillars, and these are again composed of globular and concentric lamellar concretions. Sometimes the whole mass of the bed is arranged into balls or globular concretions, or is disposed in tabular concretions. The beds vary in thickness from a few inches to many fathoms, and in the thicker beds stratification is discernible.

Cotemporaneous Veins.—Very often beds of secondary greenstone include veins of various descriptions that appear to be of cotemporaneous formation with the rock. The fol-

* In some imperfectly known greenstones, hypersthene is substituted for hornblende; this aggregate may be named *Hypersthene Greenstone*.

lowing enumeration contains a few of the veins met with in the secondary greenstones of Scotland:

1. Calcareous-spar. 2. Calcareous-spar and quartz; the quartz sometimes in the form of amethyst or rock-crystal, but more frequently as common quartz. 3. Calcareous-spar, common quartz, and calcedony. 4. Calcareous-spar, heavy-spar, and quartz. 5. Calcareous-spar, and heavy-spar, with glance coal. 6. Calcareous-spar, heavy spar, and brown hematite. 7. Quartz, with red hematite and iron-glance. 8. Calcareous spar, brown spar and sparry iron. 9. Calcareous spar, heavy spar, prehnite, and zeolite. 10. Felspar, either grey or red. 11. Iron-pyrites. 12. Red cobalt. 13. Yellow copper-pyrites.

Petrifactions.—Fossil organic remains are of rare occurrence in trap-rocks. Petrified shells have been found in greenstone, and also in that slaty rock (slaty compact felspar) frequently associated with it.

Geognostic Situation.—Occurs in beds, imbedded masses, mountain-masses, and veins, in the old red sandstone, coal formation, variegated sandstone, and in various secondary limestones. Veins occur in primitive and transition districts. It is occasionally associated with *secondary syenite* *.

Geographic Situation.—It is a very abundant rock in the sandstone and coal districts of Scotland, and is not unfrequent in many primitive and transition tracts also in this country. Veins of it traverse the coal formation in the North of England, and although met with in other parts of England, is by no means so abundant as in Scotland.

2. Syenite.

Composition.—Is a granular aggregate rock, of a grey, white, or reddish colour, composed of felspar and hornblende, with occasional intermixtures of quartz, mica, epidote, and chlorite.

In this rock the felspar is the predominating ingredient, while, in greenstone, as already mentioned, the hornblende or augite are the most abundant constituent minerals.

* Also in veins in primitive rocks.

Structure.—It occurs massive, disposed in columns, in globular, and also in lamellar concretions.

Geognostic Situation.—It occurs in mountain masses, beds, and rarely in veins, in alpine limestone and red sandstone districts.

Geographic Situation.—The Craig of Ailsa, at the entrance of the Frith of Clyde, is formed of secondary syenite, it also occurs in Arran, St Kilda, Island of Skye, and other parts of Scotland.

3. Amygdaloid.

Mandelstein, *Werner*.

Characters.—This rock has a basis or ground including amygdaloidal portions of various minerals. The basis or ground is generally an intimate combination of hornblende or augite, with felspar in a very imperfectly crystallized state, or with impure claystone. Its colour is frequently green; sometimes reddish, when much iron-shot; or nearly black, when the predominating material is hornblende or augite. The amygdaloidal masses vary in their nature; some are calcareous-spar, or brown spar, or heavy spar, while others are green earth, quartz, agate, calcedony, heliotrop, amethyst, steatite, or lithomarge, zeolites of various kinds, and also fluor and arragonite occur in the cavities of amygdaloid.

Imbedded Minerals.—Besides amygdaloidal masses, the rock sometimes contains crystals of felspar, augite, or hornblende, thus affording examples of the union of the amygdaloidal and porphyritic structures.

Structure.—It occurs in columnar, globular, and also in tabular distinct concretions; and occasionally it is imperfectly stratified.

Geognostic Situation.—It generally occurs in mountain masses or beds, and sometimes in veins, and principally associated with rocks of the sandstone and limestone series.

Geographic Situation.—It is an abundant rock in the south and middle divisions of Scotland, both on the mainland and among the islands, as in Arran, Mull, Rum, Eigg, Canna, and Sky.

4. Wacke. an earthy greenstone

Wacke, *Werner*.

Characters.—This rock has generally a greenish-grey colour; less frequently it is reddish, or of a brown or blackish cast. The fracture surface is dull, or only faintly glimmering, and the fracture is even or flat conchoidal. It is opaque, and more or less shining in the streak; soft and sectile; easily frangible; and specific gravity about 2.8.

Composition.—It appears in many cases to be a very intimate combination of earthy augite or hornblende and earthy felspar.

Structure.—Sometimes occurs in globular and imperfect columnar concretions, and occasionally it has the amygdaloidal structure.

Geognostic Situation.—It occurs in beds, imbedded masses, and in veins in sandstone and limestone.

Geographic Situation.—It occurs along with amygdaloid and greenstone in our coal-fields in different parts of Scotland, and also in the new red sandstone and some other secondary formations.

5. Basalt.

Basalt, *Werner*.

Characters.—Its colours are generally greyish or greenish black, and rarely inclines to grey. Internally it is dull or feebly glimmering. The fracture in the coarser varieties is large or small grained uneven; of the more crystalline varieties, even inclining to large and flat conchoidal, and seldom to splintery. It is opaque, or feebly translucent on the edges. It yields a pale grey-coloured streak. It is semi-hard, bordering on hard. It is rather brittle, and is difficultly frangible. Specific gravity = 3.08.

Composition.—There are two kinds of basalt; one is an intimate combination of hornblende and felspar, and the other of augite and felspar. The felspar generally appears to be the compact kind.

Structure.—It occurs in distinct concretions of various descriptions. They are generally columnar, varying from a few inches to some fathoms, even to upwards of 100 feet in length, and from a few inches to 10 or 12 feet in thickness; the number of sides varies from three to nine, and of these the nine-sided are the rarest; they are either straight or curved, and either parallel or diverging; sometimes they are articulated, and the joints have concave and convex faces. In mountains, these concretions are collected into large groups, and many of these groups or colossal concretions form a hill or mountain. Sometimes it occurs in tabular, sometimes in globular concretions; these latter are frequently composed of concentric lamellar concretions, or of columnar concretions radiating from a centre. Some varieties are composed of large, coarse, and fine granular concretions.

There is sometimes a tendency to stratification, and varieties occur with the amygdaloidal, and also with the porphyritic structures.

Imbedded Minerals.—The most frequent imbedded minerals are olivine and augite; besides these, grains and crystals of felspar, and also of basaltic hornblende, calcareous-spar, and magnetic iron-ore, are met with.

Decomposition.—Some varieties are easily decomposed, particularly those that incline to wacke and amygdaloid, while others long resist the action of the atmosphere. The earth formed by their decomposition has a greasy feel, and the great fruitfulness of basalt countries is owing to this basaltic earth. Sometimes the imbedded minerals decompose, at length fall out, and thus leave the basalt with a vesicular structure. Olivine is one of the most easily decomposable of the simple minerals met with in basalt, being even more easily broken by the influence of the weather than calcareous-spar; on the contrary, we often find augite and hornblende unchanged, after the basalt has been reduced to a clayey mass.

Forms.—It occurs frequently in the form of mountain caps, having tabular or conical forms; or it is distributed in long ridges, or in scalarlike cliffs and terraces.

Geognostic and Geographic Situations.—It occurs in beds, imbedded masses, mountain masses, and veins in sandstone and limestone formations in Scotland, England, and Ireland.

6. Trap-tuff.

Trap-tuff, *Werner.*

Composition.—This rock has a conglomerated structure, and therefore has a basis or ground, with imbedded masses of various forms and sizes. The ground or basis varies in its nature; sometimes it is wacke or greenstone, or it inclines to basalt or amygdaloid. The imbedded masses, which are of various roundish and indeterminate angular forms, are of wacke, amygdaloid, greenstone, and basalt; and intermixed with these are sometimes masses of sandstone, limestone, slate-clay, bituminous shale, and jasper. The masses vary in size, from that of a pea, to several yards, or even fathoms, in length, breadth, and thickness.

Petrifactions.—It sometimes contains trunks and branches of trees, more or less bituminised.

Structure.—It occurs in beds, which are from a few inches to many fathoms in thickness; is sometimes distinctly stratified, and occasionally it is disposed in globular distinct concretions, the balls varying from a few inches to several feet in diameter, and also in columnar concretions.

Geognostic Situation.—It occurs in imbedded masses, mountain masses, beds, and veins, along with the other rocks of the secondary trap series already enumerated.

Geographic Situation.—A considerable portion of Arthur Seat is composed of this rock; it abounds in many of our red sandstone and coal districts, and is very frequently met with among the Hebrides, as in Canna and Eigg.

Secondary Porphyry.

Flœtz-Porphir, *German Mineralogists.*

The secondary porphyries are composed of felspar in various states of aggregation, also of hornstone and pitchstone, with intermixed grains and crystals of felspar, quartz, and other minerals.

The following are the rocks arranged under this head:

1. Claystone. 2. Claystone-Porphyry. 3. Felspar. 4. Felspar-Porphyry. 5. Clinkstone. 6. Hornstone-Porphyry. 7. Pitchstone. 8. Pitchstone-Porphyry.

1. *Claystone.*

Thonstein, *Werner.*

This rock, which is described in p. 336, appears to be felspar in a comparatively loose state of aggregation. It is sometimes conglomerated, and then is named Claystone-tuff. It is disposed in beds and veins in sandstone districts, and in coal-fields both in England and Scotland. It always accompanies rocks of the secondary porphyry formation.

2. *Claystone-Porphyry.*

Thonstein Porphir, *Werner.*

Composition.—This porphyry, as its name intimates, has a basis of claystone, in which imbedded crystals of felspar are contained.

Structure.—It occurs in columnar, tabular, and globular distinct concretions; is sometimes conglomerated, rarely vesicular, and occasionally imperfectly stratified.

Imbedded Minerals.—These are felspar, quartz, either in grains or in double six-sided pyramids, mica, augite, hornblende, and iron-pyrites.

Petrifactions.—Trunks, branches, and twigs of trees, occur imbedded in this rock, and these are generally penetrated or petrified with wood-stone.

Geognostic Situation.—It occurs in mountain masses, imbedded masses, beds and veins, in secondary sandstone and limestone districts, and is frequently associated with the secondary trap-rocks.

Geographic Situation.—The Pentland and Ochil Hills, near Edinburgh, contain abundance of secondary porphyry, and the same is the case in some districts in the south and north of Scotland, and also in England and Ireland. It is a frequent rock in similar situations on the Continent of Europe.

3. *Felspar.*

This mineral occurs as a mountain rock, with red or grey colours, and either very minutely foliated, or in a compact state.

Geognostic and Geographic Situations.—It occurs along with porphyry and claystone, in the Pentlands and Ochils; also in Arran, and in several places on the east coast of Scotland, associated with old red sandstone.

4. *Felspar-Porphyry.*

Felspath-Porphir, *Werner.*

This rock differs from the preceding, in always containing imbedded grains and crystals of felspar.

Geognostic and Geographic Situations.—It occurs along with claystone porphyry, and other rocks of this series, in the Pentlands and Ochils, and in other parts of Scotland.

5. *Clinkstone Porphyry, or Porphyry-Slate.*

Klingstein-Porphir, *Werner.*—Phonolith, *Daubuisson.*

This rock has a basis of that kind of felspar named Clinkstone, with imbedded crystals of felspar, whence it is named clinkstone-porphyry, or porphyry-slate, from its slaty structure. The colour of the basis is greenish, yellowish, smoke, bluish, or ash grey; sometimes also blackish-green, and, when much impregnated with iron, liver-brown and reddish-brown. Sometimes several colours occur in the same mass, and it is occasionally marked with greyish-coloured spots, and frequently shews dendritic delineations on its surface. Its fracture is splintery in the small, but slaty in the large. Hardness same as that of felspar. It is more or less translucent on the edges, and some varieties are opaque.

Imbedded Minerals.—Besides the imbedded grains and crystals of felspar, it also occasionally contains crystals of augite or basaltic hornblende, zeolite in drusy cavities, and very seldom quartz, calcareous-spar, iron-pyrites, and iron-sand. It is sometimes vesicular.

Structure.—It is frequently arranged in columns and tables, like those of basalt.

Decomposition.—It long resists the action of the weather, but in course of time it becomes covered with a thin crust, which has usually a greyish-white colour in the pure, but a reddish colour in the ironshot varieties.

Forms.—Like basalt, it frequently forms conical and tabular hills, and exhibits numerous, striking and rugged cliffs.

Geognostic Situation.—It occurs in mountain masses, imbedded masses, beds, and veins, in red sandstone, in the coal-formation, and also in secondary limestone.

Geographic Situation.—It is a frequent rock in the islands of Arran and Lamlash in the Frith of Clyde; is met with in the Girleton Hills near Haddington, North-Berwick Law, Traprain Law, and Braid Hills, near Edinburgh.

6. *Hornstone-Porphyry.*

Hornstein-Porphir, *Werner.*

This porphyry occurs in imbedded masses, beds, and veins, along with claystone-porphyry, and in similar situations, both geognostically and geographically.

7. *Pitchstone.*

Pechstein, *Werner.*

This rock, of which a description is given in page 215., occurs in considerable abundance, in the form of beds and veins in red sandstone, in Arran, and other districts in Scotland.

8. *Pitchstone-Porphyry.*

Pechstein-Porphir, *Werner.*

This rock, which has a base or ground of green or black pitchstone, always contains imbedded grains and crystals of felspar, which is generally the glassy kind.

Structure.—It occurs in globular, columnar, and tabular concretions.

Imbedded Minerals.—Besides felspar, it sometimes contains imbedded calcedony, common quartz, calcareous-spar, and also zeolite.

Geognostic Situation.—It occurs in beds, imbedded masses and veins, in various secondary trap-rocks, in red sandstone, and in secondary limestone *.

Geographic Situation.—It abounds in the island of Arran, occurs also in Lamlash, and is met with in Mull, Eigg, Sky, and other parts of Scotland.

Tertiary Rocks.

Secondary Formations above Chalk.

These are, first, Paris Formation; and, second, Brown-Coal.

I. Paris Formation.

Terrain tertiaires, *Daubuisson.*

Under this division, we include many of the different secondary beds which are of posterior formation to chalk. They are principally marl, clay, and sand, interstratified with beds of limestone, sandstone, and gypsum. The only metalliferous minerals they contain are iron-pyrites, and brown ironstone, but many of them abound in organic remains. This set of rocks appears more of a local nature than any of those hitherto described. The following description is illustrative of this formation as it occurs around Paris.

Geographic Distribution.—It extends all around Paris; to the north, as far as Senlis and Laon; to the east, to Rheims

* Also in veins in granite, and other primitive rocks, as in Arran.

and Epernay; to the south, to Orleans; and to the west, to Chartres and Mantes. It may be considered as composed of seven systems of beds, viz.

1. Plastic clay with sand.
2. Coarse limestone, or limestone with cerites, and accompanying sand and sandstone.
3. Siliceous limestone.
4. Gypsum and marl.
5. Marl.
6. Sand and Sandstone.
7. Fresh-water limestone and millstone or buhrstone.

The chalk on which they rest, presents numerous inequalities, in and over which these beds are arranged, and generally in a horizontal or slightly inclined position.

1. *Plastic Clay and Sand.*

This bed, which rests immediately upon the chalk, consists of an unctuous, tenacious, and variously coloured clay, employed by potters, and named by Brongniart Plastic Clay. It contains little chalk, but is frequently intermixed with sand, particularly towards its upper part; sometimes this sand is divided into two beds. It varies in thickness, in some points not exceeding a few inches, in others being many fathoms. It contains a few shells, and these are marine.

also [illegible] Pudding stone + Brown [illegible]

2. *Coarse Limestone, with Sand and Sandstone.*

Above this clay is a bed principally of a calcareous nature, composed of an alternation of beds of coarse limestone, marl, and slate-clay, which occur always in the same order, over an extent of 25 leagues of country. The average thickness of the whole together is about 90 feet.

The lower beds are very sandy, and often contain grains of a green matter, resembling that found in the *green sand*, already described as lying under the chalk formation, and abounds in marine shells.

In the superior beds, there are layers several feet thick, of a pale yellow limestone, which is pretty hard, and in large grains, and forms the principal building-stone at Paris. They contain great abundance of petrifactions, and particularly of cerites, and are covered by marly beds. Siliceous productions occur principally towards the upper part of the formation, and these are flint, or flint passing to hornstone, and crystals of quartz. In some places the siliceous matter occurs in considerable masses, even whole beds; sometimes in the form of sandstone, which abounds in marine shells, and occasionally also contains fresh-water shells, such as lymnææ and cyclostomæ. + the London clay is of this

3. *Siliceous Limestone.* 2

Above the coarse limestone is a limestone which contains fresh-water shells. It is stratified, and the strata are sometimes soft and white, sometimes grey and compact, and penetrated with silica. Sometimes the walls of cavities and fissures are lined with calcedony and small crystals of quartz; in other instances the siliceous matter is formed into masses of vesicular and corroded quartz, named *buhrstone* or *millstone*, whieh has been regarded as the skeleton body of a siliceous limestone, the calcareous portion of which has been removed.

3 4. *Gypsum.*

The gypsum formation rests on the beds just described. It consists of an alternation of beds of gypsum and marl. Where thickest, as at Montmartre, near Paris, it is divided into three beds. The *lowest bed*, is composed of thin layers of gypsum, which is often lamellar, of solid calcareous marl, and slaty argillaceous marl, in which menilite is found; and the under part of this bed sometimes incloses marine shells. In the *second bed*, the gypsum is in great quantity, but the marl in small quantity; no shells occur, but petrified fishes are met with. The *uppermost bed*, which is the principal one, is four times thicker than the others, and is that which is quarried on account of its gypsum; thin beds of marl occur; the gypsum is sometimes 60 feet thick; it is naturally divided into large irregular prisms like basalt; it is pure, and is granular foliated; the lower part often contains flint, and the superior part passes into marl. This bed is particularly distinguished by the multitude of bones, particularly of quadrupeds, which it contains; and it also contains some fresh-water shells. This formation at its line of junction with the rock of limestone on which it rests, is intermixed with, and passes into it.

5. *Marl.*

The marls that rest upon the gypsum, and which often replace it, are of two kinds; one is of the same nature as that which alternates with the gypsum, and contains fresh-water shells, while the other contains marine shells.

The first are in general white and calcareous; they contain silicefied trunks of the palm-tree, and species of lymnæa and planorbis. Above these are beds of argillaceous marl, which are sometimes 60 feet thick. In these beds balls of celestine or sulphate of strontites occur. It is succeeded by several thin beds, and the whole is terminated by two beds, containing vast abundance of oysters.

4. 6. *Sand and Sandstone.*

Resting upon the marls, when the succession of beds is complete, there is a great bed, composed of sand and sandstone, sometimes 300 feet thick.

The sand consists of angular particles of quartz, mixed with earthy carbonate of lime, and fragments of shells. Sometimes it is quite pure, and it is used for making plate-glass. There is associated with this sand a sandstone, which is used in paving the streets of Paris, and the roads in its vicinity. It is composed of transparent shining angular particles of rock-crystal, immediately connected together, and, therefore, without a basis or cement. Sometimes the particles are so loosely aggregated, that they can be separated by the simple pressure of the finger, while in other cases they are so closely aggregated as to form a mass nearly approaching to compact quartz. The sandstone or quartz is disposed in the sand in various ways; sometimes it is in large or small imbedded masses, or in beds sometimes several feet thick, and extending to a considerable distance. This bed of sand and sandstone contains few marine organic remains, and those that do occur are confined to its upper part, where it is intermixed with a calcareous sand. It is indeed a general observation, that animal remains occur very rarely in quartzy rocks, but abundantly in those of a calcareous nature.

Sometimes the sandstone contains cotemporaneous portions of flint, hornstone, flinty-slate, and thus a conglomerate is formed. of considerable importance in the arts

5 (7.) *Fresh-Water Limestone, with Millstone or Buhrstone.*

There frequently rests immediately upon the preceding sand and sandstone, a thick bed, consisting of layers of sand, marl, clay, and millstone. The mill or buhr stone, is quartz in a vesicular and corroded form, and which forms beds sometimes upwards of one hundred feet thick. Its vesicular form adapts it for millstones, and hence it is very extensively quarried for this purpose, and exported to England and other countries.

Above these layers, and forming the uppermost portion of the series of rocks which rests upon chalk, is a formation of limestone different from those already described, and which extends to very considerable distances. It is highly impregnated with quartzose matter, and contains abundance of fossil shells, which are said to belong to the division of *land and fresh-water shells*, and hence this limestone has been named *fresh-water limestone.* It is of a yellowish-white colour, fracture earthy or conchoidal, varies in hardness from that of compact limestone to that of the softer marls. It frequently contains flint and hornstone, and also beds of the vesicular quartz, or buhrstone, which, in general, is more compact than that found in the preceding formation. It is further particularly distinguished by its containing numerous irregular cylindrical cavities, and by the mineral remains it contains, resembling, in characters, the genera lymnæa, planorbis, cyclostoma, and helix, of our present marshes.

Observations on the Paris Formation.

This remarkable group of rocks has been sometimes distinguished into four divisions, or beds, according to the kind and distribution of the organic remains it contains. The *first or lowest bed* includes the plastic clay, coarse limestone and inferior sandstone, in all of which the organic remains are said to be entirely *marine*. The *second bed* contains the lower siliceous limestone, and the lower gypsum and marls, both of which contain scarcely any other petrifactions than those of land and fresh-water animals; and hence is called a *fresh water formation*. The *third bed* is composed of the superior marls, sands, and sandstones, and the few petrifactions it contains are of *marine shells*. Lastly, the *fourth bed* is a great *fresh-water formation*.

A series of rocks, possessing many of the characters of those around Paris, occurs in the Isle of Wight, and the neighbouring districts in the south of England, and has been well described and illustrated by an excellent man and good observer, Mr Webster of the Geological Society of London.

II. Brown-Coal, associated with Rocks that lie above Chalk.

Associated with a group of rocks above chalk, there are sometimes extensive formations of brown-coal. There is a fine example of this arrangement of brown-coal in the North of France, in the country extending from Beauvais to the vicinity of Rheims. There are five beds of brown-coal, varying from two to six feet in thickness, which are separated from each other by layers of gravel and loam; and both the coal and the layers between it are impregnated with iron-pyrites. The whole is covered with beds of marl and limestone; those beds which rest immediately upon the coal, contain fresh-water shells, while those at a distance from it include marine shells; and it is said that the uppermost part is a shelly sandstone. M. Marcel de Serres informs us, that in the vicinity of Beziers fresh-water shells are found in a bed of brown-coal, which is covered by bituminous beds, bituminous limestone, with fresh-water shells, compact limestone without shells, and, lastly, with a limestone containing impressions of cerites. Sometimes this brown-coal is covered with trap-rocks or lavas.

The brown-coal formation contains a few imbedded minerals, such as iron-pyrites, bog iron-ore, selenite, honey-stone, retin-asphalt, and a mineral of an inflammable and waxy nature.

Class IV.—Alluvial Rocks.

Aufgeschwemte-Gebirge, *Werner*.—Terrain de Transport, *Daubuisson*.—Terrains d'alluvion, *French Geologists*.

This class comprehends those earthy substances formed from previously existing rocks, by the agency of water and air, which are generally loose in their texture, and are never covered with any real solid and rocky secondary strata.

Werner divides them in the following manner:

1. *Mountain Alluvial Formations.*
   - *a.* On the summits of mountains.
   - *b.* In valleys, and at the foot of mountain ranges.
2. *Alluvial Formations of Low or Flat Lands.*

1. Mountain Alluvial Formations.

a. On Summits of Mountains.

The alluvium found on the tops of mountains, and mountain-chains, consists generally of a thin bed formed by the decomposition of the immediately subjacent rocks. This bed, particularly when covered with vegetable matter, forms a coat which long protects the solid strata from the wasting influence of the weather.

b. In Valleys.

The disintegrated rocks on the sides of valleys, yielding to their own weight, or carried downwards by torrents, are stopped at the foot of the mountain; they are accumulated there, and, in the course of time, form a deep protecting cover for the lower part of the mountain, and fill up the bottoms of the valleys.

c. *At the Foot of Mountain Ranges.*

Besides the alluvial covering on the bottoms of valleys and on the basis of their bounding hills and mountains, there often occur very extensive alluvial formations, extending to a greater or less distance from the general foot of the acclivity of the great mountain-chains, or mountain-groups. These formations are composed of fragments of the neighbouring mountains, but are arranged in a vast horizontal bed; thus intimating that they must have been levelled by the action of a great mass of water, in the form of a lake or inland sea. The plains of Piedmont and Lombardy, at the foot of the Alps, present a colossal example of this kind of alluvial formation.

2. Alluvial Substances of Low and Flat Countries.

The alluvial substances met with in great plains, and in low or flat countries, are coarse conglomerates and sandstones, rolled masses or boulders, sand and gravel, marl, clay, loam, calcareous-tuff, bog iron-ore, ores, metals, gems, common salt, subterraneous and submarine forests, and peat.

a. *Conglomerates and Sandstones.*

These alluvial rocks have either a clayey iron-shot basis, which includes fragments, often of considerable size, of quartz, and other minerals; or the basis is calcareous carbonate, which cements sand or gravel of different kinds. Sometimes, particularly on the shores of many of the West India Islands, fragments of shells and corals become firmly cemented together by minute particles of the carbonate of lime, and thus form a calcareous sandstone, or coarse shell-limestone.

b. *Rolled Blocks or Boulders.*

Boulder stones, often of great size, are found in single masses, or accumulated in great quantity, in low countries and sea-shores, far removed from their original situation. The distribution of these boulders is connected with the operation of some general cause.

c. Sand.

Sand of the Desert.—Sand, as is well known, is formed of small grains, supposed to have been derived from previously existing rocks of a quartzy nature. It sometimes covers immense tracts of country, and forms great deserts, as those of Barbary and of Arabia.

The extreme fineness of the particles renders the sand moveable by the slightest breath of wind, so that when the storm rages, the desert presents a picture of moving waves, mountains, and pillars, that baffle all description, and which overwhelm vast tracts of country, carrying every where desolation and destruction.

Coral and Shell Sand.—Sands formed of broken corals and shells, are found in considerable abundance on some sea-shores. These are occasionally blown into the interior of the country, and sometimes heaped into hillocks. This sand is often much mixed with comminuted shells, and these furnish a cement, which, in particular cases, binds the particles of sand together.

Downs.—When the sea-coast is low, and the bottom consists of sand, the waves push this sand towards the shore, where, at every reflux of the tide, it becomes partially dried; and the winds, which almost always blow from the sea, drift up some portion of it upon the beach. By this means, *downs*, or ranges of low sand-hills, are formed along the coast. These, if not fixed by the growth of suitable plants, either disseminated by nature, or propagated by human industry, would be gradually, but certainly, carried towards the interior, covering up the fertile plains with their sterile particles, and rendering them unfit for the habitation of mankind; because the same winds which carried the loose dry sand from the shore to form downs, would necessarily continue to drift that which is at the summit further towards the land.

d. Marl.

This kind of marl is either formed of shells, generally of land and fresh water tribes, or is a deposition from calcareous waters. The first contains the shells in greater or less abundance, and in a more or less perfect state, and is known under the name ***Shell-Marl***, while the second, which is sometimes intermixed with the shell-marl, is, properly speaking, but a variety of calcareous tuff. These marls are founded in lakes, where they are often associated with peat; also on sea-shores, or in sea alluvial formations. Small formations of shell-marl sometimes occur pretty high upon mountains.

e. Clay and Loam.

The clays are frequently potters-clay, and the loam the common varieties of that substance. The following are their characters.

Potters-Clay.—The colours are white and grey. Occurs massive. Internally it is dull or glistening. Fracture is earthy or slaty. Is more or less shining in the streak. It is opaque. Soils slightly. It is soft, passing into friable. It is sectile. It adheres more strongly to the tongue than loam. It feels rather greasy, and becomes plastic in water.

Loam.—Colour grey, frequently spotted yellow or brown. Occurs massive. It is dull or feebly glimmering, owing to intermixed scales of mica. Fracture coarse earthy. Soils slightly. Easily frangible. Is sectile, and slightly resinous in the streak. Is soft, and more friable than potters-clay. Adheres slightly to the tongue. Feels rather rough, and slightly greasy. differs from Potters [illegible] in containing [illegible]

Along with these are coarser bluish clays, which are sometimes very soft, sometimes even harder than potters-clay.

Many extensive plains are covered with these clays and loams; they also occur filling up hollows in plains, and forming extensive tracts on the sides of lakes, and at the mouths of rivers, where they enter lakes, or meet with the waters of the ocean. These clays and loams are formed by the disintegration of felspar, micaceous and slaty rocks, and frequently are intermixed with sand and gravel, and sometimes even alternate with beds of these substances, and also beds of peat. The *porcelain-earth* or clay also occurs in beds, or covering the bottoms of lakes.

f. Calcareous Tuff.

There are two kinds of this rock, one of old formation, and another which is daily forming. The first appears to have been deposited from the waters of lakes that formerly existed in limestone districts, but which have long since disappeared. Thuringia affords striking examples of this formation of calc-tuff. The tuff there rests upon gravel, or on the rocks of which the country is composed: It sometimes forms beds upwards of fifty feet thick, composed of strata of compact and porous tuffa, which frequently alternate with each other, and between them are sometimes thin beds of a brown bituminous earth. When the lakes contain no plants, then the tuff deposited in them is always compact, but if, on the contrary, they abound in reeds, rushes, confervæ, &c. the tuff, owing to this intermixture, is porous, and loose in its texture. These tuffs, in Germany, contain osseous remains of elephants, rhinoceroses, megatheria, deer, &c. and sometimes also remains of fresh water shells, analogous to the species at present met with. Impressions of indigenous plants have likewise been found; and very lately fossil human skulls are said to have been met with in this formation.

The waters which flow along the surface of the globe, and which are charged with calcareous earth, deposite it on the districts they traverse, and thus form tuffas, which are either porous or compact, and are of the newest formation. An example of this formation occurs at Starlyburn, near Burntisland, in Fifeshire.

g. Bog-Iron Ore.

Water, in its passage over and through rocks containing iron, abstracts a portion of it; it also carries away the iron contained in the beds of decaying vegetable matter it passes through, and in both cases a portion of the water combines with the iron, so that when it comes to be deposited on the bottom of lakes, or spread over the flat country, it appears in the form of hydrate of iron, and thus gives rise to the beds of *bog iron-ore* met with in alluvial districts. In many districts in Scandinavia, where the primitive strata are very richly impregnated with iron, bog iron-ore is found in great abundance on the bottom of lakes, and so rich as to yield 60 *per cent.* of hydrate of iron. The iron is dredged out in some instances every ten, in others every twenty and thirty years, thus shewing the rapid renewal of the deposite.

h. Ores, Metals, and Gems in Grains.

Some kinds of alluvia, particularly those in mountainous districts, contain masses and grains of ores and native metals, which are derived from metalliferous veins, metalliferous beds, or from rocks through which the metalliferous minerals have been disseminated. If the minerals yield easily to decomposition and trituration, they are reduced to very minute particles, and become intimately mixed with various clays and loams; but if their hardness and tenacity is such that they resist obstinately, then they appear in rolled pieces, and in grains of various sizes and forms. The ores and metals most frequently met with in this form, are iron-pyrites, tin-ore, native gold, and platina. The three latter are those which, on account of their value, are extracted from the sands and clays by washing.

Many of the gems are obtained by washing alluvial sands and clays; the pyrope or garnet of Bohemia, zircons, rubies, topazes, and diamonds, are collected in alluvial districts.

i. Common Salt.

Rock-salt occurs in great abundance in the deserts of Africa and Arabia, on the plains of Persia, and in the steppes of Siberia.

k. Subterranean and Submarine Forests.

Sometimes whole forests are found covered with alluvial deposites, and these are either under alluvium on the dry land, or extend under the waves of the ocean. The first are denominated subterranean, and the latter submarine forests. There is an extensive subterranean forest in Lincolnshire, and another in Lancashire; and on the coast of Lincolnshire there is an immense submarine forest, which has been particularly described by Mr Correa. The sinking and sliding of the alluvial strata, the breaking down of natural sea-barriers on front of flats, marshes and lakes, and changes in the situation of lakes and rivers, enable us to explain the phenomena exhibited by submarine and subterranean forests.

1. Peat.

Peat, which is composed of vegetables of different kinds, in a state of decomposition, occurs generally at the surface, and usually resting upon alluvial soil. It sometimes is observed to alternate with sand, clay, and loam, on the sides and bottoms of lakes, on the sides and at the estuaries of rivers, and on the sea-shore, and even with shell-marl, in inland situations. Although it occurs on the summits of hills, yet it is most abundant in comparatively low and flat situations, where it sometimes forms beds in hollow places, upwards of fifty feet thick. Many varieties are described by authors, and these exhibit a series from the spongy and earthy to the compact, and occasionally bituminous. One remarkable kind, termed *Fluid Peat,* is a mixture of earthy peat and water, which, on drying, becomes very compact. It is the *flow moss* of some authors, and is so fluid as sometimes to flow from its original situation over neighbouring tracts.

3. Formations of Alluvial Rocks.

Alluvial substances may be divided according to their formation, into the following classes: 1. Diluvian. 2. Postdiluvian.

1. *Diluvian.*—Under this class we include certain sands, clay, and gravels, composed of fragments both of neighbouring rocks and of distant rocks, containing remains of the elephant, rhinoceros, hippopotamus, &c. These appear to have been formed by the deluge. Many of the boulders or rolled masses, so well known to geologists, belong to the same era of formation.

2. *Postdiluvian, or those formed since the Deluge.*—Of this class there are the following orders: (1.) Untransported. (2.) Fluviatile. (3.) Marine; and, (4.) Those formed by sliding of debris on the sides of valleys.

(1.) *Untransported.*—The alluvium on the summits of mountains and hills, which is composed of the broken down and disintegrated rock under the soil, belongs to this order. Striking examples of it occur in sandstone and trap districts; near Fochabers there is a fine section of conglomerate rock, which is disintegrated to the depth of several fathoms from the surface, thus presenting a deep cover of untransported alluvium.

(2.) *Fluviatile*—Those alluvial depositions which are formed by rivers in their course towards the sea, and at their estuaries, where they flow into lakes, or meet the waters of the ocean, belong to this order.

(3.) *Marine.*—The alluvial formations of this order are of two kinds, viz. 1st, Those formed of the sand and mud thrown on the sea-shore by the waves of the ocean, assisted by winds and currents; and, 2d, Those formed of sand and comminuted shells, drifted inland by the winds from the sea-shore.

(4.) *Those Alluvial Accumulations formed by the slipping or falling down of the disintegrated materials of Rocks along the sides of Valleys.*—These are entirely formed of the debris of the hills on which they rest, and consist of rolled and broken masses of these rocks, more or less intermixed with smaller particles of the same rocks.

Class V. 6 Volcanic Rocks.

Volcanic Rocks are those mineral masses considered to have been formed by the agency of volcanoes. They may be divided and arranged in the following manner:

I. Pseudo-volcanic. II. Volcanic: these are divided into 1. Ignigenous. 2. Thermal. 3. Muddy.

I. Pseudo-volcanic Rocks.

Pseudo-volcanic rocks are portions of previously existing strata, which have been more or less altered by the action of heat emanating from beds of coal in a state of combustion. The following species are enumerated by geologists. 1. *Burnt-clay*. 2. *Porcelain-jasper*. 3. *Earth-slag*. 4. *Columnar clay-iron-ore*. And, 5. *Polishing-slate*.

1. *Burnt-Clay*.—Its colour is usually red, and sometimes grey, yellow, and brown, and occasionally spotted or striped. Sometimes it incloses impressions of plants. It is clay or slate-clay burnt, but not so much changed as to form a porcelanous mass.

2. *Porcelain-Jasper*.—It is slate-clay, or common clay, changed into a kind of porcelain by the action of heat. Like the preceding species, it sometimes contains impressions of plants, a fact which shews that it has not been completely melted.

3. *Earth-Slag*.—This is clay, or clay iron-stone, converted into a kind of slag. It is black, brownish, or reddish, and it has occasionally a tempered-steel tarnish. It is amorphous or vesicular, and has sometimes a metallic lustre.

4. *Columnar Clay Iron-Ore*.—This is clay iron-ore, which is supposed to owe its columnar concretionary form to the action of heat.

5. *Polishing-Slate*.—Is a grey or white coloured thin slaty light mineral, which Werner conjectures to be the ashes of burnt coal, which have been carried by water into low situations, and deposited in a slaty form. Swims on Water

Situation.—Pseudo-volcanoes usually occur in low situations, and sometimes also in hilly country, and always in rocks of the coal formation.

Phenomena.—They are discovered by the heat of the surface of the earth in their vicinity ; sometimes by smoke, and more rarely by flames issuing from rents in the ground. Sulphureous and ammoniacal vapours frequently occur, and these, in their course upwards, incrust the fissures of rocks, and even the surface of the ground, with sulphureous and ammoniacal matters.

II. Volcanic Rocks.

1. *Ignigenous Volcanic Rocks, or True Volcanic Rocks.*

This series is divided into Modern and Ancient.

Rocks of modern Volcanoes, many of which are at present in a state of Activity.

The following are the most characteristic of these substances. 1. Lava; 2. Tuffa; 3. Volcanic Ashes; 4. Volcanic Glass.

1. *Lava.*—Many different kinds of lava are enumerated by geologists; but for our present view it will be sufficient to arrange them under the following heads, viz. Compact, Vesicular, Slaggy and Spumous.

a. Compact Lava.—Colour grey; massive. Lustre glimmering. Fracture uneven or splintery. Opaque. Semi-hard, approaching to hard. Brittle and easily frangible. Feels dry and rough. Sp. gr. = 2.80. It always occurs in the form of streams (coulé), and generally forms the middle part of the stream.

a b c d

the order of their position

b. Vesicular Lava.—Colours grey, black, and brown. Structure vesicular. Generally occurs in the upper, and also on the under sides of streams of lava, when they have run over moist ground.

c. Slaggy Lava.—Colour black or brown, and has a completely slaggy aspect. It occupies the uppermost part of lava streams.

* *d. Spumous Lava.*—Colour red or brown, and so very vesicular, that it sometimes will float in water. Like slaggy lava, it always occurs on the surface of streams.

2. *Tuffa* is a conglomerated volcanic rock, with an earthy basis, including masses of different kinds of lava, volcanic glass, &c.

† 3. *Volcanic Ashes.*—These are the loose powdery earthy matters thrown out when volcanoes are in a state of activity.

4. *Volcanic Glass.*—This is lava with the vitreous fracture and lustre, a rare mineral in modern volcanoes.

Rocks of Extinct and Ancient Volcanoes.

Of these there are two principal sets, one includes the rock named *Trachyte,* and its tuffa,—the other *Basaltic Lava, Greenstone Lava,* and their tuffa.

1. *Trachyte* *.

This rock, which is of the nature of felspar, is generally porphyritic, the imbedded felspar crystals being most frequently of the glassy kind.

The colour is generally grey, passing frequently to white, approaching sometimes to black; and other varieties are said to be red, brown, green, and even yellow. The fracture is generally more or less coarse or earthy; and some varieties incline to even, and are more compact than those with the earthy fracture.

Its hardness varies, some kinds resisting the knife, while others, particularly the coarse earthy, are nearly friable. These latter are almost always rough and sharp to the feel, and this roughness may be said to occur in all the varieties of this volcanic rock.

On exposure to the blowpipe, it melts with ease into a white enamel; but some rare dark varieties afford a black enamel. Trachyte, like all other felspathose minerals, on exposure to the atmosphere, disintegrates and falls into a meagre and ashy like earth.

It is generally porphyritic, and the crystals it contains are the following:

1. *Felspar, which is usually the Glassy kind.*—It is often fibrous, and sometimes so much so as to appear like pumice.

2. *Hornblende.*—It is generally acicular, black, foliated, and splendent or shining.

3. *Mica,* of a dark colour, and in hexagonal plates.

4. *Sphene,* said to be rather frequent in some varieties.

5. *Augite.*—Rarely in the trachyte of Europe, but frequent in that of the Andes.

6. *Quartz.*—True trachyte rarely contains crystals of quartz, or imbedded masses, or veins of jasper, calcedony and opal.

* Trachyte, from the Greek word τραχυς, rough.

7. *Iron-Glance, or Specular Iron.*—This ore of iron occurs in cavities and veins. The trachytes of Mont d'Or and Puy de Dôme, and more particularly those of Stromboli, contains crystals of this beautiful mineral. appears to have [illegible]

Daubuisson and others, describe the Pearl-stone as a variety of trachyte, under the title *Trachyte emaillé*, and arrange all those Obsidians that afford, before the blowpipe, a white enamel, as varieties of the *Trachyte vitreux*. The Pitchstone, too, is considered as a variety of siliceous trachyte; and all the varieties of true Pumice are maintained to be fibrous and very porous varieties of the trachyte emaillé and trachyte vitreux.

Structure.—Trachyte is sometimes arranged in columns like basalt, but it has not been observed stratified.

Geographical Distribution.—It abounds in Auvergne, Banks of the Rhine, Italy, Hungary, and in the Andes.

2. *Tuffa of the Trachyte Formation.*

This tuff has a felspar base, which includes portions of various minerals, such as scoriaceous, vesicular, and basaltic lava; also masses of pumice, pearlstone, pitchstone, and trachyte. It is said also to contain imbedded masses and veins of various kinds of opal, and occasionally opalised wood and fossil shells.

To this rock, Dr Daubeny remarks, probably must be referred those beds occasionally interstratified with trachyte, which consist of an apparently homogenous rock, having a resemblance to Tripoli, possessing a rough earthy feel and slaty fracture, generally grey, but sometimes of an ochre-yellow colour. Daubuisson supposes, that these beds, as well as the tuff, owe thesr origin to the disintegration of the trachyte, and the subsequent agglutination of the finely divided fragments into an uniform mass.

3. *Basaltic and Greenstone Lava, and their Tuffa, Scoria, and Slag.*

Lavas.

These lavas bear a striking resemblance to the secondary basalts and greenstone, and many geologists are of opinion, that they are merely varieties of these rocks which have been softened by volcanic heat. It is said they do not occur in streams (coulé), but in a form very similar to secondary greenstones and basalt. They occur in Iceland, South of France, Italy, Banks of the Rhine, and in many other quarters.

Basaltic Tuffa.

This tuffa has a basaltic or clayey basis, which includes masses of basaltic lava, greenstone, and scoria. It is said to occur in beds with the basaltic lava.

Scoria.

The very vesicular basaltic lavas are termed Scoriæ, and generally occur on the upper side of the beds of lava.

Slag.

Slags differ from scoriæ, in having a vitreous aspect, and in being very uneven and rugged on the surface.

2. *Thermal Rocks, or those formed from the Water of Hot-Springs.*

In Iceland and other countries, rocks bearing a strong resemblance to secondary traps are said to be formed by the agency of hot-springs *. These *thermal rocks*, as they may be denominated, are alleged to be brought from the interior of the earth by the water of hot-springs, partly in a state of solution, partly in a state of mud, and deposited over flat or hilly tracts of country, where they gradually harden, sometimes crystallise, and assume their various permanent characters.

The famous rock named *travertino* by the Italians, and which abounds in South-western Italy, is a product partly of hot, partly of cold springs. The ancient temples, and the gorgeous palaces and churches of Rome, and indeed the whole of the streets and squares of the former Mistress of the World,

* These hot springs probably owe their high temperature to their coming in contact with the earths in the metallic state; indeed it might be rendered very probable, that many phenomena of volcanoes are caused by a change of the state and position of metalloidal matter seated deep in the earth.

are built of concretionary masses which have been deposited by springs.

There are many considerable hot-springs around Guancavelica in South America, the waters of which spread over the neighbouring country, and deposite upon it an ash-grey or whitish substance, (calc-tuff, sinter and travertine?), which acquires a great degree of hardness. The spring-water is so highly impregnated with the earthy matter, that the inhabitants receive it in square boxes or moulds, which it fills in a few days, and the blocks, thus formed, are used for building. Indeed the greater part of Guancavelica, like Rome, is built of the concretionary rock formed from springs.

3. *Rocks formed by Torrents of Mud flowing from Volcanoes.*

Torrents of mud are often observed to flow from the craters and sides of the American volcanoes. In the earthquake of the year 1746, which overturned Lima, four volcanoes opened at Lucanas and in the mountains of Conception, and occasioned frightful deluges. The volcanoes of the kingdom of Quito sometimes exhibit phenomena of the same kind, but accompanied with circumstances so extraordinary, that we shall now state them. The enormous volcanic cones of Cotopaxi, Pichincha, Tungouragua, &c. in South America, never throw out lava, but frequently ashes, scoriæ, and pumice, and sometimes vomit forth immense quantities of water and mud. These eruptions take place more frequently from the sides than from the craters of the volcanoes, and the muddy waters appear to be derived from lakes situated in the interior of the mountains, which burst forth with incredible fury, when any accidental cause, such as an earthquake, splits, and thus opens the side of the mountain. In the year 1698, the mountain of Carguarazo, near to Chimboraço, fell down and covered eight square leagues of country with mud. In the earthquake of the 4th February 1791, 40,000 persons were destroyed by the erutions of water and mud (moya.) Muddy waters, resembling those which flow from volcanic mountains, are vomited forth in great quantity, from districts where no volcanic rocks occur, when these are agitated by earthquakes or other causes. In Peru and Quito, the devastations occasioned by volcanoes are not caused *by streams of lava*, but by water and *enormous streams of mud*, which, when hardened, is found to contain crystals of felspar, and to resemble porphyry, particulary that named trachyte.

In some countries, jets or great bubbles of water, highly impregnated with mineral matter, are thrown out of the earth by means of gas. The earthy matter is deposited in the state of mud, principally around the mouths of the cones from whence it is expelled; and as these cones somewhat resemble volcanoes in form, they have been termed *Air-volcanoes.* One of the most remarkable of these air-volcanoes hitherto described, is that of Macalouba in Sicily, of which an account has been published by Dolomieu. It consists of a hillock of hardened mud, about 150 feet in height. Its superior part forms a plain more than half a mile in circumference, and rising from it are numerous small cones, not more than three feet in height, each of which has a crater or hollow filled more or less deeply with a liquid mud, which is in a state of perpetual agitation, owing to the constant passage of great bubbles of air through it. Portions of the mud are constantly thrown out, and thus add to the bulk and height of the cones.

There are many small *mud-volcanoes* in the neighbourhood of Modena, whose height is not more than a few feet. They are named *Salses,* on account of the saltness of the water they throw out; and which, indeed, is also the case with the water of Macalouba, and of that of most other muddy eruptions observed in different countries. These volcanoes, during their paroxysms, which are attended with slight agitations of the earth, throw out much mud, which extends to the distance of three thousand feet. The gas which occasions the eruptions, is sulphuretted hydrogen mixed with petroleum, and a little carbonic acid. Similar air-volcanoes are described by Pallas as occurring in the Crimea, particularly in the Island of Taman. In the year 1794, one of these burst with a noise like that of thunder, and flame and smoke rushed from it to the height of more than three hundred feet. Immense masses of dried mud were projected from it to great distances, and it vomited forth currents of *a bituminous mud or slime*, to the amount of one hundred thousand cubic fathoms. Humboldt describes air-volcanoes which he saw in the middle of an elevated plain, in the province of Carthagena in South America. There were twenty small cones, having an elevation of from twenty-one to twenty-seven feet in height, and formed of bluish-coloured clay. Their summits were hollow or crater-like, filled with water, from the surface of which air arose, and burst with an explosion, and often threw out mud. In the Island of Trinidad, and also in Java, there are considerable air or mud volcanoes.

VIII. Description of Veins, Metalliferous Beds, and Irregular Imbedded Masses.

Veins, as already mentioned at page 344., are tabular masses, that generally traverse the strata of the rock or rocks in which they are contained, and are composed of materials that either differ more or less from those of the bounding rocks, or are of the same nature.

I. *External Relations of Veins.*

1. *Inclination.*—Veins are usually more inclined than strata or beds; the average inclination of strata is 45°, that of veins much higher. In inclined veins, the upper side is denominated the *hanging side*, (hangendes in German; toit in French); and the lower or under side the *lying side*, (liegendes, German; mur, French).

2. *Width*, (machtigkeit, German; puissance, French.)—Veins generally becomes narrower as we approach their *ends*, and at length terminate in a wedge; or they divide into numerous small branches that soon terminate in the rock. Veins not only ramify towards their ends, but also in their course, sending out branches in many directions from their *main body* into the adjacent strata. These lateral branches assume a curved direction, and again join the main vein after a longer or shorter course, or they, after a course more or less straight or tortuous, terminate in a wedge-form, or by

division into smaller branches in the strata. Veins vary much in width, some being many fathoms, while others are even less than an inch in width. The width often varies in the same vein; thus, some veins in one part of their course will have a breadth of ten feet, while in another and not very distant part, it will not exceed a few inches. In metalliferous veins, the range of width is not so great as in those composed of mountain rocks; for in mineral veins the range is from the smallest width to 150 feet; in rocky veins from the smallest breadth to 300 feet.

3. *Length.*—Narrow veins are in general very short, whereas those of considerable breadth extend to a great distance. In this country secondary trap-veins can be traced for several miles.

4. *Depth.*—It is seldom we have an opportunity of reaching the bottom of a vein, so as to ascertain its actual depth. Some metalliferous veins have been worked to the depth of 300 fathoms, without reaching the bottom, while, in other cases, the bottom has been found at a few hundred feet from the surface.

II. *Structure and Internal Relations of Veins.*

1. *Mass of the Vein not the same as that of the surrounding Strata.*—The mass or body of a vein, as already observed, is generally different from that of the surrounding strata. In some cases, however, as in veins of granite in granite, they are nearly the same; the difference consisting in the state of the constituent parts, and the accompanying minerals, not in the general mass itself.

2. *Junction of Veins with the bounding Strata.*—The sides of veins are sometimes divided from the bounding rock by a seam of clayey substance, named *besteg* by German miners. This clay in some instances continues throughout the whole extent of the vein, in others it is only partially distributed. Many veins, at their line of junction with the surrounding strata, are separated from them by a thin seam; while in other cases, the veins and rock where they meet are

intermingled, and sometimes the matter of the vein is disseminated through the bounding strata to a considerable distance.

3. *Substances of which Veins are composed.*—Some veins are composed of mountain rocks, such as granite, gneiss, clay-slate, alum-slate, porphyry, sandstone, conglomerate, secondary limestone, coal, secondary trap, and pitchstone. Metals of every description, and in all combinations, are met with in veins, and frequently in great quantity.

4. *Vein-stones.*—It rarely happens that ores and metals occupy whole veins, the metalliferous minerals being generally associated with earthy minerals of different descriptions. Of these the most frequent and characteristic are the following: 1. Quartz, in the form of common quartz, hornstone or jasper; 2. Calcareous-spar and brown-spar; 3. Heavy-spar; 4. Fluor-spar. These earthy minerals are technically named *vein-stones*, (Matrix, Lat.; Gangarten, Germ.; Gangue, Fr.). In some veins, the vein-stone or matrix is of a clay or loam; and veins of this description, although frequently sterile, are not always so; for in some of the richest veins in Peru, the ores are intermixed with a ferruginous clay named *paco*.

5. *Distribution of Ores, &c. in Veins.*—The ores in veins occur in various ways, as disseminated in imbedded masses, or arranged in layers with the veinstones. Further, the ore is not equally distributed throughout the whole extent of the vein; in some cases it occurs disseminated through a great extent of the vein; in other instances the ores are concentrated in particular, and often distant points, but it rarely happens that ore is found in every part of a metalliferous vein. From the facts just stated, it is evident, that the miner will often have to cut through extensive tracts of veinstone, in passing from one metalliferous point to another.

6. *Structure of Veins.*—Some veins are composed of but comparatively few minerals, and these are massive and intimately aggregated together; others are composed of a greater variety of minerals, but which shew little regularity in their structure; and lastly, veins frequently occur, having a regu-

lar structure, where the different materials are arranged in layers parallel among themselves and to the walls of the vein; and these throw great light on the origin of veins, and on the formation of the minerals they contain.

When veins are composed of different layers, or are stratified, the same succession of layers is to be observed from both sides towards the middle. Each succeeding layer rests on the preceding, in such a manner that the crystals of the second layer are always impressed by those of the first. A beautiful example of the venigenous stratified structure occurs in the vein Hulfe-Gottes, at Gersdorf in Saxony. This vein is from six to nine feet wide, and is composed of parallel layers, which sometimes amount to forty in number. These layers are composed alternately of calcareous-spar, fluor-spar, lead-glance, grey copper, with fluor-spar, heavy-spar, and a very small portion of quartz. Similar appearances occur at Leadhills, and in many other mining districts.

7. *Druses.*—Cavities lined with crystals, termed *Druses*, (*Fours*, Fr). occur in veins of all kinds, but particularly in those having a stratified structure. They have usually a longish shape, and are generally parallel with the vein. They have various contractions and widenings. They vary much in size, being from a few inches to several fathoms in magnitude. Their surface is covered with crystals, which are usually of the same minerals as those that form the massive part of the vein. Thus, the druses in veins composed of quartz, are lined with quartz-crystals; those in veins of brown-spar, with brown-spar crystals. When druses are lined with a variety of crystallizations of different minerals, we observe that the one series is laid on the other in a determinate order; the oldest part of the formation being that on which all the other crystals rest; the newest, that which covers all the others. Druses are sometimes filled with water; and when they are of great size, the quantity of water they contain is so considerable, as to endanger the lives of miners, when they are cut into. It is also observed, that druses occur most abundantly,

and of greatest size, in the upper parts of veins, but become gradually smaller, and less numerous in the deeper parts.

8. *Stratified Veins composed of Mountain Rocks.*—Veins composed of mountain-rocks sometimes present a stratified appearance. In the Island of Arran, wacke and greenstone occur in layers in the same vein; in other cases, veins are composed of layers of greenstone, porphyry-slate, and pitch-stone, or trap-tuff, with occasional layers of sandstone.

9. *Open spaces extending from side to side of the Vein.*—Besides the drusy cavities, there sometimes occur very considerable open spaces in veins, that reach from the one side to the other, or from the hanging to the lying side.

10. *Converging arrangement of the Layers in Veins.*—When we attend to the layers of which veins are composed at different depths, we observe that they frequently approach nearer and nearer to the centre, towards the lower part of the vein, but expand or recede from it in the upper part. Thus, those layers, which, in the upper part of the vein are near to its sides, are at a considerable distance from them lower down, and, still deeper, approach nearer to the middle of the vein.

11. *a. Crossing and Meeting of Veins.*—When a number of veins that do not intersect one another, occur in the same district, it is observed that they have usually the same direction and constituent parts; thus intimating, that all of them are of the same general formation. When different venigenous formations occur in the same district, then the direction of the veins of these different formations is various, and they are arranged in such a manner, that each particular formation has a certain direction.

b. Veins running in different directions, either cross, or simply meet one another. When they cross, that which is intersected is said to be the *oldest*, and that which crosses or intersects, the *newest*,—an opinion, the accuracy of which may be questioned.

c. Veins sometimes cross each other, without causing any change of direction; but more frequently we find the direction considerably changed.

d. When veins meet under an acute angle, the newer frequently traverses the older; runs parallel with it to a considerable extent, on its lower side, and then again diverges, under the same angle at which it crossed it. Sometimes the newer vein does not fully traverse the older, but changes its direction in the middle of the older vein; runs through the body of the vein; and after a longer or shorter course, again diverges at the same angle it entered. Sometimes the newer vein does not even traverse the older; only meets it; then runs parallel with it; again diverges; and this is frequently repeated in the course of the vein.

e. Newer veins in some cases do not even run parallel with the older, but fairly terminate in them; and this takes place usually on the hanging or upper side.

12. *Different groups of Minerals or different Formations in the same Vein.*—In the same veins we sometimes meet with two or three different formations. Thus, in some Saxon metalliferous veins, the lowest formation is lead-glance; immediately above it there is a formation of native silver; and the uppermost is sparry-iron. In France, there are veins, whose lowest formation is copper-ore; immediately above it, a formation of silver-ore; and the uppermost is a formation of iron-ore. Many more examples of the same kind might be mentioned.

13. *Shifts in the Strata in the walls of Veins.*—Sometimes the strata or beds, traversed by veins, are merely separated; so that the strata or beds on opposite sides of the vein correspond. In other cases, there is a dislocation, or what miners call *a shift* of the strata, that is, the similar strata or beds on opposite sides of the vein do not correspond, but are depressed or sunk generally on the hanging or upper side of the vein. The degree of depression or dislocation usually corresponds to the magnitude of the vein.

14. *Alteration of the Walls of Veins.*—The walls of veins are frequently more or less altered; and this alteration is caused either by an intermixture of the materials of the vein with that of the wall, or by a decomposition of the wall, owing to the agency of percolating water, or the substances of which the vein is composed.

15. *Mode of Formation.*—Veins are either of simultaneous formation with the rock which they traverse, as in granite, metalliferous veins, &c. or are rents that have been filled up from above with the mineral matter they now contain, as in those veins that contain true fragments.

II. Metalliferous Beds.

Erzlager, *Germ.*—Banc, *Bonnard.*—Couche, *Daubuisson.*

1. Metalliferous beds, like beds of mountain rocks, have the same position with the bounding strata. The smallest extent of the bed is denominated its *thickness;* the rock on which it rests is named its *floor;* and that by which it is immediately covered, its *roof.* Beds vary in thickness from a few inches to many fathoms. When the thickness is considerable, the beds are frequently divided into tabular masses, and then they are said to be *stratified.* Sometimes two beds meet together at their extremities, when the interposed mass of rock, which is often of great magnitude, appears as a vast imbedded mass in the bed.

2. *Distinction of Beds and Veins.*—Metalliferous Beds have been confounded with metalliferous Veins; but the following, besides other circumstances, serve to distinguish them; 1. They are parallel with the strata of the mountain in which they are contained; 2. They are not, as is the case with many veins, divided into equal halves, having the same symmetrical arrangement of the same minerals; 3. Their mass is more uniform than that of veins, that is, composed of fewer minerals; 4. Drusy cavities seldom occur in these beds, and when they do appear, are less numerous, of smaller extent, and contain fewer minerals than similar cavities in veins; 5. Layers of

clay are seldom observed on the sides of beds, these latter being usually fresh, and unchanged, both in their upper and under sides.

3. *Outgoing of Beds.*—The *outgoing* of metalliferous beds is, in general, more regular than that of veins, that is, presents fewer differences in direction, thickness and inclination, and fewer branchings and derangements.

4. *Extent.*—Metalliferous beds vary in extent; some are not more than a few fathoms long, while others, as bituminous marl-slate, may be traced for several hundred miles. Very thick beds are sometimes very short, and assume the form of *imbedded masses.* In general, metalliferous beds are more extensive in secondary than in primitive or transition mountains.

5. *Mode of Termination of the Beds.*—They generally terminate in the wedge-form, more rarely divide into branches at their extremities, or they terminate suddenly in the strata without any diminution of thickness.

6. *Relation of Metalliferous Beds to the bounding Strata.*—Metalliferous beds are sometimes distinctly separated from the secondary strata at their line of junction; in other cases they are intermingled with each other, and veins or branches of the bed shoot into the strata, and portions of the strata project into the bed *.

7. *Formations in which Metalliferous Beds occur.*—Magnetic iron-ore, iron-glance, tin-ore, copper-pyrites, iron-pyrites, lead-glance and cobalt-pyrites, occur in beds in various primitive rocks, but principally in mica-slate, clay-slate and gneiss; lead-glance, calamine, clay iron-ore and cinnabar, form frequent beds in secondary formations.

III. Irregular imbedded Masses.

Short and very thick beds sometimes terminate suddenly in all directions, thus forming great lenticular masses, parallel with the bounding strata. Such may be denominated *lenti-*

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* Beds with projecting branches have sometimes been described as Veins.

cular imbedded masses. In other cases, all dimensions of the mass are nearly alike, and the surface either uniform or very uneven. Such masses vary in magnitude from a few inches to to several miles. They are either wholly inclosed in a particular stratum, or a part rises above the surface of the stratum, and frequently the great masses rise through whole series of strata, which meet them either in horizontal or variously inclined positions.

Granite, Sienite, Limestone, Quartz-rock, Trap, Serpentine, occur in imbedded masses, of all dimensions, and in every variety of form. Magnetic Iron-ore, Iron-pyrites, Copper-pyrites, Iron-glance, &c. also occur in irregular masses, in rocks of various descriptions.

IX. Arrangement of Mountain Rocks depending on their Structure.

1.

In the tabular arrangement of Rocks which follows, they are divided into Simple and Compound: The simple rocks are arranged according as they are Compact, Granular, or Slaty; the compound rocks are divided into Aggregated and Conglomerated; the aggregated into granular, slaty, porphyritic, and amygdaloidal, but the conglomerated do not require any subdivision. This scheme, although far from satisfactory, will, I trust, prove useful to the student. Suppose we meet with a compound mountain rock, and we wish to ascertain its name, we examine its structure; if it prove to be slaty, we look under the division Slaty, where we find arranged four kinds of rock. On referring to the short descriptions of these in the account of Primitive Rocks, we shall soon determine to which of the four our specimen belongs. In this manner all the determinations are to be made.

Tabular View of Rocks arranged according to Structure.

MOUNTAIN ROCKS.

1. Simple Mountain Rocks.

I. Compact †.

*

1. Limestone.
2. Chalk.
3. Oolite.
4. Marl.
5. Calc-tuff.

* *

6. Serpentine.
7. Fullers' Earth.

* * *

8. Wacke.
9. Basalt.

* * * *

10. Claystone.
11. Compact Felspar.

* * * * *

12. Pitchstone.
13. Obsidian.
14. Pearlstone.
15. Pumice.

* * * * * *

16. Clay, including Potter's, Common and Plastic clay.
17. Loam.

* * * * * * * *

18. Quartz.
19. Jasper.

* * * * * * * * *

20. Clay iron-stone.
21. Calamine.

* * * * * * * * * *

22. Coal.
23. Peat.

II. Granular.

1. Limestone.
2. Gypsum.
3. Quartz-rock.
4. Hornblende-rock.
5. Felspar.
6. Calc-sinter.

III. Slaty.

1. Clay-slate.
2. Chlorite-slate.
3. Talc-slate.
4. Potstone.
5. Alum-slate.
6. Drawing-slate.
7. Whet-slate.
8. Bituminous-shale.
9. Slate-clay.
10. Flinty slate.
11. Adhesive-slate.
12. Polier-slate.
13. Bituminous-marl-slate.
14. Hornblende-slate.
15. Tripoli.

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† Under this head we include all those rocks in which the fracture is compact, that is, which exhibit varieties of the earthy, uneven, even, conchoidal, or splintery fractures. These terms are explained in my Treatise on the Characters of Minerals.

2. Compound Mountain Rocks.

	a. Aggregated.	*b. Conglomerated.*
I. Granular.	1. Granite. 2. Syenite. 3. Protogine. 4. Whitestone. 5. Greenstone. * * 6. Quartz-rock. 7. Sandstone. * * * 8. Topaz-rock.	1. Conglomerate and many Sandstones. 2. Conglomerated Granite, Gneiss, Mica-slate, Clay-slate, porphyry, &c. 3. Grey-wacke and grey-wacke-slate. 4. Tuffa trap. claystone. volcanic.
II. Slaty.	1. Gneiss. 2. Mica-slate. 3. Greenstone-slate.	
III. Porphyritic.	1. Porphyry. 2. Porphyritic-granite, Syenite, Basalt, Greenstone, Gneiss, Mica-slate. 3. Trachyte.	
IV. Amygdaloidal.	1. Amygdaloid. 2. Amygdaloidal Porphyry, Greenstone, and Basalt.	

Short Characters of the Different Mountain Rocks.

It was my intention to have appended to the tabular view short characters of the different species of mountain rocks; but, on reviewing the descriptions already given in the preceding sheets, this did not appear necessary. We shall now only give the characters of those rocks which have not been already sufficiently described.

1. *Fullers' Earth.*—The colours of this rock are grey and green. It is dull on the fracture surface, which is fine-grained uneven, sometimes also conchoidal, and even inclining to

slaty. It is opaque. It becomes shining and resinous in the streak. It yields readily to the nail, and is sometimes nearly friable. It is sectile, adheres slightly to the tongue, and feels greasy. Specific gravity 1.72,—2.198.

Chemical Characters.—It falls into powder in water, without the crackling noise which accompanies the disintegration of bole.

Constituent parts.—Silica, 53.00; Alumina, 10.00; Magnesia, 1.25; Lime, 6.50; Muriate of soda, 0.10; Oxide of iron, 9.75; Water, 24.00. = 98.60.

2. *Alum-Slate.*—Of this rock there are two subspecies, viz. Common, and Glossy Alum-slate.

Common Alum-Slate.—Its colour is bluish-black. It occurs massive, and sometimes in roundish balls, which are imbedded in the massive varieties. Its lustre is more or less glimmering. Its fracture is straight slaty, and the fragments are tabular. It is opaque, and does not soil. It retains its colour in the streak, but becomes glistening. It is intermediate between soft and semi-hard. Specific gravity = 2.384.

Glossy Alum-Slate.—Its colour is nearly bluish-black, and sometimes exhibits on its surface tarnishes of various kinds. Its lustre, on the principal fracture, is semi-metallic, and is splendent, shining, or glistening. On the cross fracture it is dull or glimmering. The fracture is more or less curved slaty. In other characters, agrees with the common kind.

3. *Drawing-Slate or Black Chalk.*—Its colour is greyish-black. The lustre of the principal fracture is glimmering; of the cross fracture dull. The principal fracture is slaty; the cross fracture earthy. It is opaque. It writes and soils. It retains its colour in the streak, and becomes glistening. It is soft and sectile. It feels fine but meagre. Specific gravity = 2.111.

Constituent Parts.—Silica, = 64.06; Alumina, 11.00; Carbon, 11.00; Water, 7.20; Iron, 2.75.

4. *Whet-Slate or Hone.*—Its colours are grey and green. Internally it is feebly glimmering. The fracture in the large

is straight slaty; in the small splintery. The fragments are tabular. It is translucent on the edges. The streak is greyish white. It is soft, sometimes inclining to semi-hard. It feels rather greasy. Specific gravity, = 2.722.

X. Petrifactions, or Fossil Organic Remains found in Mountain Rocks.

Petrifactions, or fossil organic remains, have not been discovered in any rocks of the Primitive class. They first appear in Transition rocks, and afterwards more or less abundantly in the principal formations of the Secondary and Alluvial classes, but are of comparatively rare occurrence in Volcanic rocks. Their mode of distribution, physical condition, and geographical arrangement, do not enter into our present view, which is simply to enumerate in systematic order the Classes, Orders, and a few of the Genera and Species of these interesting remains. are mentioned by many [illegible]

older [illegible]

There in [illegible] remains [illegible]

Systematic View of Petrifactions.

Division I.—ANIMALS.

Class I.—ANTHROPOLITES.

Under this head we include the various remains of the human species found in a fossil situation. They are either complete skeletons or single bones, and seldom occur penetrated with any fossil matter, being generally merely changed by the action of the weather, or of percolating water. There are no authentic instances of anthropolites having been found in secondary rocks; these remains occurring only imbedded in alluvial substances of various descriptions, such as loam, clay, sand, peat, alluvial sandstone, &c *.

Quadrumanes. none have yet found

Class II.—MAMMALIA.

Order I.—CHIROPTERA.

The only known fossil animal which approaches to the order Chiroptera, or the bat tribe, is that described by Sömmering under the name *Ornithocephalus*.

It is conjectured to form one of a series of animals intermediate between the class Mammalia and the class Aves. In the scale of nature, its place appears to be between flying quadrupeds and birds, and certainly it is more nearly allied to birds than the famed ornithorynchus or duck-billed quadruped of New Holland. Two species have been described by Sömmering, viz. Ornithocephalus brevirostris and antiquus. These occur in secondary limestone, and, should they prove to belong to the order Chiroptera, will fall to be considered as among the oldest or earliest created of the land mammalia.

Order II.—DIGITATA.

Family Glires.

Cavia.

In the quarries of slaty limestone of Æningen there occur remains of a species of this genus which Cuvier conjectures to belong to the Cavia porcellus or Guinea pig, or more likely to an unknown species either of this tribe or of that entitled *Arvicola*.

Mus.

In the slaty limestone rocks at Walsch, in the circle of Saatz in Bohemia, there are fossil remains of a species of this tribe very nearly allied to the Mus terrestris.

* Human bones have been lately discovered in loam in gypsum caves, associated with remains of the rhinoceros, fossil horse, &c., a fact which goes to prove that the human species was in existence when these animals inhabited Europe and other temperate regions.

Family FERÆ.

Ursus. Bear.

1. *U. Spelæus.*—The size of a horse, and different from any of the present existing species.

2. *U. arctoideus.*—Is a smaller species, and appears also to be extinct. Both species are fossil, and remains of them are found in great abundance in limestone caves in Germany and Hungary. These caves vary much in magnitude and form, and are more or less deeply incrusted with calcareous sinter, which assumes a great variety of singular and often beautiful forms. The bones occur nearly in the same state in all these caves: detached, broken, but never rolled, and consequently have not been brought from a distance by the agency of water: they are somewhat lighter, and less compact than recent bones, but slightly decomposed, contain much gelatine, and are never mineralized. They are generally enveloped in an indurated earth, which contains animal matter; sometimes in a kind of alabaster or calcareous sinter, and by means of this mineral are sometimes attached to the walls of the caves. These bones are the same in all the caves hitherto examined; and it is worthy of remark, that they occur in an extent of upwards of 200 leagues.

Canis. Dog.

Of this genus several species are described as occurring in the caves already mentioned; one species very closely resembles the *Cape hyæna*, and is about the size of a small brown bear; another species is allied to the *dog* or *wolf*; and a third species is almost identical with the *common fox* *. A fossil species also resembling the common fox has been found in the gypsum quarries near Paris; and in the same formation there are fossil remains of a genus intermediate between *canis* and *viverra*. In the alluvial deposites there are remains of the *hyæna*.

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* Blumenbach has lately described the remains of a fossil hyæna, nearly resembling the *canis crocuta*, which was found in marl along with remains of the lion and the elephant, between Osterode and Herzberg in Hanover.

Felis. Cat.

One species of this tribe occurs in the limestone caves, and appears to be nearly allied to the *iaguar;* another species, nearly allied to the *tiger*, is found in alluvial soil along with fossil remains of the elephant, rhinoceros, hyæna, and mastodon.

Viverra. Weasel.

Two species of this genus occur in the limestone caves; the one is allied to the common *polecat*, and the other to the *zorille*, a polecat belonging to the Cape of Good Hope, Another species allied to the *ichneumon*, but double its size, occurs in the gypsum quarries around Paris.

Family BRUTA.

Bradypus. Sloth.

There are but two living species of the sloth tribe, the ai, or bradypus tridactylus; and the unau, or bradypus didactylus. Cuvier describes two fossil species which are nearly allied not only to these species, but also to the myrmecophaga or anteater. The following are the two fossil species:

1. *Megalonix.* It is the size of an ox, and its bones were first discovered in limestone caves in Virginia, in the year 1796. 2. *Megatherium.* This species is the size of the rhinoceros, and its fossil remains have hitherto been found only in South America. Another species [illegible] with the [illegible]

ORDER III.—MARSUPIALIA.

Didelphis. Opossum.

One species of this extraordinary tribe of animals has been found in a fossil state in the gypsum quarries near Paris. It does not belong to any of the present existing species, and is therefore considered as extinct. Cuvier remarks, that as all the species of this genus are natives of America, it is evident that the hypothesis advanced by some nuturalists, of all the fossil organic remains of quadrupeds having been flooded from Asia to northern countries, is erroneous.

Order IV.—SOLIDUNGULA.

Equus. Horse.

Equus adamiticus; Equus Caballus?

Fossil remains of a species of horse are found in alluvial soil, in different parts of Europe, associated with those of the elephant, rhinoceros, hyæna, mastodon and *tiger?* Cuvier confesses that he is not in possession of any means of ascertaining the species of horse to which they belong. It is conjectured by some naturalists, that they may belong to the equus caballus, the common horse; by others that they are remains of an extinct species larger * than the present, and which lived in Europe at the same time with the elephant, rhinoceros, &c.

Order V.—BISULCA.

Cervus. Deer.

1. *Alce gigantea,* Blumenbach.—*Fossil Elk of Ireland.*—This is the most celebrated of all the fossil ruminating animals. It is a different species from any of those at present known to live on the earth's surface, and may therefore be considered as extinct. It was first found in Ireland, where it generally occurs in shell-marl and in peat-bogs. It has also been found in superficial alluvial soil in England, Germany, and France. A magnificent and perfect skeleton of this species lately dug up in the Isle of Man, has just reached the Royal Museum of the University of Edinburgh, an account of which will appear in the first part of the fourth volume of the Memoirs of the Wernerian Society.

2. *Fossil Roe Deer.*—Horns and skulls of an animal nearly allied to the common roe of this country, are found in peat-bogs.

3. *Fossil Red-Deer or Stag.*—This species resembles the red-deer or stag. Its horns are found abundantly in peat-bogs, or sand-pits, in Scotland, England, France, Germany and Italy.

* The teeth of the fossil horse are considerably larger than those of the living species.

Bos. Ox.

1. *Aurochs.*—This species Cuvier considers as distinct from the common ox, and differs from the present existing varieties in being larger. Skulls and horns of this species have been found in alluvial soil in England, Scotland, France, Germany, and America.

2. *Common Ox.*—The fossil skulls of this species differ from those of the present existing races, in being larger, and the direction of the horns being different. They occur in alluvial soil in many different parts of Europe, and are considered by Cuvier as belonging to the original race of the present domestic ox.

3. *Large Buffalo of Siberia.*—The fossil skull of this animal is of great size, and appears to belong to a species different from any of those at present known. It is not the common buffalo, nor can it be identified with the large buffalo of India, named *arnée.* Cuvier conjectures that it must have lived at the same time with the fossil elephant and rhinoceros, in the frozen regions of Siberia.

4. *Fossil Ox, resembling the Musk Ox of America.*—The fossil remains of this species more nearly resemble the American musk ox, than any other species, and have hitherto been found only in Siberia.

Order VI.—MULTUNGULA.

Rhinoceros.

1. Rhinoceros antiquitatis.—*Blumenbach.*

Four species of this genus are at present known to naturalists, as inhabitants of different parts of the world. These are two species of two-horned rhinoceros of Africa, the one-horned rhinoceros of Asia, and the rhinoceros of the Island of Sumatra. Only one fossil species has hitherto been discovered, which differs from the four living species, not only in structure, but in geographical distribution. It was first noticed in the time of Grew; and the bones he mentions were dug out of alluvial soil near Canterbury. Since that period, similar remains have been found in a limestone cave near Plymouth, and in different places of Germany, France, and Italy. In Siberia, not only single bones and skulls, but the whole animal, with the flesh and skin, have been discovered.

2. *Hippopotamus.*

Only one species of this genus is at present known to live on the surface of the earth. It is an inhabitant of Africa; and, according to Marsden, also of Asia: for he mentions it as one of the animals of the Island of Sumatra. Two fossil species have been ascertained by Cuvier. The larger is so very nearly allied to the species at present living on the surface of the earth, that it is difficult to determine whether or not it is not the same. Its fossil remains have been found in alluvial soil in France and Italy. The smaller is well characterised, the animal not being larger than a hog, and entirely different from any of the existing species of quadrupeds.

3. *Tapir.*

The tapir was at one time considered as a genus peculiar to the new world; but the specimen of Tapir from India, now in the Royal Museum of Edinburgh, proves that it also occurs in the old world. The Indian species is smaller than the American. Two fossil species of this genus, different from the living species, have been discovered in alluvial soil in different parts of Europe; and one of these appears to have been as large as the elephant.

4. *Fossil Elephant or Mammoth.*

Elephas primigenus.—*Blumenbach.*

Of this genus, two species are at present known as inhabitants of the earth. The one, which is confined to Africa, is named the African elephant; the other, which is a native of Asia, is named the Asiatic elephant. Only one fossil species has hitherto been discovered. It is the *mammoth* of the Russians. It differs from both the existing species, but agrees more nearly with the Asiatic than the African species. Its bones have been found in many different parts of this island;

as in the alluvial soil around London; in the county of Northampton, at Gloucester, at Trenton, near Stafford, near Harwich, at Norwich, in the Island of Sheppy, in the river Medway, in Salisbury Plain, in Flintshire in Wales, in Ayrshire and West Lothian; and similar remains have been dug up in the north of Ireland. Bones of this animal have been dug up in Sweden; and Cuvier conjectures that the bones of supposed giants, mentioned by the celebrated Bishop Pontoppidan, as having been found in Norway, are remains of the fossil elephant. Torfæus mentions a head and tooth of this animal, dug up in the Island of Iceland. In Russia in Europe, Poland, Germany *, France, Holland, and Hungary, teeth and bones of this species of elephant have been found in abundance. Humboldt found teeth of this animal in North and South America: and I have in my possession a grinder found in the new world, high on the stoney mountains near the source of the river Saskashanan, by Mr Auld, late Governor of that country. But it is in Asiatic Russia that they occur in greatest abundance. Pallas says, that, from the Don or the Tanais to Tchutskoinoss, there is scarcely a river, the bank of which does not afford remains of the mammoth; and these are frequently imbedded in, or covered with, alluvial soil, containing marine productions. The bones are generally dispersed, seldom occurring in complete skeletons, and still more rarely do we find the fleshy part of the animal preserved, as was the case in the carcass found on the shores of the Asiatic arctic ocean, by Mr Adams.

5. *Sus. Hog.*

Sus scrofa.

Only single bones and teeth of this tribe have been hitherto met with, and these appear to belong partly to the Sus scrofa, or common hog, and partly to some race or species different from the present. They are found in peat-mosses, marl-pits, and in other very new alluvial deposites.

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* In Germany alone, there have been found above one hundred skeletons of the fossil elephant, generally in varieties of calc-tuff and loam, which appear to have been formed by previously existing lakes.

6. *Mastodon*.

This is entirely a fossil genus, no living species having hitherto been discovered in any part of the world. It is more nearly allied to the elephant than to any other animal of the present creation. It appears to have been a herbivorous animal; and the largest species, the *great mastodon* of Cuvier, to have been equal in size to the elephant. Five species are described by Cuvier.

1. *Mammuth Ohioticum*, Blumenb.—*Great Mastodon.—Mammoth of the Americans.*—This species has been hitherto found in greatest abundance in North America, near the river Ohio, and remains of it have been also dug up in Siberia. It has been frequently confounded with the mammoth or fossil elephant, and in North America it is named Mammoth. It is not, as was formerly supposed, a carnivorous animal, but is herbivorous.

2. *Mastodon with narrow Grinders.*—The fossil remains of this species have been dug up at Simorre, and many other places in Europe, and also in America.

3. *Little Mastodon with small Grinders.*—This species is much less than the preceding, and was found in Saxony and Montabusard.

4. *Mastodon of the Cordilleras.*—This species was discovered in South America by Humboldt. Its grinders are square, and it appears to have equalled in size the great mastodon.

5. *Humboldien Mastodon.*—This, which is the smallest species of the genus, was found in America by Humboldt.

7. *Palæotherium* *.

This is a new and entirely fossil genus, of the order multungulata, which occurs in the rocks of the Paris formation, and also in alluvial soil. Cuvier describes ten species, some of which equal the rhinoceros in magnitude, while others are not larger than the sheep.

* Palæotherium signifies ancient large animal, or beast.

8. *Anoplotherium* *.

The species of this genus are entirely extinct, and vary in size from that of the horse to the Guinea pig.

ORDER VII.—PALMATA.

Family GLIRES.

Castor. Beaver.

Fossil remains of the Castor fiber, or common beaver have been found in beds of shell marl in Loch Marlee, in the parish of Kinloch in Perthshire, and in a similar situation in the estate of Kimmerghame in the parish of Edrom, near the head district of Berwickshire called the Merse. The skull found in Berwickshire is preserved in the Royal Museum of Edinburgh. An account of the Fossil Beaver of this country has been published by Mr P. Neill, in the 3d volume of the Memoirs of the Wernerian Society.

Family FERÆ.

Phoca. Seal.

The remains of a species of seal nearly three times the size of the common seal, or Phoca vitulina, have been found in the coarse marine limestone of the department of the Maine and Loire. Another species of this genus, but somewhat less than the common, is also described by Cuvier, as occurring in the same limestone.

Family BRUTA.

Lamantin.

Two species of this remarkable genus have been found imbedded in the coarse marine limestone of the department of the Maine and Loire.

* Anoplotherium signifies beast without weapons; thus referring to its distinguishing character its want of canine teeth.

Order VIII.—CETACEA.

Balæna. Whale.

The entire skeleton of a whale, seventy-two feet in length, now in the Royal Museum of Edinburgh, was found at the depth of four feet and a-half, in a bed of clay under peat, at the foot of the Ochil hills. According to measurement, this skeleton was imbedded in the clay about twenty feet above the surface of the present highest tides in the river Forth. Mr Bald, Civil Engineer, has published a short account of it in the Edinburgh Philosophical Journal. Cortesi found a complete skeleton of a whale near Pulgnasco in Italy, in a bed of black marine clay.

General Observations.—Of the true mammalia, the oldest or first formed, appear to be those of a marine nature, such as seals and lamantins, because these are the first met with in our secondary rocks, while the terrestrial mammalia do not appear until the period of the formation of the fresh water series of rocks above chalk. Of these land quadrupeds, the oldest are the Palæotherium and Anoplotherium: next in the order of formation are the elephant, rhinoceros, mastodon, &c. All the other remains found along with these latter, are either unknown, or at least doubtful. Those fossil mammalia that appear to agree with the presently existing, occur only in the newest alluvia, in the bottoms of marshes and of lakes, on the sides of rivers, and sometimes in the fissures and caves of some rocks, and even in the soil itself.

Class III.—AVES.

Fossil remains of unknown birds have been met with in the secondary limestone of Sohlenhoff, Pappenheim, Œningen, and in the Heinberg near Göttingen.

Sturnus. Starling.

Fossil remains of species of this genus occur in the secondary formations around Paris.

Coturnix. Quail.

Bones of this tribe of birds have been found in the secondary strata near Paris.

Sterna. Tern.

Bones of terns are occasionally found along with those of the quail in the Parisian strata.

Gallinæ.

Bones of a gallinaceous bird, nearly resembling the domestic fowl, have been found in loam in gypsum caves in Germany,—a fact, which proves that Europe formerly possessed a species of gallus, but different from the present, which is originally a native of India.

Grallæ. Wadders.

Bones of birds resembling those of the order grallæ have been found near Paris inclosed in the solid rocks.

Pelecanus. Pelican.

Bones nearly resembling those of the pelican tribe occur in the Paris formations.

Observations.—Ornitholites or fossil remains of birds are of rare occurrence in secondary rocks, and in alluvial strata are found principally in a bleached state in the newer formations.

CLASS IV. AMPHIBIA.

ORDER I. REPTILES.

Testudo. Tortoise.

Fossil remains of this tribe are met with in different parts of Europe. Thus, fossil marine tortoises, of unknown species, are found imbedded in coarse marine limestone at the village of Melsbroeck, in the environs of Brussels; and remains of the same description occur in the coarse chalk or limestone of the hill of Saint Peter, near Maestricht. They are irregularly distributed throughout the rock, along with different marine productions, and bones of the gigantic monitor.

Remains of a marine, but unknown species of tortoise were found in the limestone slate of Glaris; and unknown species have also been dug out of the rocks of a formation analogous to that around Paris, situated in the vicinity of Aix. The gypsum quarries near Paris, which are so remarkable on account of their geognostical relations, have afforded specimens of fresh water tortoises. in the Isle of Sheppy

Crocodilus. Crocodile.

Two extinct species of fossil crocodiles, nearly allied to the gavial (Lac. gangeticus) or gangetic crocodile, occur in a pyritical bluish-grey compact limestone, at the bottom of the cliffs of Honfleur and Havre; and one of these species at least is found in other parts of France, as at Alençon and elsewhere *. It would also appear that the skeleton of a crocodile, discovered at the bottom of a cliff of pyritical slate, about half a mile from Whitby, by Captain William Chapman, probably belongs to one of these species. And it may further be remarked, that the fragments of heads of crocodiles found in the Vicentine, may be referred to the same species, while the fossil heads found at Altorf, are different from those of the gavial, and have a longer snout than that of the animal of Honfleur, and may therefore belong to the other fossil species found in France. The remains of an unknown species of fossil crocodile was found near Newark, in Nottinghamshire, by Dr Stukely; and the supposed crocodiles found along with fish in the copper-slate, or bituminous marl-slate, of Thuringia, are reptiles of the genus Monitor.

Monitor.

In the well-known quarries of Maestricht there occur remains of a large fossil monitor lizard. This species, which is

* Cuvier describes bones of a crocodile found in the slaty limestone of Altorf, which had been considered as remains of the human species.

Sir Everard Home has described, in the Transactions of the Royal Society of London for the year 1814, the fossil remains of an animal possessing characters partly of the crocodile, partly of the species of the class of fishes. It was found in a blue-coloured clayey limestone, named *Lias*, on the estate of Henry Host Henley, Esq., between Lyne and Charmouth, in Dorsetshire.

one of the most celebrated of all the fossil species of oviparous quadrupeds, occurs in a soft limestone which contains flint, and the same kinds of petrifactions as are observed in the chalk near Paris. Even so early as the year 1766 it had engaged the attention of enquirers, and up to the present day has not ceased to be an object of discussion and investigation among naturalists. Some have described it as a crocodile, others as a whale; and it has even been arranged along with fishes. Cuvier, after a careful study of its osteology, ascertained that it must have formed an intermediate genus between those animals of the lizard tribe, which have a long and forked tongue, and those which have a short tongue and the palate armed with teeth. The length of the skeleton appears to have been nearly twenty-four feet. The head is a sixth of the whole length of the animal; a proportion approaching very near to that of the crocodile, but differing much from that of the monitor, the head of which animal forms hardly a twelfth part of the whole length. The tail must have been very strong, and its width at its extremity must have rendered it a most powerful oar, and have enabled the animal to have opposed the most agitated waters. From this circumstance, and from the other remains which accompany those of this animal, Cuvier is of opinion that it must have been an inhabitant of the ocean. We have here, then, an instance of an animal far surpassing in its size any of the animals of those genera to which it approaches the nearest in its general characters; at the same time, that, from its accompanying organic remains, we find reason to believe it to have been an inhabitant of the ocean, whilst none of the existing lizard tribe are known to live in salt water. However remarkable these circumstances are, still they are not more wonderful than those we contemplate in many of the numerous discoveries in the natural history of the ancient world. We have already seen a tapir of the size of an elephant; the megalonix, an animal of the sloth tribe, as large as a rhinoceros; and here we have a monitor possessing the magnitude of a crocodile.

Salamandra. Salamander.

In the valley of Altmühl, near Aichsted and Pappenheim, and also at Œningen, there is a formation of calcareous slate rich in petrifactions. One of the most remarkable of these is that described by Scheuchzer, under the name "Homme Fossile," and which some naturalists maintained to be the Siluris glanis of Linnæus, but which is, in reality, nothing more than an unknown, and probably extinct species of salamander or proteus. It was found imbedded in the limestone of Œningen.

Bufo. Toad.

Fossil remains of an animal of this tribe occur in the slaty limestone of Œningen. Dr Karg, who has published a long description of the Œningen quarries, is of opinion, that this petrifaction is that of a common toad; whereas Cuvier is inclined to refer it to some species nearly allied to the bufo calamita.

Class V. PISCES.

Cuvier mentions in a very general way, the few genera of fossil fishes met with in the gypsum quarries around Paris. Five species are enumerated. The first described belongs to a new genus allied to that named *amia*, and is conjectured to be a fresh-water species. The second is nearly allied to two fresh-water genera, viz. the *mormyrus* of La Cepede, natives of the river Nile, and the *pæcilia* of Bloch, natives of the fresh waters of Carolina. The third appears to be a species of *sparus*, different from any of the present species. The fourth and fifth are very dubious.

La Cepede describes thirty species, partly of marine, partly of fresh-water fishes, found in the limestones of Bolca and Pappenheim, and in the bituminous marl-slate of Hessia. Several of these nearly resembles living species, but no absolute identity has been proved.

Vertebræ, teeth and scales of fishes are met with in second-

The teeth of sharks are found in [illegible] plenty
[illegible]

ary limestone, newer sandstone, chalk, and in various alluvial formations.

Class VI. INSECTA.

Various fossil remains of animals of this class have been drawn and described by naturalists.

Gamarrholites, or Petrified Crabs.

Several tribes of this order have been found in a fossil state, but are to be considered as of comparatively rare occurrence. They are met with in the Jura limestone, also in other newer limestones, as in chalk; and fine specimens are found in alluvial districts. In the works of Herbst, Catesby, Rumphius, and Rösel, there are many figures which resemble petrified species of crabs, but none of them are identical with the fossil kinds.

Trilobites.

This remarkable fossilized animal, which was named *Entomolithus* by Linnæus, is referred by some writers to the class Mollusca, by others to the present class Insecta. Data are still wanting for enabling us to give it its true place; in the mean time, it is here arranged with the Insecta, from its near resemblance to those animals in several of its characters. It occurs in transition limestone and slate in Norway and Sweden; in limestone at Dudley, and hence is sometimes named the *Dudley fossil;* in limestone in Derbyshire; and in fullers' earth in other parts of England.

Insects in Limestone.

The more perishable kinds of insects rarely occur in a fossil state. Schroeter gives an account of the impression of a butterfly in the limestone-slate of Sohlenhoff, which he refers to the Linnæan generis Sphinx, and says was as large as the species termed *ligustri.* The same author also describes the impression of an insect resembling the genus Cerambyx, Lin.

and enumerates specimens in his cabinet of species of the genus Bombilio, Lin., and impressions of larvæ of insects of the genera Phryganea, or Ephemera, all found in the limestone of Sohlenhorff. Impressions, and even petrified insects, are found in the limestone of Œningen.

Insects in Coal.

Petrified insects of the genus Hydrophylus Fabric. are sometimes found in the brown coal of France; and fossil remains of the genus Carabus, Lin. occur in the brown coal of Hessia.

Insects in Amber.

Amber frequently incloses insects of various descriptions. Accounts of these have been published at different times by collectors, but, in general, in so loose a manner, as to render a revisal of nearly the whole of them absolutely necessary, in order to enable us to judge with certainty of the species. Species of the genera Cimex, Blatta, Tenthredo, Cynips, Ichneumon, Formica, Termes, Tipula, Culex, Empis, Musca, Lepisma, Phalangium, and Aranea, are enumerated by authors as occurring in amber.

Class VII. MOLLUSCA.

In this class are included all the different tribes of fossil shells, but these are so numerous that we cannot venture to enumerate them in this sketch.

Class VIII. CRUSTACEA.

The different tribes of petrified Asterias or star-fish, of Echinus or sea-urchin, and of Encrinus, are arranged in this class.

Class IX. CORALLIA.

All the fossil corals, and other bodies of the same general description, are included in this class. The following are the genera enumerated by naturalists:

1. Isitolites.	8. Hypurites.
2. Corallinites.	9. Madreporites.
3. Keratophytes.	10. Milleporites.
4. Escharites.	11. Tubiporites.
6. Fungites.	12. Spongites.
7. Porpites.	13. Alcyonites.

Division II.—PLANTS.

From the imperfect state of the fossil remains of vegetables, it is very difficult to classify and describe them. Many naturalists still follow the old method of arranging them under the names Phytolites, Bibliolites, Carpolites, &c. which were given to them in the 16th century. Mr Parkinson divides them in the following manner: 1. Fossil trees *; 2. Fossil plants †; 3. Fossil roots ‡; 4. Fossil stalks; 5. Fossil leaves ‖; 6. Fossil fruits and seed-vessels §. Schlotheim, in his Petrefactenkunde, adopts a better mode of arrangement, of which the following is an outline.

I. Dendrolites.

1. *Lithoxylites.* Different kinds of petrified wood.

2. *Lithanthracites.* Wood more or less completely changed into coal.

3. *Bibliolites.* Petrified leaves.

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* Phytolithi arborum of Linnæus, Lithoxyla of Wallerius, and Stelechites and Dendrolithes of others.

† Phytolithi plantarum of Linnæus, and Plantæ petrificatæ of Wallerius.

‡ Rhizolithi of Wallerius.

‖ Lithophylla of Wallerius.

§ Carpolithi of Wallerius, and Spermolithi of others.

2. *Botanolites.*

Under this division are included those fossil plants which cannot be included under any of the preceding divisions; such are the fine examples of chara in calc-tuff, &c.

3. *Phytolites.*

1. *Palmacites.* Plants of the palm tribe.
2. *Casuarinites.* Plants resembling the casuarina tribe.
3. *Calamites.* Plants of the reed tribe.
4. *Filicites.* Plants of the fern tribe.
5. *Lycopodiolites.* Plants of the lycopodium tribe.
6. *Poacites.* Plants of the poa tribe.

4. *Carpolites.*

Under this division are included the different kinds of fossil fruits and seeds.

5. *Anthotypolites.*

Fossil impressions of the flowers of plants are of rare occurrence, and these belong to the present division.

In arranging and describing fossil vegetables, we cannot use the methods of botanists, because the stamina, cotyledons, &c. never occur. In many cases, the bark affords us excellent characters; in others, the form and arrangement of the leaves. In using the bark as a character in the arrangement and determination of fossil vegetables, we find that the spiral arrangement of the scales or tubera around the stem afford general characters for the families; and the differences of their form, the number of their glandulæ, &c. enable us to determine the species. The following tabular view of the characters of several of the fossil trees and reeds of the coal formation of this country, as given by Count Sternberg in his Flora of a Former World, will shew the degree of certainty to be obtained by following this method of determination.

Tentamen Classificationis Systematicæ Plantarum Primordialium.

Familia I. Lepidodendron *.

Character essentialis.—Caudex squamatus, squamis foliiferis caudicem spiraliter ambientibus.

Conspectus familiæ.—Tribus 1. (Lepidotæ) squamis convexis.

A. Scutatæ, 7.
B. Escutatæ, 1.

Tribus 2. (Alveolariæ) squamis subconcavis, 3.

Tribus I. Lepidotæ squamis convexis.

A. Scutatis.

1. Lepidodendron *dichotomum.* Caudice arboreo, a medio dichotome ramoso, squamis inferioribus obovatis, superioribus rhomboidalibus, medio scutatis, scutis ad insertionem foliorum glandulis tribus horizontaliter notatis. Foliis angustis linearibus, 12—18 policum longitudine. Sternberg, Flora der Vorwelt, t. i. ii. iii. Burntisland, Fifeshire.

2. Lepidodendron *obovatum.* Caudice arboreo, squamis obovatis inferne attenuatis seu decurrentibus, medio linea verticali ad scutum usque divisis glandula una in utroque latere, scuto palæformi venoso. Id. t. vi. f. 2. et viii. f. 1. B. a. et b. Near Bradford, in Yorkshire.

3. Lepidodendron *aculeatum.* Caudice arboreo, squamis sub-rhomboidalibus margine revolutis, costa media aculeata, glandula una in utroque latere, scuto transverse rhomboidali, glandulis tribus horizontaliter notato. Id. t. vi. f. 2. et t. viii. f. 1. B. a. et b.

4. Lepidodendron *crenatum.* Caudice arboreo, squamis sub-rhomboidalibus, utrinque acuminatis, costa media crenata, glandula una in utroque latere, scuto triangulari eglanduloso. Id. t. viii. f. 2. A. a. et b.

5. Lepidodrendron *rimosum.* Caudice arboreo, cortice inter squamas distantes rimoso, squamis lanceolatis utrinque at-

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* From λεπις, *squama,* and δενδρος, *lignum.*

tenuatis nudis, glandula unica sub scuto transverse rhomboidali, glandulis scuti oblitteratis. Id. t. x. f. 1.

6. Lepidodendron *undulatum.* Squamis rhomboidalibus continguis dextrorsum spiraliter imbricatis undulato-lineatis, scuto orbiculari lineæ mediæ insidente, uni glanduloso. Id. t. x. f. 2. Near Bradford, in Yorkshire.

7. Lepidodendron *laricinum.* Caudice arboreo, squamis imbricatis, arcuatis, (in planta fossili) plerumque laceris, scuto transverse rhomboidali, glandulis tribus horizontaliter notato. Id. t. xi. f. 2, 3, 4. Midlothian coal-field.

B. Squamis escutatis.

8. Lepidodendron *punctatum.* Caudice arboreo, squamis obovatis, acuminatis margine inferiore septem punctatis, medio (ad insertionem petioli trigoni?) in figuram, forficum tonsorum excisis. Id. t. iv. et t. viii. f. 2. A. a. b.

Synonima ad hanc tribum spectantia denuo inquirenda.

Cylindrus lapideus Byerleus compressior echini facie, acetabulis majoribus oblongis e puteis carbonariis prope Byerley in Yorkshir. Petiv. gaz. nat. et art. dec. 2da, t. xvi. f. 1.

Schistus Byerleus caucaloides, ibid. t. xxii. f. 12.

Schistus pinoides major et minor, ibid. t. xxxv. f. 9, 10.

Volkmann, Sil. subt. t. xv. f. 4.

Strobilus laricinus ejusdem, p. 127, t. xxiv. f. 4. Forte ic. nost. t. xi. f. 2. a pictore ob similitudinem squamarum in figuram strobili coacta et app. t. iv. f. 4, 5, 6.

Morand, die Kunst auf Steinkohlen zu bauen, t. vi. f. 5. t. viii. f. 3, 4, 5, 6. ex Museo D. Bomar, et t. ix. f. 5, 6.

Tribus II. Alveolariæ squamis subconcavis.

9. Lepidodendron *alveolare.* Caudice arboreo, squamis minutis subconcavis subrotundo ovatis, ad basim glandulis tribus horizontaliter notatis. Sternberg, Flora, t. ix. f. 1. a. et b.

10. Lepidodendron *trigonum.* Caudice arboreo, squamis subconcavis trigonis, glandulis tribus in medio squamarum. Id. t. xi. f. 1.

Knorr. L. cit. i. t. x. c. f. 1. exemplar defectuosum squamis oblitteratis. Morand. 1. cit. t. vi. f. 3. ic. mala glandulis deficientibus.

11. Lepidodendron *hexagonum.* Caudice arboreo, squamis subconcavis perfecte hexagonis, glandula unica? in medio squamarum. Knorr. Lap. Dil. test. t. i. t. x. a. f. 1.

Morand. i. cit. t. ix. f. 2.

Inquirenda Knorr i. cit. t. x. a. f. 2.

II. Variolariæ.

Character essentialis. — Caudex scutatus seu verrucosus scutis foliiferis caudicem spiraliter ambientibus.

1. Variolaria *ficoides.* Caudex arborescens, diametri 2—4 policum, alterne ramosus, scutis orbicularibus ad insertionem foliorum uni glandulosis, foliis lineari-lanceolatis, basi cuneata coarctatis 4—6 policum longitudinis. Sternberg, Flora, t. xii. f. 1, 2, 3. Midlothian coal-field, and Fifeshire.

Synonima Auctorum.

Cylindrus lapideus Byerleus, compressior echinite laticlavii maximi facie acetabulis, rotundis e puteis carbonariis prope Byerley in Yorkshire. Pet. gaz. dec. ii. t. xviii. f. 11.

Lythophyllon, opuntiæ majoris. Volkm. Sil. subt. p. 106. t. xi. f. 1.

Schistus variolis depressis, schistus variolis elevatis. Morand. L. cit. t. ix. f. 3, 4.

III. Calamitæ.

Character essentialis. Caudex striatus ad internodia suturis interceptus.

1. Calamitis *pseudo-bambusia.* Caudex arboreus lineis parallelis striatus, ad internodia secundum magnitudinem plantæ plus minus distantia, suturis interceptus. Sternberg, Flora, t. xiii. f. 3. Midlothian and Fifeshire coal-fields.

Synonima auctorum plures forte species includentia denuo indaganda.

Calamitæ. Valch. Lapid. Dil. test. t. iv. suppl. p. 148. t. i. ii. iii. f. 3. t. iii. f. 1—4. t. iii. b.

Arundini saccharinæ germanicæ similis. Valk. Sil. subt. p. 110. t. xiii. f. 7.

IV. Syringodendron.

Character essentialis.—Caudex arboreus, fistularum sibi invicem aglutinatarum forma, glandulis nudis, caulem spiraliter ambientibus.

1. Syringodendron *organum.* Caudice arboreo, fistulis latioribus, glandulis integris. Sternberg's Flora, t. xiii. f. 1. Fifeshire.

2. Syringodendron *pes-capreoli.* Caudice arboreo, fistulis angustioribus, glandulis duabus conjugatis, vel una divisa. Id. t. xiii. f. 2.

Synonima Auctorum comparanda.

Knorr, Lap. Dil. test. t. i. t. x. c. f. 2, 3.
Knorr, 1. cit. t. x. b. f. 1. t. x. a. f. 3. t. x. c. f. 4.
Volkm. Sil. subt. app. t. iv. f. 2.
Morand. t. vi. f. 1, 2, 4.

Fossil Organic remains are those included [illegible]
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DESCRIPTIONS OMITTED.

1. Adhesive Slate.

Klebschiefer, *Werner*.

External Characters.—Colours grey and white. Occurs massive. Internally dull. Fracture straight, and thick or thin slaty. Fragments tabular. Soft, passing into very soft. Sectile. Feels slightly greasy. Adheres strongly to the tongue. Sp. gr. = 2.080, *Klaproth*.

Chemical Characters.—Infusible before the blowpipe.

Constituent Parts.—Silica, 58.0; Alumina, 5.0; Magnesia, 6.5; Lime, 1.5; Iron and Manganese, 9.0; Water 19.9, = 100, *Bucholz*.

Geognostic Situation.—Occurs in beds in secondary gypsum above chalk, and frequently contains imbedded menelite.

Geographic Situation.—Occurs in the Paris Formation, near Paris.

2. Arsenical Silver.

Arsenik-Silber, *Werner*.

External Characters.—Colours on the fresh surface tin-white, which soon tarnishes greyish-black. Occurs massive, reniform, and in lamellar concretions. Internally glistening, and metallic. Fracture uneven.

Constituent Parts.—Arsenic, 35.00; Iron, 44.25; Silver, 12.75; Antimony, 4.0; = 96.00, *Klaproth*.

Geognostic and Geographic Situations.—Occurs in primitive and also in transition rocks in Germany and Spain.

3. Native Magnesia.

External Characters.—Colour snow-white, passing occasionally into greenish-white. Occurs in coarse granular and prismatic concretions, and in regular six-sided prisms. Lustre pearly and shining; alternates from transparent to translucent. It adheres slightly to the tongue. Hardness = 1,—1.5. Sp. gr. = 2.13,—2.33.

Chemical Characters.—Dissolves entirely in muriatic, sulphuric, and nitric acids.

Constituent Parts.—Magnesia, 70.0; Water, 30; =100.

Geognostic and Geographic Situations.—Occurs in veins in serpentine at Portsoy, and in serpentine in Shetland.

4. Corneous Lead.

Hornblei, *Werner.*

External Character.—Colours white, grey, and pale wine-yellow. Occurs crystallized in oblique four-sided prisms. Internally splendent, and lustre adamantine. Threefold cleavage, the cleavages parallel with the planes of the prism. Fracture conchoidal. More or less transparent. Rather softer than white lead-spar. Sectile, and easily frangible. Sp. gr. = 6.065, *Chenevix.*

Chemical Characters.—On exposure to the blowpipe on charcoal, it melts into an orange-coloured globule, and appears reticular externally, and of a white colour when solid; when again melted it becomes white; and on encrease of the heat, the acid flies off, and minute globules of lead remain behind.

Constituent Parts.—Oxide of Lead, 85.5; Muriatic Acid, 8.5; Carbonic Acid, 6.0; = 100, *Klaproth.*

Geognostic and Geographic Situations.—Occurs in Cromford Level, near Matlock, in Derbyshire; and has also been met with in Germany, and in North America.

5. Arseniate of Lead.

It is divided into three kinds, viz. Reniform, Filamentous, and Earthy.

1. *Reniform Arseniate of Lead.*

External Characters.—Colour on the fresh fracture reddish-brown and brownish-red; externally ochre-yellow and straw-yellow. Occurs reniform and tuberose; also in curved lamellar concretions. Internally shining and resinous. Fracture conchoidal, sometimes inclining to even and uneven. Opaque. Soft, and brittle. Sp. gr. = 3.933.

Chemical Characters.—It is insoluble in water. Before the blowpipe on charcoal, it gives out arsenical vapours, and is more or less perfectly reduced. It colours glass of borax lemon-yellow.

Constituent Parts.—Oxide of Lead, 35.0; Arsenic Acid, 25.0; Water, 10.0; Oxide of Iron, 14.0; Silver, 1.15; Silica, 7.0; Alumina, 2.0; = 95.15.

Geognostic and Geographic Situations.—Occurs at Nertschinsky, in Siberia.

2. *Filamentous Arseniate of Lead.*

External Characters.—Colours green and yellow. Occurs massive, in granular concretions, and either in small acicular six-sided prisms, which are collected into flakes, or in very delicate capillary silky fibres, which are transparent, slightly flexible, and easily frangible. Sp. gr. = 5.0,—6.4.

Constituent Parts.—Oxide of Lead, 69.76; Arsenic Acid, 26.4; Muriatic Acid, 1.58; = 100, *Gregor.*

Geographic Situation.—Occurs in the mine of Huel Unity in Gwennap, and in other mines in Cornwall.

3. *Earthy Arseniate of Lead.*

External Characters.—Colour yellow. Occurs in crusts. Fracture earthy. Friable. Sp. gr. = 5.6.

Geognostic and Geographic Situations.—Occurs along with filamentous arseniate of lead at St Prix, and also near St Oisans, in France.

6. Tripoli.

Tripel, *Werner.*

External Characters.—Colours grey, white, and yellow. Occurs massive, and in whole beds. Internally dull. Fracture sometimes fine, sometimes coarse, earthy; and in the great inclines to slaty. Opaque. Soft, sometimes passing into very soft. Not very brittle, and rather easily frangible. Feels meagre, and rather rough. Does not adhere to the tongue. Sp. gr. = 2.02, *Bucholz.*

Chemical Characters.—It is infusible before the blowpipe.

Constituent Parts.—Silica, 4; Alumina, 86; Carbon, 10; = 100. *Phillips.*

Geognostic and Geographic Situations.—Occurs in beds in coal-fields; also in beds in secondary limestone, alternating with clay, under secondary trap. It is found at Bakewell, in Derbyshire, where it is named *Rotten Stone.*

Uses.—On account of the hardness of its particles, it is used for polishing stones, metals, and glasses of different kinds.

7. Native Minium, or Native Red Oxide of Lead.

External Characters.—Colour scarlet-red. Occurs massive, and pulverulent; but when examined by the lens, exhibits a crystalline structure, like that of galena, on which it generally rests.

Chemical Characters.—Before the blowpipe, on charcoal, it is first converted into litharge, and then into metallic lead.

Geographic Situation.—It is found in Grassington Moor, Craven; Grasshill Chapel, Wierdale, Yorkshire.

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